Using Online Assessments in the Age of Covid-19: An Exploratory Study of Cognitive Load in Higher-Education Teachers

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Abstract

Cognitive load is based on the principle that working memory is limited in its capacity to hold and store information. The demands of assessment on teachers; designing, implementing, and providing feedback to students, may create a strain on working memory. With the onset of the Covid-19 pandemic, post-secondary systems world-wide shifted teaching, learning and assessments to online platforms. Considering the sudden shift from in-person to online modes, this paper explores cognitive load in higher-education teachers who use online assessment in a pandemic context, to answer two research questions; What is the process of using online assessment among higher-education teachers? How does this process influence cognitive load? The study uses a case study approach to explore cognitive load in teachers, wherein the major case is higher-education assessment during the Covid-19 institutional closures, with each participant presenting a unique instance of the case. The study included a heterogenous sample of six post-secondary level teachers (n = 6) from a public university in Canada and used an online questionnaire, assessment artefacts and a semi-structured interview to address the two research questions proposed. The findings of this paper show the process of using online assessment as including experiences that tied to affect, moments that required support and moments that were high and/or low in terms of workload. There may not be a unidirectional influence on cognitive load. Rather, the load may also influence the process, potentially suggesting a relationship between the two that could build on each other until sufficient mental resources are acquired to address the load. The findings ultimately support the conclusion that regardless of new technologies or new features, cognitive resources were still potentially exhausted with how to use the technologies rather than what technologies were available to use.

Statement of Originality

I hereby declare that this work has not been submitted or accepted for any other degree. I also confirm that all work presented in this paper is my own. The written content presented in this thesis is original work prepared and written entirely by me, with the avid support and guidance from Dr. David Trumpower, Dr. John Ranellucci and Dr. Michelle Hagerman.

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Abbreviations

CLT	Cognitive load theory
IL	Intrinsic load
EL	Extraneous/ extrinsic load
GL	Germane load
WM	Working memory
TPACK	Technological pedagogical content knowledge
PCK	Pedagogical content knowledge
TK	Technological knowledge
PK	Pedagogical knowledge
CK	Content knowledge
TCK	Technological content knowledge
TPK	Technological pedagogical knowledge
PCK	Pedagogical content knowledge
NCATE	National Council for Accreditation of Teacher Education
ISTE	International Society of Technological Education
ICT	Information communication technology
LMS	Learning management system

Using Online Assessments in the Age of Covid-19: An Exploratory Study of Cognitive Load in Higher-Education Teachers

Chapter 1: Introduction

Assessment is a core element of educational practices (Dixson & Worrell, 2016). Teachers design assessments to facilitate student learning and achievement, but the administration of assessments may require teachers to divert and divide their attention between simultaneous tasks. These include student work, how well the work aligns with set assessment criteria, and the provision of feedback. Recent scholarship suggests that online assessments could create an additional mental strain of navigating through a digital environment (Hamer & Smith, 2021). Contrastingly, it could also reduce mental strain with the use of different input (graphics, text and colors) (Korbach et al., 2017; Lee et al., 2006; Tarmizi & Sweller, 1988). This ultimately provides an outlook on online systems as having the potential to be both facilitative and inhibitory depending on how information interacts with cognitive resources and their subsequent limits.

The study of the limits of human cognition, also known as cognitive load, has been an ongoing focus of investigation in educational research for the past three decades, with its inception in the late 1980s (Brünken et al., 2003; Sweller, 1988, 2020). Cognitive load is based on the principle that working memory (i.e., the main system of processing and comprehension) is limited in its capacity to hold and store information (Kalyuga & Liu, 2015). Sweller (1988) distinguishes three types of cognitive load and for the purpose of this paper, all three types will be discussed in the context of online assessment and evaluation, as experienced by teachers.

The first type of cognitive load is *Extraneous Load;* the mental strain caused by external input, for example, attention diverted towards unnecessary structural content such as web layout. The second type of load, *Intrinsic Load,* is induced by the internal complexities of assessment material, such as the clarity of a rubric. The final type of load, which has also been the most controversial in contemporary research (Kalyuga, 2011; Leppink & van den Heuvel, 2015), is *Germane Load,* categorized as the level of intrinsic and extraneous load necessary for effective evaluation. For example, the intrinsic load of teacher content knowledge and an extraneous load of verbal and non-verbal cues generated by a student during a presentation evaluation, could facilitate and inform the assessment process. The overall capacity of cognitive load can be

measured by what research distinguishes as either subjective (i.e., self-report questionnaires or reflections), and/or objective means (physiological measures such as heart rate or pupil dilation) (Sweller et al., 2011).

Dixson & Worrell (2016) state that classrooms usually encompass two types of assessments; summative, a cumulative evaluation capturing what students have learnt throughout a term or semester, and formative, ongoing assessment used to inform learning and feedback. This variety of assessment, along with the demands of designing, implementing, and providing feedback for the assessments using technologies may, however, create a demand on a teacher's cognition, consequently pushing on its own limitations.

When considering the ongoing demands on teachers, the year 2020 brought on a new set of educational challenges with the onset of the Covid-19 pandemic. These challenges involve post-secondary systems world-wide shifting learning to online platforms, with the United Nations (2020) reporting up to 80-85% of distance learning coverage in high-income countries such as China, Japan and the Russian Federation. Specifically, in Canada, over 100,000 post-secondary students reported courses being moved online either partially (17%) or completely (75%) after institutional closures (Doreleyers & Knighton, 2020). Although the modality shift ensured the continuity of lessons, whether it reflected the continuity of *learning* is still debated among global organizations (United Nations, 2020).

Learning in cognitive research is heavily influenced by the capacity of working memory processing (i.e., cognitive load). Due to the sudden shift in modality, post-secondary students as well as their teachers, are exposed to new methods of assessment in place of in-person modes (Doreleyers & Knighton, 2020). Cognitive load is commonly characterized as affecting a student's ability to learn (Kalyuga, 2011; Paas & van Merriënboer, 1994; Sweller et al., 1998). However, whether the same cognitive limitations influence a teacher's ability to assess is yet to be explored. To bridge this gap, this paper aims to explore cognitive load in higher-education teachers in the context of online assessment. The findings from the study aim to provide preliminary data to address the present research gap of investigating cognitive load in post-secondary teachers and aims to be a valuable informant in a teacher's intentional and reflective use of online assessments in higher education.

Chapter 2: Theoretical Framework

The theoretical frameworks behind the design of this paper consider two influences that may shape a teacher's use of technology for assessment. As this paper seeks to explore the complexities of technology use, it is deemed appropriate to, first, discuss the three facets of knowledge involved in the use of technologies in classrooms: Technological pedagogical content knowledge (TPACK), to then, align the framework along its influence on the major theoretical framework behind the study: Cognitive load.

Technological Standards and TPACK

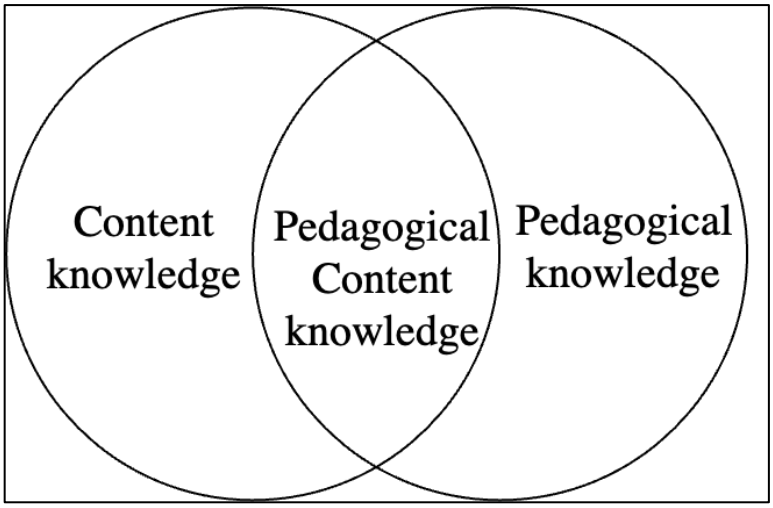
In the process of addressing growing concerns about the preparation to adopt technology in schools, the National Council for Accreditation of Teacher Education (NCATE), United States, in alliance with the International Society for Technology in Education (ISTE) created a set of technology standards in 1993, focusing on basic technology skills (Kelly & McAnear, 2002). These set of skills have evolved over the years to include dimensions of planning, implementing and assessing, along with social, ethical, legal and humanistic issues related to technology use. Specifically in terms of assessment, Crompton & Sykora (2021) highlight the standards in terms of an educator's role as an analyst. The current ISTE standards for education in assessment expect teachers to:

a. Provide students with alternative means to demonstrate competencies and facilitate reflection on their own learning with the use of technologies
b. Use technologies for the design and implementation of formative and summative assessments accommodating learning needs, feedback and informed instruction
c. Use data gathered through assessment to guide progress and build student self-direction

With the inception of the early ISTE and national educational technology standards, the application of Shulman's (1986) concept of pedagogical content knowledge (Figure 1; PCK) arose in teacher education research to situate the presence of multiple interacting facets of knowledge in the practices of teaching (Cochran et al., 1993; Gudmundsdottir, 1990; Prawat, 1989; Wallace, 2004). Scholars found that depending on a teacher's expertise, new teachers would often depend on subject matter knowledge that is unmodified and directly reproduced from curriculum material with little to no coherent framework as to how the information is

presented during lessons (Carpenter et al., 1988; Cochran et al., 1993). New teachers may also make pedagogical decisions that were broad, creating a general assumption regarding student prior knowledge, ability and learning needs (Carpenter et al., 1988). Mishra & Koehler (2006) later depicted the TPACK model derived from Shulman's (1986) PCK model, with technological knowledge (TK) occupying a third domain.

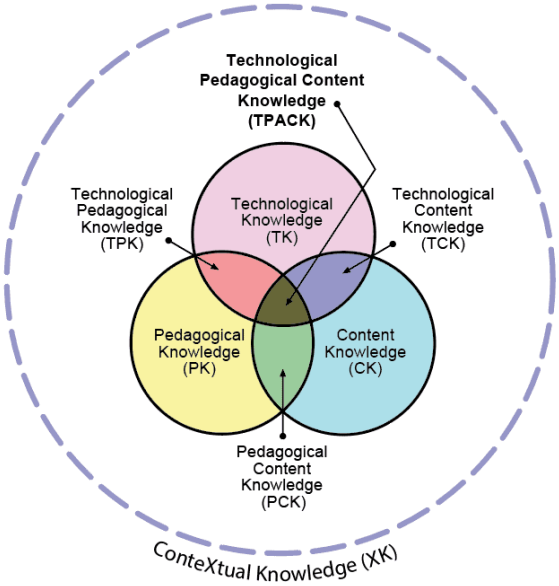
Figure 1: *Interaction between CK and PK. Adapted from Shulma's (1986) theorization of PCK.*



TK is defined by Mishra & Koehler (2006) as the general knowledge about information technology allowing for a person to use it at home and at work, along with the ability to assess whether its integration would assist or impede in a specified goal to be achieved. The model combines PK and CK from Shulman's framework, with TK, generating 7 subdomains (TK, PK, CK, TPK, TCK, PCK, TPACK), introducing three subdomains to Shulman's PCK model (TPK, TCK and TPACK). Technological pedagogical knowledge (TPK) is a teacher's ability to understand how the integration of technologies would influence teaching and learning practices (Koehler & Mishra, 2009). As an example, a teacher may review the use of calculators during an assessment to reduce time required for administering calculations. Technological content knowledge (TCK), is defined as the understanding behind how digital tools available could facilitate or hinder the curriculum content. In an assessment of cell anatomy, teachers could reflect on how the use of an augmented reality projection of a cell would be appropriate for a fill-in-the-blanks assessment. Finally, TPACK is the knowledge behind the interplay between TK,

CK and PK. The revised TPACK model in 2018 includes contextual knowledge (XK) to represent a teacher's knowledge of the context. Although context in itself was considered in the previous (Koehler & Mishra, 2009) model, the revision highlights the integral role of this nuance. Especially within the context of this study (the Covid-19 pandemic), the paper considers the inclusion of XK to be essential to its procedure (Figure 2).

Figure 2: *TPACK Model (Mishra, 2018)*



The TPACK model as a framework for teaching and learning was supported by studies using structural equation modelling to provide evidence for how each domain of TPACK are interrelated (Dong et al., 2015; Koh et al., 2013). In Koh et al.'s study of 445 teachers, a confirmatory factor analysis of TPACK yielded an acceptable model fit (χ^2 = 1,024.20, χ^2 /df = 2.89, $p < .0001$, TLI = .94, CFI = .95, RMSEA = .07 (LO90 = .06, HI90 = .07), SRMR = .04) with statistically significant ($p < .01$) positive correlations between each of the TPACK constructs.

From the evidence behind cognitive load so far, the amount of attention demanded from working memory in order to process interacting elements of information, may lead to an excess cognitive strain in individuals; consequently, reaching its own limits (Kalyuga, 2011; Kalyuga & Liu, 2015; Paas & van Merriënboer, 1994; Sweller, 1988). When considering the TPACK model,

the integration of technologies in classrooms are depicted through 7 interactional domains that need to be considered by teachers. The process of planning and designing how technologies will be integrated, in itself, may influence a cognitive overload, as it requires teachers to make multiple decisions to serve multiple purposes (Koh et al., 2013). For example, an assessment design would require teachers to understand student learning needs and challenges regarding a topic (PCK), while also understanding the possible demands on students using the online interface (TPK). Teachers would, thus, be required to concurrently apply multiple elements of the TPACK model for technology integration. The TPACK model acts as a major framework highlighting the complexities of using technologies in education and is used in this paper as a practical alignment with the theorization behind cognitive load; detailed in the next section.

Working Memory and Cognitive Load

The construct of cognitive load was first conceptualized by Sweller (1988) and was defined as the amount of cognitive activity imposed on working memory (WM), based on the assumption that WM has a limited capacity to store novel information at a given time. WM uses two distinct systems to process visual and auditory information; the visuo-spatial sketchpad which processes visual input (images and videos), and the phonological loop which processes auditory input (written and spoken words) (Constantinidis & Klingberg, 2016). Due to the limited capacity for processing in the two systems of WM, both systems can be overwhelmed by the type of input received, albeit in either visual or auditory means, and once WM capacity is exceeded, this results in a cognitive load.

Within the next two decades, this initial conceptualization developed into a multidimensional construct recognizing three types of cognitive load; extraneous, intrinsic and germane load (Kalyuga, 2011; Paas & van Merriënboer, 1994; Sweller et al., 1998). According to Sweller et al. (2011) all three types of cognitive load can occur in online learning contexts to varying degrees depending on the complexity of the input and activities experienced by an individual. Due to the limited research focusing on cognitive load in teachers, the literature used in the definition of key terms and literature review, is skewed towards cognitive load in learners and learning. Dalinger & Asino (2021) comment on the lack of research exploring cognitive load in teachers and identify Feldon (2007) as providing one of the most relevant findings on a teacher's cognitive load so far. Feldon investigated cognitive load in novice teachers, finding

content delivery, task management and student behaviors to burden WM. Similarly, when investigating cognitive load to facilitate a teacher-training program, Kear et al. (2012) found that interacting factors when using web-conferencing to communicate with students present a cognitive demand, as teachers are expected to manage multiple communication channels (on-screen video of students, chats, teaching material etc.). Although the limited research on a teacher's cognitive load have focused on novice teachers and teacher-trainees, this paper makes the assumption that the principles discussed can correspondingly apply to all teachers, albeit in varying degrees, thereby creating a foundation for its exploratory nature.

Extraneous Cognitive Load

This refers to when information is presented in an inappropriate manner, resulting in unnecessary strain or confusion in teachers (Sweller et al., 1998). Extraneous load is controlled by the design of the assessment interface and influences teachers from an external point, hence the term *extraneous* load. As an example, Çakiroğlu & Aksoy (2017) used Adobe Connect (a web conferencing software) to identify design elements of online platforms that can be seen as redundant and even limiting to information-processing due to the extraneous load it induces. Adobe Connect enables the designer to control the placement of panels (i.e., chat panel, PowerPoint presentation panel, poll panel etc.). When measuring extraneous load through self-report questionnaire data, it was found that the panel placement and number of panels (especially the presence of overlapping and unused panels) relates to an increase in extraneous cognitive load. Here, the higher the number of panels, as well as its placement in terms of presence of an increased number of overlapping panels, related to a higher cognitive load.

Intrinsic Cognitive Load

This load refers to the inherent complexities of material, which increases with subsequent level of material interactivity with respect to an individual's existing knowledge and strategies used to make sense of input (Paas & van Merriënboer, 1994; Sweller et al., 1998). In other words, this involves the variety of information input occupied by WM at the same time and is fixed according to the demands of the task. Ayres (2006) investigated intrinsic cognitive load by using bracket expansion instruction with grade 9 students as a means for student reflection. Multiplication combinations with the same sign resulted in higher ratings of ease, for example, (-3) x (-3) = (+9), explained as generating a lower intrinsic cognitive load due to a reduced level of

interacting elements. Questions with multiple signs having a combination of plus and minus signs, resulted in lower ease ratings, explained by a higher intrinsic cognitive load, as attention needs to be dedicated to the interacting elements and its influence on the answer. In an assessment context from a teacher's perspective, the extent to which a teacher may experience intrinsic load will be dependent on their prior knowledge relating to the content being assessed (in this case, bracket expansion) and the pedagogical knowledge required to determine how to assess it.

Germane Cognitive Load

This refers to a design that can be manipulated by teachers in a way that is beneficial to assessment processes (Kalyuga, 2011; Sweller et al., 1998). Germane load functions under the principle that assessors can "separate useful, learning-relevant demands on working memory from irrelevant and wasteful forms of cognitive processing" (Sweller et al., 1998, p.34). DeLeeuw & Mayer (2008) represent germane cognitive load by relating the process of knowledge transfer in terms of worked examples in college students. Here, comparisons in effort and difficulty ratings are made with regards to students who answer correctly on subsequent tests assessing similar concepts (that is, transferring knowledge from one question to the next, applying the instruction provided through the worked examples). Questions including knowledge transfer, thus, resulted in lower effort and difficulty ratings, indicating a facilitative cognitive load, which DeLeeuw & Mayer identify to be germane cognitive load. From an assessment context, transfer of knowledge can be with regards to the awareness of prior knowledge in students, their engagement with the topic and interpretation of verbal and non-verbal cues, by which all elements take space in WM. However, if all of these elements are attended to, it may facilitate student learning, in turn, imposing a germane load.

Recent Advances in the Conceptualization of Cognitive Load

Germane Load: From Load to Process

Although the Sweller (1988) model of cognitive load was widely used in educational psychology studies (Ayres, 2006; Çakiroğlu & Aksoy, 2017; DeLeeuw & Mayer, 2008; Paas & van Merriënboer, 1994), a few elements of its iteration gained controversy. Germane load, in particular, sparked several debates with regards to its theoretical relevance (Kalyuga, 2011;

Leppink & van den Heuvel, 2015). Contrasting with germane load, both intrinsic and extrinsic load were theorized as interfering with learning or the achievement of a goal, whereby a reduction of both would reduce the chance of a cognitive overload. Therefore, the introduction of germane load seemed theoretically plausible in regards to the presence of a separate type of load accounting for the *facilitation* of learning rather than the inhibition of it (Sweller, 1988).

With the traditional definition of cognitive load, germane load is considered essential to learning and schema development, however, in this process, intrinsic load can be argued as also playing an important role. Intrinsic load is concerned with material interactivity and interrelation of information which subsequently influences schema construction (Paas & van Merriënboer, 1994; Sweller et al., 1998). Therefore, the load type influencing schema construction (potentially seen as the 'good' cognitive load), could include both intrinsic and germane load. Considering the overlapping concepts, recent scholarship argues that germane load may not be distinguished from intrinsic load (Kalyuga, 2011). In response to this limitation, factor analysis data of cognitive load survey responses found that a two-factor model including intrinsic and extraneous load may be more acceptable compared to the traditional triarchic model (Jiang & Kalyuga, 2020). The study reported an acceptable model fit with $\chi^2 = 54.069$, df = 53, $p = .433$, TLI = .993, CFI = .994, RMSEA = .018, SRMR = .077, concluding with the revised CLT removing germane load from the total additive framework of cognitive load, to include it as a separate dimension named germane processing (Jiang & Kalyuga, 2020; Sweller et al., 2019). It is important to note that germane processing has been associated with emotional elements contributing towards cognitive engagement, subsequently facilitating the 'germane process' (Sweller et al., 2019).

Affective Influence

Specifically in the context of online learning and assessment, research has shifted from perceiving learning as a solely cognitive process, towards including affective dimensions (Brom et al., 2018; Plass & Kalyuga, 2019). The principles behind a more affective and emotional basis as well as approach in cognitive research is to include elements in online interfaces such as warm colors or images that induce a positive emotional response, subsequently having a positive influence on cognition. Brom et al.'s meta-analysis of 33 independent samples (N = 2924) provide evidence for the use of an emotional design approach by which the addition of pleasant

colors and anthropomorphic faces on graphics provided a statistically significant effect in terms of retention ($k = 18$, $d_+ = .387$), comprehension ($k = 14$, $d_+ = .317$) and perceived difficulty ($k = 14$, $d_+ = - .208$). However, in this respect, emotional design has been achieved through the addition of decorative design elements to a user interface that has not transformed the contents of the learning tasks or goals. Although authors argue that the inclusion of emotional design elements will not reduce cognitive resources (Plass & Kalyuga, 2019), Brom et al. also highlight that emotional design could have the potential to become an extraneous load if included in excess. Nonetheless, the emotional and affective influence on cognitive load remains prevalent in that CLT may no longer be considered as solely cognitive in nature.

Chapter 3: Literature Review

The literature review focusses on the main construct measured in the study; cognitive load in the use of online assessment, specifically during the Covid-19 pandemic. The review will first discuss assessment and move to discerning the types of input in online assessment to discuss how types of input are linked to cognitive load. The next section reviews how the construct of cognitive load is measured in contemporary research and concludes by contextualizing the literature to the research questions proposed in this paper. This review may be skewed, however, towards older empirical studies (earlier than 2010) as the distribution of studies published in the topic of cognitive load and online learning has reduced between 2010 and 2020, decreasing by almost half after 2016 and more than 80% by 2018 (Mutlu-Bayraktar et al., 2019). The reduction of research could possibly be due to existing controversies of its iteration, resulting in new conceptualizations (affective influence and removal of germane load).

Assessment: A Focus on Higher Education

The study centralized its focus in the exploration of cognitive load in teachers using online assessments, to a higher-education context. Distance education, by definition, is a type of instruction that uses one or more technologies to deliver its learning material to individuals who are physically away from their instructors (Seaman et al., 2018). Distance education, in itself, is not a new concept to post-secondary institutions. Specifically in Canada, between the years 2011 and 2015 alone, an increase of over 58% of enrolment is shown in online courses (Bates, 2018). Although these numbers do highlight a significant increase in student participation in distance learning programmes, it is still a minority (about 16%) when comparing with in-person enrollment. With the sudden shift in modality during the global pandemic, the vast majority of students enrolled in in-person courses were forced into online modes of learning and assessment with no other options available to them. An increase in students enrolled in online courses subsequently result in an increase in teachers partaking in online courses. Although post-secondary teachers may be experienced in online teaching, there is little evidence investigating the influence of the compete shift. The complete shift, herein, factors in assessment as a centralized facet of learning and the justification behind this core focus is elaborated in the next section.

Assessment in Higher Education: History and Philosophies

The early 1970's brought about a view of learning with assessment at its core focus. Literature by Snyder (1970) and Miller & Parlett (1974) indicated that student engagement in higher-education learning was influenced more from assessment than teaching (Gibbs & Simpson, 2005). In both texts students associated all elements of their studies; for example, how they studied for the course and strategized their focus on course material, to the demands of the system of assessment experienced. Rowntree (2015) expanded on these findings to convey that "if we wish to discover the truth about an educational system, we must first look to its assessment procedures" (p. 1).

Assessment procedures are distinguished as having an interaction with teaching and learning philosophies behind the subsequent decision-making processes (Farhady, 2021). In this regard, the early positivist paradigm gave importance to the use of standardized testing, functioning under the assumption that meaning is constant across learners, contexts, and purposes (Paulson & Paulson, 1994; Rahman, 2020). Following this principle, testing was concerned with the information to be transmitted from teacher to learner, involving what the learner could produce with regards to the stored information. Due to the focus on the product of learning compared to the process of learning, this paradigm is categorized as product-oriented in this paper in accordance with contemporary literature (Farhady, 2021; Hosseini et al., 2021).

Over the succeeding decades, the paradigm shifted from positivist philosophies to a constructivist approach, whereby testing was to focus on the process of learning rather than its product (Gipps, 2011). During this period, testing involved the facilitation of learners to achieve their goals by directing instruction and feedback towards specific needs. Paulson & Paulson (1994) draw comparisons between the positivist and constructivist approach with constructivism in assessment representing the process of learning, assuming that meaning will vary across individuals over time and with different purposes. It is important to note, however, that in order to accommodate for the theoretical changes and contrast between product and process-oriented procedures, scholars distinguished between the concepts of 'assessment' and 'testing'.

Types of Assessment

The assumptions behind the concept of assessment were that it would serve as an alternative to the psychometric testing system as by definition, assessment was categorized as the process of gathering information about learning (Farhady, 2021). With regards to the purpose of

assessment, Cheng et al. (2008) highlights its purpose as assigning multiple tasks and activities to identify and inform teaching, in contrast with the concept of testing in which a single test could be used to inform judgements on learning performance. Popham (2004) aligns early definitions of assessment with the concept of assessment literacy as a meaningful process of using multiple forms of measurement to inform and facilitate the teaching-learning process. With an increasing focus on assessment, the concept was subsequently further broken down into specific types: performance-based, authentic, alternative, diagnostic, summative and formative (Farhady, 2021).

Formative and summative assessment were categorized as the major dichotomy in assessment research, distinguishing between ongoing assessment to improve learning (formative) and the assessment of how much a student has retained at the completion of a course or lesson sequence (summative) (Phelps, 2011). Dixson & Worrell (2016) comment on formative assessment as encompassing a host of measurement tools to facilitate the process of providing ongoing information to teachers as well as tutors, parents and students themselves about their current understanding, to accommodate instruction accordingly. Contrastingly, summative assessment is highlighted as a cumulative assessment intended to determine a student's academic level or proficiency at a specific time. Although summative and formative assessment have been juxtaposed as having different objectives, this paper takes the view that formative assessment and summative assessment should be used in complementary ways to support student learning.

Situated Practice

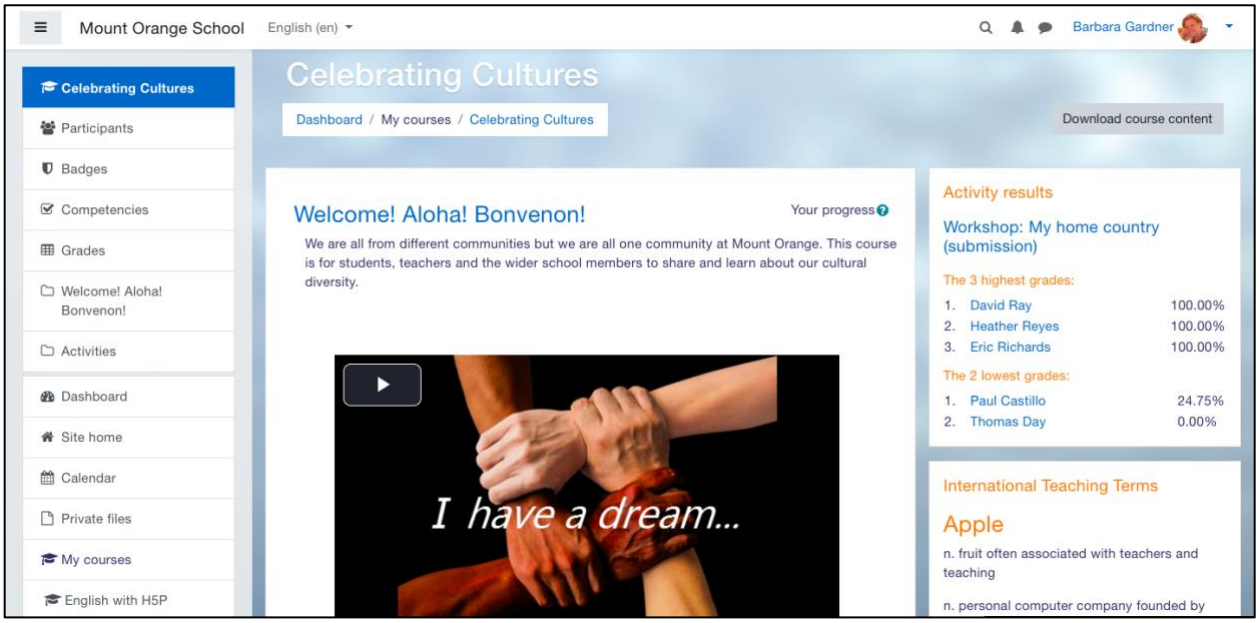
Keeping learning at the forefront, tempting as it is to assume the practicality of research and theory behind assessment scholarship, it may not always translate into educational practice. Laurillard (2013, p.62) underscores the "situated character of all learning and the impossibility of defining reliable prescriptions for teaching strategies". Similarly, this paper argues that how teachers carry out assessments in their own classrooms will be situated in the contexts of their own experiences and physical, emotional and cognitive demands. Therefore, the growing body of research on assessment contributes towards a useful basis to review and support meaningful practice, to which the study aims to build on.

Online Assessments

Sharma et al. (2019) distinguishes online learning as an approach that uses technology to provide learning instruction and assessment to students off-campus. In comparison, in-person

assessment occurs in classrooms and can use either online, paper-based or a combination of systems. Online learning offers a medium for assessment that can be completely online and accessed world-wide, relying on information and communication technologies (ICT) as its operational tool. The technologies used can be web-based systems or Learning Management Systems (LMS) such as BrightSpace and Moodle (see Figure 3 for Moodle LMS platform), where assessors are able to upload assessment content, criteria and rubrics for students to access at any given point during the course of their study (Kasim & Khalid, 2016). Figures 4 and 5 demonstrate the use of an LMS to not only provide teachers a platform to collect student assessments, but to also monitor, provide feedback and cumulate grades over the course of an academic term.

Figure 3: *Moodle Learning Management System*



Note. These images are accessed through the public-access demo teacher account. https://school.moodledemo.net/course/view.php?id=59

Figure 4: *Sample online assessment format through Moodle*

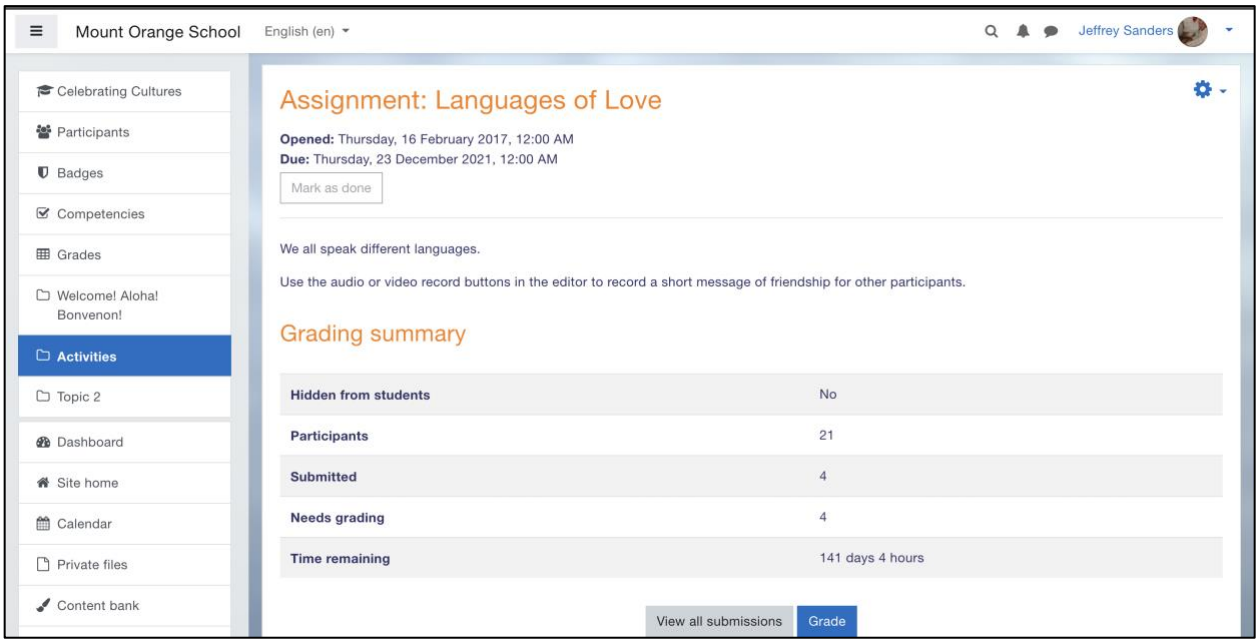
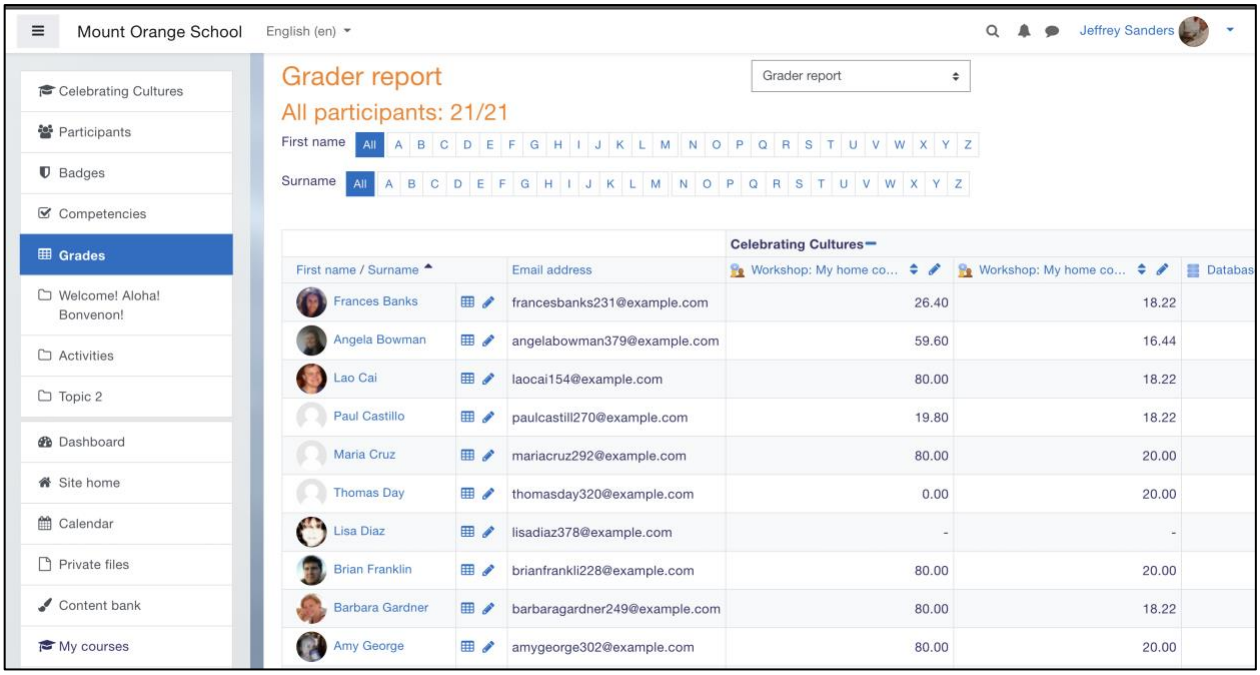


Figure 5: *Sample class grade report*



Types of Input in Online Assessment

The variety of input involved in assessment submissions; either audio, video, PowerPoint slides or combinations of each, will present information differently. This variation in input can

be differentiated into two main sections, auditory input, and visual input (Anmarkrud et al., 2019). Auditory input can be further divided according to whether it is provided through written or spoken text, and visual input can be further divided into the presentation of static graphics (graphs and images), and dynamic graphics (videos and animations). Although it could be assumed that written words are processed visually, the authors highlight both written and spoken text as being processed at the phonological loop (i.e. relating with auditory information). Written and spoken text are categorized together as the graphemes (written symbols) will correspond with the phonemes (spoken sound). Visual components address visual characteristics such as size, color, and shape, while spatial components address the control of movements. Therefore, written and spoken text are distinguished as relating to auditory input while images, graphs, videos, and animations are categorized as visuo-spatial.

Influence of Types of Input on Cognitive Load

Literature distinguishes the differentiation between auditory and visual input in online assessments (Anmarkrud et al., 2019; Chen & Wu, 2015). However, the influence of type of input on assessors can also be considered as largely cognitive in nature. In a bibliometric analysis reviewing research between 1996 and 2016, it was found that the construct of cognitive load displayed the highest frequency of occurrences in 411 publications investigating digital learning and assessment (Li et al., 2019). Despite its high frequency of occurrence, only a limited amount of literature to date was found to explore cognitive load with respect to the relevant skills required to navigate through a variety of multimedia formats. This further indicates the need to explore cognitive load in the context of integrating technologies in lessons. Mutlu-Bayraktar et al. (2019) reflect the interaction between cognitive load and types of instruction by linking the processing of visual and auditory instruction to the two systems of WM; the visuo-spatial sketchpad and phonological loop, respectively.

Mayer (2019) expands on this interaction by using two assumptions in his investigation. The first assumption in the case of an assessor, is that a teacher will have two cognitive channels to process visual and auditory instruction (i.e., the two systems of WM). The second assumption is that each channel is limited in its capacity to process and store specific input (i.e., cognitive load). Due to the variety of input received in online assessments, teachers cognitively map the input alongside the appropriate channel for information processing. In order to facilitate this

process, however, the type of input used, needs to present the subsequent input in a manner that reduces cognitive load, to increase the ability to process what is presented (Cook et al., 2009; Korbach et al., 2017).

Studies investigating the influence of types of input on cognitive load find that appropriate input can result in the reduction of cognitive load (Korbach et al., 2017; Lee et al., 2006; Tarmizi & Sweller, 1988). Tarmizi & Sweller, (1988) conceptualize appropriate input by investigating the influence of either diagrams or text in mathematical problem-solving. It was found that those who received both visual and auditory input had a statistically significant higher cognitive load, as attention to the specific input used both systems of WM simultaneously.

Hsin & Paas (2015) found contrasting evidence when investigating the influence of dynamic graphics on cognitive load. The study used an experimental group which received visual representations of mathematical instruction to teach arithmetic operations. Here, the control group was provided the same instruction, with no visual representations. The findings of the study revealed that the experimental group that received visual instruction with dynamic graphics illustrating the mathematical representations, resulted in lower cognitive load. Despite there being an influence of type of instruction on cognitive load, according to recent research and literature reviewed in the Li et al. (2019) analysis, studies also indicate that the nature of this influence is still unclear (Chen & Wu, 2015; Korbach et al., 2017).

The differences in influence between the two constructs may involve methodological complexities due to differences in how cognitive load is measured in these studies. Cognitive load can be measured through different techniques (labelled in previous research as either subjective or objective methods) and are measured with no indication as to which component of cognitive load was influenced (i.e., either extraneous or intrinsic). For example, the studies reviewed in this section (Chen & Wu, 2015; Hsin & Paas, 2015; Korbach et al., 2017; Tarmizi & Sweller, 1988) investigated cognitive load holistically rather than differentiating it into its constituent types, consequently reporting influence of online input as either increasing or decreasing cognitive load as a whole.

This paper takes this limitation into consideration and aims to explore cognitive load in teachers using online assessment in accordance with a collection of pre-determined proxies to determine its individual types. As an example, Foster et al. (2018) finds that participants with higher intrinsic load may benefit from visual input which provide worked examples of concepts

covered in courses, compared to sole auditory instruction. However, this instruction may be redundant in participants with lower intrinsic load as they may be more familiar with the tasks and input provided, subsequently not requiring visual guidance. Redundant information accumulates within the WM system and increases extraneous load. Therefore, the ability to measure the types of cognitive load facilitates assessors in understanding how the processing of input may differ according to different formats between individuals.

Measuring Cognitive Load

Cognitive load measurements are distinguished as either subjective, such as self-report questionnaires, surveys and reflections (Ayres, 2006; Çakiroğlu & Aksoy, 2017; DeLeeuw & Mayer, 2008), and objective measures in terms of physiological data i.e., eye-tracking, heart rate and pupil dilation (Andrzejewska & Skawińska, 2020; Appel et al., 2019). Objective measures function under the main assumption that cognitive load results in a physiological increase of stress (Appel et al., 2019). However, it can be argued that so called objective measures may not be entirely objective in their methodology. Due to the major assumptions made by the assessors that physiological changes such as heart rate or pupil dilation are due to cognitive load, other influences such as time of day, unrelated stresses, and the inherent stress of completing the task under experimental conditions, may be overlooked. Furthermore, the influence on cognitive load will be measured as a whole, rather than its subsequent types. In comparison to subjective methods, physiological data has been reported to be used in only 2% of research in a literature review of 351 studies investigating the influence of cognitive load in online learning (Mutlu-Bayraktar et al., 2019). Due to the prevalence of subjective measures within the area of cognitive load studies, this section will focus on the measurement of cognitive load through subjective means.

From a methodological standpoint, the studies considered in each type of cognitive load in this paper all involve subjective measures in order to operationalize the construct. It can be argued, however, that subjective measures may be influenced by the subjectivity of the construct conceptualization itself. Anmarkrud et al. (2019) indicates subjective measures to be the most commonly used measure of cognitive load (with 71% of studies reviewed using subjective measures), similar to the Mutlu-Bayraktar et al. (2019) findings. However, a key issue of this

approach lies in the inconsistencies of the conceptualization and the subsequent operationalization of the construct.

Perceived difficulty as well as effort ratings are used as proxies for the measurement of cognitive load (Anmarkrud et al., 2019; DeLeeuw & Mayer, 2008). However, the DeLeeuw & Mayer study, used as an example for germane cognitive load in this paper, does not offer a clarification of the differences between the two measures. A review of 381 studies conducted by de Jong, (2010) indicated that close to 40% of studies use mental effort and perceived difficulty interchangeably, in contrast to the use of the two measures in isolation as in DeLeeuw & Mayer's (2008) study. Perceived difficulty is used when operationalizing the construct of cognitive load, while the term mental effort is used when discussing results (de Jong, 2010).

In comparison, Ayres (2006) measured cognitive load by operationalizing the construct through self-report data on degree of ease. Although degree of ease can be similar to perceived difficulty as both concepts involve students making a judgement on the amount of effort necessary to understand instruction, it is still unclear whether each conceptualization can be used and measured interchangeably. Therefore, this highlights a lack of consistency in terms of how cognitive load is conceptualized and consequently operationalized in subjective measures of the construct.

Despite its limitations, subjective measures have been argued to provide a broader view of the construct in terms of its subsequent types, in comparison to objective physiological measures (Sweller, 2018). For instance, Majooni et al. (2018) studied pupil dilation as well as number of blinks, linking eye-tracking measures with comprehension scores in order to investigate the level of cognitive load imposed by specific input. In comparison to the Ayres (2006), Çakiroğlu & Aksoy (2017) and DeLeeuw & Mayer (2008) studies, the objective measure offers a holistic view of cognitive load, while subjective measures enable researchers to investigate the specific types of load in detail. This paper thus argues that if specific types of cognitive load can be determined by a subjective measure (such as using self-report questionnaires), strategies can be used to further explore facilitative elements while reducing limiting processing factors in assessors during the assessment process. In turn, the depth and detail subjective measures provide, result in a higher frequency of use of subjective measures in cognitive load studies (Anmarkrud et al., 2019). However, it is important to note that due to the recent developments of the new CLT (i.e. removal of germane load in the overall additive

framework of cognitive load and presence of affective influence), tools measuring cognitive load do not yet reflect the recent advances of CLT scholarship.

Selecting a Cognitive Load Measurement

From the subjective measures highlighted in the Mutlu-Bayraktar et al. (2019) study, the authors highlight the lack of instruments available to measure the different types of cognitive load. Recent literature has brought focus onto the development of such measures, addressing the earlier gap, to differentiate between the types of load (Klepsch & Seufert, 2020). In this regard, two approaches are distinguished as standing out, namely, the Leppink et al. (2013) 10-item questionnaire, as well as the Klepsch et al. (2017) questionnaire designed to measure cognitive load through differentiated means.

This paper is especially interested in cognitive load, however, aims to explore cognitive load in teachers; a context that has seldom been studied in cognitive research. Therefore, the paper required a questionnaire that could differentiate between the two types of load (intrinsic and extraneous) with the ability to use the tool in a variety of educational contexts (i.e. the use of assessments from a teaching perspective rather than a learning one). The Leppink et al., (2013) instrument is critiqued as being less adaptable to contexts other than learning, which may contribute towards a reduced comparability over different educational topics (Klepsch & Seufert, 2020). Considering this criticism, the study adapts the Klepsch et al. (2017) questionnaire to the context of a teachers' cognitive load in the use of online assessments, to operationalize the construct of cognitive load. Klepsch et al. reported the reliability of the questionnaire through the measure of internal consistency for each question, with the questions focusing on intrinsic load having a reported $\alpha = 0.81$ and extraneous load having a reported $\alpha = 0.86$. As each alpha level was higher than 0.5, it was considered by the authors as an indication of acceptable reliability.

Research Questions

Considering the significant need to explore cognitive load in assessment and the limited research on the influence of using online assessments on a teachers' cognitive load (Dalinger & Asino, 2021; Feldon, 2007a; Kear et al., 2012), this paper proposes the research objective of creating in-depth profiles of educators in post-secondary level education, to explore the complexities of teachers' use of technologies in the context of assessment and evaluation.

Complexity, herein, is derived from the possible influences discussed in the paper's theoretical framework and review of literature:

a. Online assessment
b. Cognitive load
c. TPACK
d. Covid-19 pandemic

Considering these elements, the paper generates its research questions.

1. What is the process of using online assessment among higher education teachers?
2. How does this process influence cognitive load?

Chapter 4: Methodology

Data Sources

Each data source aims to gather retrospective accounts of a higher-education teachers' experiences with the use of online assessments during the Covid-19 pandemic (see Figure 6 for data collection process). Retrospective accounts are gathered considering the timeline of the study, especially noting that the study and data collection process will be situated two years into the pandemic. Therefore, to collect data with regards to the complexities of online assessments specifically against the backdrop of Covid-19 restrictions and demands, retrospective accounts were used, enabling teachers to select assessments used since the emergency institutional closures in the year 2020.

Preliminary Questionnaire

An online questionnaire (Appendix A) was sent to the participants aiming to collect data with regards to the teachers' characteristics, their general perceptions of using online assessments and identifying which assessments to focus on for the study. The questionnaire was divided into 4 sections with regards to its questions and questionnaire items were refined through piloting the questionnaire prior to the study.

1. Demographic questions (age, gender, years of teaching experience, years of experience using online assessments)
2. General perceptions (use and provision of feedback in online assessments before Covid-19 shift, use and provision of feedback in online assessments after the Covid-19 shift)
3. Online assessments (types)
4. Cognitive load (assessment with perceived highest cognitive load and perceived lowest cognitive load)

Teacher characteristics were investigated through demographic questions (age, gender, years of teaching experience, years of experience using online assessments). Following the demographic questions, teachers were asked to describe their general view of using online assessments before and after the Covid-19 restrictions started. This is to gather information on their retrospective perceptions and emotions relating to its use and what has led them to the perceptions thus far. Information will then be collected with regards to the types of assessments teachers have used online since institutional closures started during the pandemic. Next, a short description of cognitive load (same description used in participant information sheet) was provided.

Participants were asked, from the types of assessments they have used during the institutional closures, which they believe to have influenced the highest cognitive load and the lowest cognitive load.

Cognitive Load Questionnaire: Klepsch et al. (2017)

This paper uses the quantitative measure adapting the Klepsch et al. (2017) instrument to an online assessment context (Appendix A: Section 4 of Questionnaire), to inform the design of the final semi-structured interview. The paper used the instrument for teachers to record their perceived cognitive load measures and use it as a frame to expand on their answers qualitatively. The questionnaire has eight items differentiating between intrinsic (IL $\alpha = 0.81$) extraneous (EL $\alpha = 0.81$) and germane load (GL $\alpha = 0.67$) with two items measuring perceived IL, three items measuring perceived EL and three items measuring perceived GL. All items are rated on a 5-point Likert scale ranging from 'strongly agree to 'strongly disagree'. The authors indicate that the final GL items can be excluded according to the need of the research and context of the study. Considering the expanding literature on the removal of GL from the additive nature of the traditional triarchic model of cognitive load (Jiang & Kalyuga, 2020; Sweller et al., 2019), the questionnaire was used in this study, removing the items focused on GL.

Semi-Structured Interview

The semi-structured interview (see Appendix B for interview protocol) was used with the aim of expanding on the answers provided on the cognitive load and preliminary questionnaires. It was designed based on the three elements discussed in this paper's literature review and theoretical framework as having a potential influence on cognitive load; TPACK, emotion and the use of online assessment, in addition to their lived experience with the impact of Covid-19. The interview was used to collect data on the process of using the two online assessments they perceived as involving the highest and lowest cognitive load. The semi-structured interview was piloted to refine the questions and process. The first section of the interview used Archambault & Crippen's (2009) measure of TPACK as a foundation for the design of interview questions. This section was to enable teachers to expand on how they determined the particular online assessments were suitable to assess the specific concept, whether they came across technical challenges, how they troubleshooted the technical challenges, what they perceive to be the demands of online assessment during its use and feedback stage, and how they met the overall

demands of the online assessment. This section focused specifically on questions relating to a teacher's technological knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and overall TPACK from the Archambault & Crippen (2009) survey. Teachers were also asked whether they experienced any emotions when using the assessment perceived as involving the highest cognitive load and the assessment perceived as involving the lowest cognitive load. How affect was interpreted is explained in detail later on in the data analysis section of this paper.

Assessment Resources

The teachers were asked to provide access to all assessment resources provided for each of the two assessments selected (perceived highest and perceived lowest cognitive load). Here, assessment resources are considered as any documents shared with students with regards to information on how to complete the assessment, the rubric, grading scale and learning management system design. This information was collected in order to create detailed profiles of the teachers participating in this study in order to fulfil the study's aim of exploring how online assessments are used by post-secondary teachers and the cognitive complexities existing within an online assessment context.

Table 1: *Alignment of research questions with data sources used*

Research question	Data Sources
What is the process of using online assessment among higher education teachers?	Interview - Informed by assessment resources shared
How does this process influence cognitive load?	Interview - Informed by preliminary questionnaire

Research Procedure and Analysis

The study is qualitative in nature to create in-depth profiles according to the teachers' lived experiences in using online assessment during the Covid-19 pandemic. The paper views cognitive load as the central phenomenon requiring exploration, considering the limited research available in its regard (Dalinger & Asino, 2021; Feldon, 2007; Kear et al., 2012). The methodology functions under the assumption that cognitive load in teachers function under the

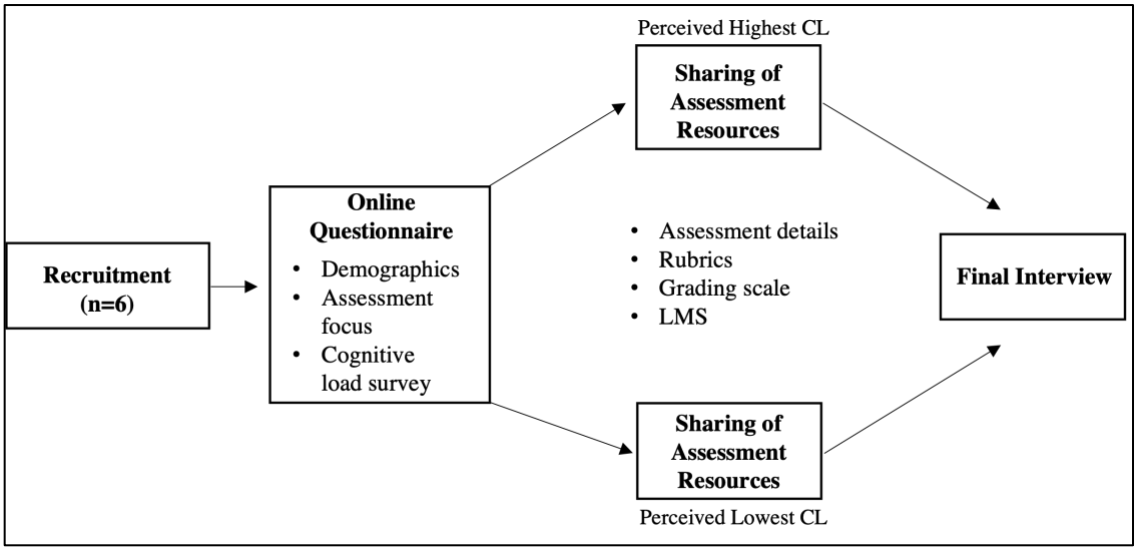
same theoretical principles as cognitive load in learners, in that, the capacity of WM will differ in individuals depending on the complexity of tasks experienced (Kalyuga, 2011; Paas & van Merriënboer, 1994; Sweller et al., 1998, 2011).

The study uses a case study approach to explore cognitive load in teachers, wherein the major case is higher-education assessment during the Covid-19 institutional closures, with each participant presenting a unique instance of the case. Due to the scope of the study, the paper focusses specifically on the use of online assessments, wherein 'use' is derived of the process of sharing of the assessment with students and providing feedback to students using a learning management system: Brightspace. This approach is ultimately aimed at allowing for a deeper understanding of multiple processes and outcomes across the multiple realities, to explore the complexities experienced by teachers when navigating an online system of assessment.

The study employed the following stages in its methodology:

1. Recruitment
2. Preliminary online questionnaire (including cognitive load survey)
3. Sharing of assessment resources
4. Final semi-structured interview

Figure 6: *Summary of data collection process*



Participant Recruitment

The study employed a purposive sampling method to recruit a heterogenous sample of post-secondary level teachers in a public Canadian university, as according to institutional

declarations, majority of the university's courses were shifted to online modes due to Covid-19 restrictions. Post-secondary level teachers teaching online courses purposefully included a range of participants teaching at different levels of studies. By opening the study to a heterogenous group, the study aimed to increase diversity with regards to the types of assessment designs used, prior exposure to online assessment and teaching experience. This paper expects the sampling technique used to provide opportunities for in-depth and comparable analyses (Hancock & Algozzine, 2017).

Participants were recruited by contacting teachers prior to conducting the investigation to share information of the procedure and receive consent to involve their courses in the present study. Once approval was granted, at the beginning of the semester, the teachers were sent a consent form adhering to the ethical standards produced by the Office of Research Ethics and Integrity at the public university.

This case study used a target sample of six cases (post-secondary level teachers) and the six participants were intentionally selected using student enrolment as a proxy for selection. The selection of each case was also informed by three factors: a) their diversity with regards to years of experience teaching online, b) diversity with regards to discipline, and c) involvement in courses previously regarded as in-person and shifted to online modes due to Covid-19 restrictions.

Teachers were provided with the university's research ethics approved information document including an outline of the aim of the study, summary of the construct being explored (i.e. cognitive load in the use of online assessments), procedure, and involvement of participants. Teachers who were open to participate in the study completed an informed consent document to agree to participate. Once informed consent was received, the preliminary online questionnaire followed. It is important to note that throughout the data collection process, teachers were asked to provide retrospective accounts of their experiences using online assessments during the Covid-19 pandemic.

Pilot

Prior to the main study, a pilot study was carried out on three participants (half of the parent study) using the same selection criteria as for the parent study. A pilot was carried out for the preliminary questionnaire and semi-structure interview. Although the designed questions are

based on existing frameworks and tools (TPACK and cognitive load), refinement was deemed necessary with regards to the study's main focus; the teacher's voice and authentic experience with using online assessments and the possible cognitive load influenced by its use during the pandemic. The desired outcomes of this pilot study were the evaluation of the feasibility of the questionnaire and semi-structured interview, time required to complete both, and practical issues as well as any other issues with the questions used.

Preliminary Online Questionnaire

After recruitment, participants were asked to take part in the preliminary online questionnaire. The questionnaire was administered at this stage to explore the demographics and pre-existing perceptions of online assessment. The questionnaire was also used to select the two assessments that each teacher will be focusing on for the rest of the duration of the study.

Cognitive Load Questionnaire

Teachers were asked to answer the 5-item cognitive load questionnaire along with the online questionnaire for each of the two selected assessments (perceived highest cognitive load and perceived lowest cognitive load) (Appendix A). It is important to note that this paper used the cognitive load survey to receive a measure of the teachers' overall experience with the use of the assessment and provision of feedback, and does not individually measure the many sub-tasks that may be involved in this process. The purpose of the survey was to ultimately inform the design of the final semi-structured interview questions. It was used for teachers to reflect on the assessments selected as influencing the highest and lowest cognitive loads on them by rating their experience on a 5-point scale. The questionnaire was used as an informant to the interview rather than a separate proxy for analysis.

Sharing of Assessment Resources

Following the selection of assessments to be focused on, the teachers were asked to share the assessment resources with the investigator. Here, the assessment resources are gathered to facilitate in the development of an in-depth profile for each teacher with regards to the instructions shared in the use of the assessment, rubric and LMS.

Final Interview

Teachers were asked to take part in the final semi-structured interview. This interview was used at this stage to expand on the answers received through the cognitive load survey and to further investigate the teachers' process of using each online assessment. The interview aimed to explore the complexities experienced by the teachers as well as components that were found to be facilitatory in addressing such complexities.

Chapter 5: Data Analysis

After the data collection process, the interviews were analyzed by primarily investigating the demographics of the participants; years of teaching experience and years of experience teaching online. The rest of the transcript was analyzed by reducing the findings into themes through a repeated set of coding procedures and grouping, aligning with accepted procedures of analyzing qualitative data which is exploratory in nature (Beach, 2017). The interviews were analyzed inductively at an idea level, in that open coding took place to create codes spanning across one idea or train of thought, directly from the interview responses (Akinyode & Khan, 2018).

The data analysis followed the process of open, axial and selective coding. Once the open codes were distinguished from the interview transcripts, the dataset used an axial coding approach to take codes broken down in the open coding stage and draw connections between the codes. Following this stage, the codes were divided into identifiable themes and the themes were validated using a member checking approach. Member checking was used to distinguish whether findings and established themes are meaningful by confirming the themes with participants (Candela, 2019; Lincoln & Guba, 1985). Participants who agreed to participate in the member checking process (n = 2), were contacted to review the established preliminary themes and provide their feedback. The aim of using member checking was to contribute towards verifying the major themes of the data and refining these themes.

The dataset then underwent a selective coding process, also distinguished as theoretical coding to select the core category and explore the emerging relationships between the core category and others for the purpose of developing a theoretical model (Charmaz, 2006) (see Figure 7 for summary of coding procedure). The core category, i.e. cognitive load in online assessment, was organized with regards to the established themes based on three components:

1. Conditions influencing the core category
2. Type of influence on the core category
3. Potential outcomes from the influence on the core category

This subsequently aimed to highlight the factors that influenced the teachers' cognitive load when using online assessments, the type of influence during their experience and the result of the influence.

Although the data underwent an open and inductive coding process, this paper considers the major factors discussed within its theoretical framework and literature review (Covid-19, cognitive load, TPACK, affect and types of input). Considering these factors, the study anticipated the following codes to be drawn from the data (Figure 8).

1. Covid-19 related codes (personal, professional)
2. Cognitive load related codes (intrinsic, extrinsic)
3. TPACK (technological, pedagogical, content-specific)
4. Affect (positive, negative)
5. Input (auditory, visuospatial, both)

Figure 7: *Summary of coding procedure*

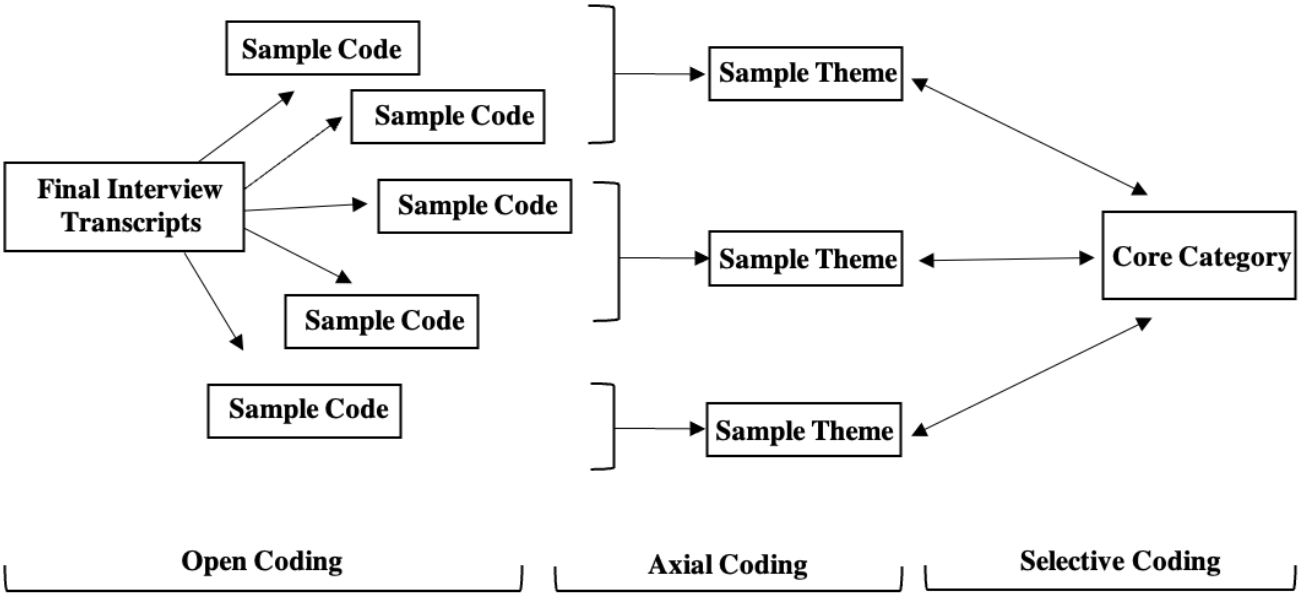
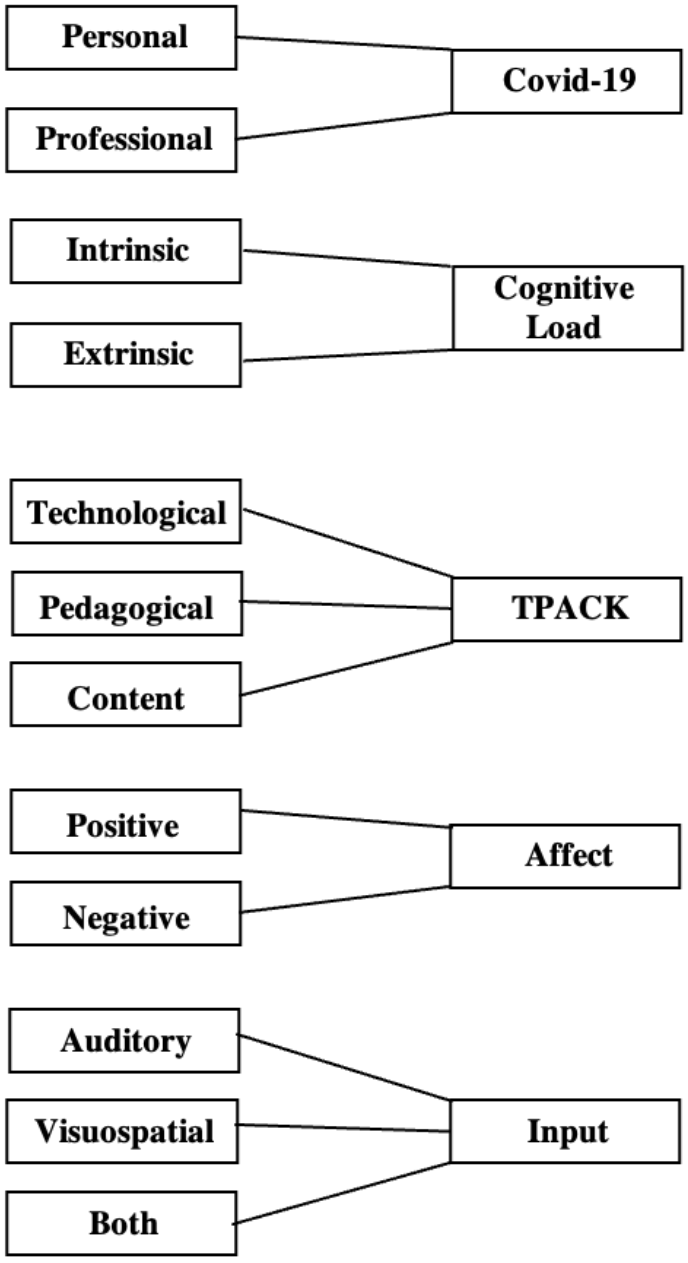


Figure 8: *Anticipated codes*



Coding Procedure

Once the transcripts were created, each transcript was sectioned according to the main sections of the interview. This included:

1. Previous teaching experience at higher-education level
2. Covid-19 related questions
3. Assessment A: highest cognitive load
4. Assessment B: lowest cognitive load
5. Overall demands and support

Although anticipated codes were determined based on the study's literature review, when undergoing the open-coding process, the themes Covid-19 (personal, professional), cognitive load (intrinsic, extrinsic) and input (auditory, visuospatial and both) were removed. The rationale behind removing the anticipated themes and codes were due to participants not naturally and explicitly referring to such factors in their interviews. In terms of the cognitive load-related codes, it was deemed more appropriate to draw codes from sections 4 and 5 to later analyze the codes under the theories of cognitive load, aligning the themes that emerged with the theoretical foundations of this paper. TPACK was retained as a theme, however the code of content knowledge was removed so as to include it as part of assessment practices. This was as the participants did not explicitly refer to their content knowledge (which was also brought up as a concern during the member checking process). Content knowledge was implicitly behind the design and implementation of the assessments, and subsequently added as part of the code 'practices' under the theme 'assessments'.

The transcripts were coded at an idea level by which one code spanned across one idea or train of thought rather than at a sentence or paragraph level. This method was considered as to capture the coded phenomena in its entirety and alleviate the possibility of including multiple trains of thought that do not fit into the code, as well as not capturing the entire idea. The actual codes drawn from the transcripts were as follows:

1. Affect (positive, negative, neither positive nor negative)
2. TPACK (technological, pedagogical)
3. Assessment (philosophy, practices – design, implementation, reflection, content)
4. Support (positive, negative)
5. Workload (high, low)

Affect was coded based on ideas where participants exhibited clear emotions associated with the thought shared. Positive and negative affect were distinguished using the American Psychological Association (2022) definitions as a basis for categorization. Positive affect was determined as any emotion that occurs when an individual has attained and achieved a goal, a source of threat is avoided/ addressed, or when individuals are satisfied with occurrences. Negative affect was determined as any emotion that occurs when goals have not been achieved, unavoidable threats are present, or when individuals are not satisfied with occurrences. The categorization of neither positive nor negative affect, although not defined or taken as a separate category by the American Psychological Association, was determined as a necessary code to include emotions of indifference, wherein goals may have been achieved/ not achieved, there may or may not be threats present, but the individual is neither satisfied nor dissatisfied.

TPACK was defined using Koehler & Mishra's (2009) definition with regards to knowledge behind the interplay between TK, CK and PK. TK was considered as any idea that involved general knowledge about ICT allowing for a person to use it at home and at work, along with the ability to assess whether its integration would assist or impede in a specified goal to be achieved. PK involved any ideas that aligned with specialized knowledge used to facilitate effective teaching and learning environments. Notably each type of knowledge functioned under the broader XK (contextual knowledge), with regards to the pandemic context, and was not explicitly coded in this study. This was as it was interpreted as being present implicitly under each and perhaps every type of knowledge.

Assessment was coded based on any ideas that involved the nature, principles, values and attitudes behind assessment as a whole (philosophy) and the practices behind the assessments that were implemented (design, implementation, reflection). Design was defined as any ideas that drew on how the assessment was created, while implementation included ideas on how assessments were used in a practical context. Reflection was coded based on when participants thought back to the assessments and considered the implications of either the assessment itself or how it was designed/ implemented.

Support was defined as the assistance participants received during their process of using online assessment wherein negative support referred to negative experiences and positive support referred to positive experiences with such assistance (or lack thereof in both cases). Finally, workload was defined as the amount of work participants had to undergo when using online

assessments in their lessons. High workload was distinguished when the responsibilities around using online assessment pushed on the boundaries of what the participants could realistically achieve in their roles. Low workload was coded when the responsibilities were achievable with lower identifiable effort by the participant. Table 2 below, provides a summary of each code with a simplified definition and example directly taken from the transcripts.

Table 2: *Summary of codebook*

Theme	Code	Example
Affect	Positive: Any emotion that occurs when an individual has attained and achieved a goal, a source of threat is avoided/ addressed, or when individuals are satisfied with occurrences	I thought like it was fun to connect with people outside the universities, so I got to go find guests and invite them and talk to them. It made it a little bit more, kind of like human feeling. So, I've enjoyed that.
	Negative: Any emotion that occurs when goals have not been achieved, unavoidable threats are present, or when individuals are not satisfied with occurrences	I feel a bit of a fraud. I've seen the battle there, expecting profs to be their enemies and I just list all the ways in which we're going to try to make this easier for them and it was still not enough.
	Neither positive nor negative: Emotions of indifference, wherein goals may have been achieved/ not achieved, there may or may not be threats present, but the individual is neither satisfied nor dissatisfied.	I mean, I think it's the same if it's not online. It was fine.

TPACK	Technological: Any ideas that involved general knowledge about information technology allowing for a person to use it at home and at work, along with the ability to assess whether its integration would assist or impede in a specified goal to be achieved	I found it easier to have a thing on the one page rather than you have to click to get access to it.
	Pedagogical: Any ideas that aligned with specialized knowledge used to facilitate effective teaching and learning environments	It made teaching feel very transactional, like there's something very specific that we're here to do. We're going to check off that list, we're going to do those things and now we're going to say goodbye and we never get to see each other again.
Assessment	Philosophy: The nature, principles, values and attitudes behind assessment as a whole	If you're if you're letting people do work that they care about anyhow, then it goes better than if you kind of force them to care about something they don't want to learn.
	Design: Any ideas that drew on how the assessment was created	What do I want people to have accomplished by the end of the semester? You know what I want them to be able to do. And then also thinking about the experience from their point of view.
	Implementation: Ideas on how assessments were used in a practical context	I didn't have any context at all when I was looking at people's assignments. It's like these

		assignments just kind of come parachuting at you from a black box as opposed to having an actual idea, like who wrote that assignment and what was going on in their life that week.
	Reflection: When participants thought back to the assessments and considered the implications of either the assessment itself or how it was designed/ implemented	Before covid, students typically would ask questions about how to prepare for the presentation, how to pick a topic to write about how to do the research for presentation for paper. In the past, I would often try to make myself available in person to have those discussions, usually at the university. That did not happen.
	Content knowledge: knowledge of subject content involving ideas, frameworks, theories and evidence of established practices.	I have had a consulting business and I've worked outside of academia. I'm hearing from my non-academic contacts is that our students are graduates, come unprepared to deal with the realities of the data analysis in the workplace expression.
Support	Positive: positive experiences with assistance	We had a really good person who was with us for a bit. Who would have like micro

		teaching about how to optimize bright space, how to use bright space and would make little videos. So we have like a little library of little videos about things.
	Negative: negative experiences with assistance	So you yourself have to somehow magically have a quiet place with a consistent internet connection and like an appropriate environment for teaching.
Workload	High: When the responsibilities around using online assessment pushed on the boundaries of what the participants could realistically achieve in their roles	I think the podcast did achieve all that, it was just a lot of work. Just the juggling, like trying to find guests for it, trying to you know, scheduling the recording of it with them, figuring out the order of everything, trying to persuade students to participate.
	Low: When the responsibilities were achievable with lower identifiable effort by the participant	It's just a very easy platform to use. Like, everything is intuitive, it's well-designed. It has good graphic design as good layout like things flow in a natural order. Whoever designed it clearly had in mind the perspective of instructors and prospective students and made those two different sets

	of tasks very easy. So, yeah, I found that kind of effortless.

The results and analysis sections of this paper are organized by considering the nature of the two research questions that guided the design of the study. The first research question (what is the process of using online assessments among higher-education teachers?), is a *what* question. To engage with this question, it required the author to report on the process of using online assessments as shared by the teachers during the data collection phase. This section will report on the data collected with little interpretation and inferences made on the data. The second research question (how does this process influence cognitive load), is a *how* question, requiring inferences to be made. To engage with this question, it required the author to infer into the process reported earlier as shared by the participants. This is as participants were not expected to explicitly relate their experiences to cognitive load theories during their interview. Rather, the data provided by the participants were analyzed by the author against theories of cognitive load post hoc. Consequently, the results section will include the participant profiles and research question 1, while the discussion section will include engagement with research question 2.

Chapter 6: Results

Participant Profiles

Based on the virtual interviews and questionnaire, this section provides profiles of each participant. The participant demographics (i.e. teaching experience, experience with online courses, general perceptions of using online assessments etc.) were derived from both the online questionnaire and the participant accounts during each interview (see Table 3 for summary). Table 4 shows the ratings provided on each participant's cognitive load questionnaire for the assessments selected as influencing the highest and lowest load. The participants' responses reported here will be analyzed in the next chapter (Chapter 7: Discussion), to explore the practices, attitudes, emotions, and tools around what they perceive as influencing the highest and lowest cognitive load on them as teachers.

Table 3: *Summary of participant demographics*

Participant	Pseudonym	Teaching experience	Online courses conducted	Highest cognitive load	Lowest cognitive load
1	Susan	12 years	6	Podcast: Participation	Annotation: Participation
2	Lance	5 years	2	Exam	Q&A: Participation
3	Larry	18 years	2	Presentation	Essays
4	Stanley	22 years	6	Project	Exams
5	Michael	30 years	1-recurring	Quiz	Essays

6	Maria	20 years	5	Presentations	Essays

Table 4: *Summary of cognitive load questionnaire ratings*

Assessment selected as influencing the highest load							
Question focusing on IL/EL	Susan	Lance	Larry	Stanley	Michael	Maria	Mean rating
IL	5	5	4	4	3	3	4
IL	5	4	4	4	3	3	3.8
EL	4	3	3	2	2	1	2.5
EL	3	3	3	2	2	1	2.3
EL	3	3	2	2	2	2	2.3
Assessment selected as influencing the lowest load							
IL	4	4	3	4	3	3	3.5
IL	4	4	4	3	3	3	3.5
EL	3	3	2	2	2	1	2.1
EL	3	3	2	2	1	1	2
EL	3	3	2	2	2	2	2.3

Note: Numerical values between 1-5 were given to ratings of strongly disagree (numerical value = 1) and strongly agree (numerical value = 5). A strongly agree rating is interpreted as influencing a higher load, while a strongly disagree rating is interpreted as influencing a lower load. The numerical values were used as a means to quantify the scale.

Susan's experience: High load podcast, low load annotation

Participant 1, Susan, had twelve years of teaching experience at higher-education level in the Social Sciences field. She had assisted in teaching at higher-education level while doing her PhD prior to joining the university as a professor. During the interview, Susan shared her interest

in the field of teaching, especially at the university, however, found teaching at this particular university a lot tougher compared to her previous work experience. Her philosophies around the use of assessments were as a means for students to progressively revise and improve on their work, referring to her practice as a revise and resubmit model. In her assessments, she encourages peer discussion and peer feedback to align assessment as a part of learning, rather than an accumulation of testing her own teachings.

In a general sense, Susan planned for her assessments by first thinking about what she wants her students to have accomplished by the end of the semester. Secondly, she thinks about the experience from the students' point of view, to foster experiences that are engaging and positive. The design process functioned under her philosophy that people remember experiences that are positive and block out experiences that are negative. The need to create positive experiences for her students spanned across this interview, with the notion of not wanting to force students to care about material they don't want to learn.

The pandemic reflected the reality of lacking choice and autonomy for this participant, in that Susan believed that everything became substantially more difficult during the institutional closures. This was due to the stress and pressure she felt to continue her lessons in an online context she was forced into. Although her previous philosophies functioned against forcing students into learning contexts they did not want to be in, she felt that Covid inadvertently created such scenarios in her lessons, consequently influencing a significant demand on her.

Susan chose a Podcast assessment as influencing the highest cognitive load on her. This assessment assessed student participation with regards to student comments on podcasts she, the teacher, creates. The high cognitive load was related to the workload Susan had to face as well as the limited supports and frustration she felt towards the design of the assessment. Susan felt that the load was influenced by the novelty of the pandemic closures and her pedagogical need to create an assessment that was painless on students and would create a social feel through vivid stories. Susan felt technological demands on her with regards to working with an interface the university recommended with which she was not familiar. She felt she had to pay close attention to each element of the site used to create her podcasts and share them with students. Although the university had assured that teachers will be provided support, the university was unable to provide timely support, taking over three months to respond to her inquiries. A major factor

influencing the high cognitive load on Susan was the pressure to use tools recommended by the university she herself was not happy with.

As the assessment influencing the lowest cognitive load, Susan chose another participation assessment where students were expected to annotate readings. Susan used a platform that she found herself as she felt she could no longer depend on the university for technological and pedagogical support. Therefore, her main objective was to find platforms that were suitable for her and her students. Susan found this particular platform exceptional in enabling student annotation, specifically mentioning the user-friendly design of the website with the visual layout of the site being intuitive and flowing in a natural order. She specifically mentioned perceiving the designers of the site as clearly having the perspective of instructors and students in mind when building the site, resulting in seamless implementation. A major factor that reduced the cognitive load on Susan was the trust she had on the platform to work as intended at any given time.

Lance's experience: High load exam, low load Q&A

Participant 2, Lance, had around 5 years of teaching experience at higher-education level with over 20 years of practical experience in his field. He joined the university to co-teach a specific course after being referred by a colleague for his expertise in his area of study. The course Lance co-taught used exams as its only form of assessment. During the pandemic, he felt that his teaching approach became completely different. Prior to the pandemic, his lessons had more discussions and were conversational with students. During the institutional closures he was forced into more lecture formats. He resorted to teaching through a series of podcasts (similar to Susan), as he found recording his lessons while presenting his slides was complicated and assumed a teaching style he was not familiar with, as he would not rely on slides during his in-person lessons prior to covid (rather, relying on learning goals, notes and assigned material).

Lance created his podcasts for students to watch prior to his lessons and dedicated his scheduled class time to discuss the material with students. He worked under the major philosophy that exams are a suitable way to assess comprehension of materials. The exams are all open-book exams, therefore, Lance believed that it was the best method to evaluate students in all of the material that has been taught throughout the course in one go. He further believed that the open-book exams are representative of professional practice as individuals will have

access to notes and resources, however need to be knowledgeable enough on the content to know where to access what is required.

As the assessment influencing the highest cognitive load, Lance chose virtual open-book exams. Although he believed the exam was a suitable method to assess his students, the considerations of making the exam online were demanding. Lance also mentioned the difficulty of engaging in a protocol that was novel to him, in a context that was forced upon his practice. This made him feel unprepared to address the pedagogical considerations of shifting exams to virtual platforms. Some of the main considerations that enhanced his cognitive demands were the proctoring of the exam. Lance felt that as an instructor, he had little to no control over the integrity of the assessment as he had limited experience and knowledge over how to proctor online examinations. He also touched on the lack of support around the pedagogical implications of such assessments.

Lance chose a Q&A assessment as influencing the lowest cognitive load on him. The Q&A was implemented as part of his discussions with students during his synchronous lessons. As students were expected to have listened to his podcast, he would prepare a set of questions to be discussed during class time. The Q&A was conducted as a form of informal assessment that was not added to the students' final grade. The major factor that influenced the low cognitive load on Lance was the premise that the assessment was informal, therefore, providing him with the freedom to engage students in ways that were suitable for him to assess their comprehension with each topic. The philosophy behind the implementation of this assessment was to provide students with a low-stakes environment to make mistakes and clarify their understanding. Therefore, the reduced pressure in not formally assessing in ways the university intended teachers to continue assessing students during the pandemic, was perceived by Lance as reducing his cognitive demand.

Larry's experience : High load presentation, low load essay

Participant 3, Larry, had experience teaching at higher-education level for 18 years as an adjunct professor. Similar to Lance, Larry was recommended for the position based on his expertise in practice and joined the university to be involved in a course as a co-teacher. Larry functioned under the philosophy that exams were not representative of learning, rather, that active participation provided a clearer view of comprehension. He also believed that essays were

a suitable form of assessment after engaging in participatory discussions, as it not only tests student knowledge but provides students with comfort in the specific subject area. Clear and detailed feedback was a factor that was emphasized throughout the interview, wherein, he aimed to provide feedback that was as detailed as possible during the student discussions and participation activities, so as to receive a final product (i.e. student essays), that reflected the feedback that was provided, consequently improving the quality of the papers he received.

Larry did not believe the pandemic to have made many changes to his assessments, other than requiring his teaching to be shifted online. Similar to Lance, Larry did not usually rely on PowerPoint slides in his in-person courses, rather, relied on notes he creates regarding the topic to be discussed as well as a general outline. Larry used participation as a means to feed off of his audience, which was evidently difficult during the pandemic due to the use of the Zoom platform. He experienced more students keeping their videos off and muting themselves, resulting in the need to prepare detailed PowerPoint presentations during his lessons, designed to convey material in ways that don't overwhelm his students, but with limited feedback from students.

Larry chose online presentations as the assessment that influenced the highest cognitive load on him. The presentation format was used prior to the pandemic with the assessment material, guidelines and design being the same as it was before, with the only difference of being online. In this assessment, not only were the presenters assessed on their presentations, but students were also given a participation grade for actively participating in the presentation by asking questions or providing comments/ generating discussion. The sections which influenced the highest cognitive load on Larry was the participation element. This was as students were less likely to participate in discussions online compared to during their in-person courses. Therefore, Larry found himself attempting to generate and facilitate discussion a lot more than he was used to prior to the pandemic, while requiring to facilitate discussions, monitor the chat as well as write notes on students being assessed. The major factor that contributed to the high cognitive load, according to Larry, were the multiple elements he had to shift focus towards during the presentation assessment.

The assessment Larry chose as influencing the lowest cognitive load was the essay assessment. This was as even prior to the pandemic, students submitted their essays online through the Brightspace LMS. This was an assessment Larry felt confident in and comfortable

with as he has used this format of grading student essays for over a decade. The familiarity with the assessment significantly reduced his perceived demand, which provided him with a sense of relief when using the assessment. The familiarity with the essay format of assessment created an experience that felt more natural to Larry. When comparing with the presentation participation, Larry believed that having to force students to participate, felt quite artificial and engaging in an assessment experience that was more natural to the instructor influenced a lower perceived cognitive load.

Stanley's experience : High load project, low load exam

Participant 4, Stanley, had 22 years of teaching experience at higher-education level. He, like Susan, started teaching at higher-education level as a graduate student. Stanley's general outlook on teaching and assessing at this level was that when he was younger, it was much easier as he could connect with students in a more personal and relatable way. Although he had years of experience teaching, as the years went by, he felt more and more disconnected with students, resulting in an experience that was perceived as more of a struggle than rewarding. His philosophies around teaching and learning were that teachers have been fighting as opposed to working together with students to facilitate learning, ultimately making the process of learning unpleasant for both teachers and learners.

With the onset of the pandemic, Stanley's major challenge was attempting to address issues of cheating during online examinations. After a semester of using an online proctoring system to monitor students while they write their exams, Stanley as well as his colleagues decided that they were no longer going to use the online proctoring system. He felt it was extremely invasive for students and if any student feels the need to use the bathroom, get some food or even walk away from their desk in frustration, they should have the freedom to do so without getting penalized. Another major consideration was acknowledging that he, as the teacher, does not have the time nor the cognitive capacity to go through hours of footage for each exam. Throughout the interview, Stanley made it clear that he became a little more lenient when it came to the use of online assessments with his students during the pandemic. He felt that although prior to the pandemic, he would address any concerns with students he wanted to raise, during the pandemic, he would carefully select concerns he felt were urgent and tried to be more understanding with less urgent matters such as a sudden drop in grades, possibilities of

plagiarism or cheating. He found himself to be less judgmental based on the knowledge that if he were to be in the students' position, he himself would most likely choose to not enroll in university in the middle of a pandemic. Similar to Susan, Stanley felt that students were forced into an environment they didn't ask for, thus requiring a more understanding approach.

The assessment Stanley selected as influencing the highest cognitive load on him was an open-ended group project. Here, Stanley provides teaching material and sources of information as well as supports to specific themes, where students have the opportunity to select a theme and build a project around a central question. He places basic guidelines with regards to the length of the product (for example: papers should not be longer than 12 pages), however, the key questions and topics/ themes each group works on will be different to one another. The participant selected this assessment as generating the highest load as projects, where each project will look completely different to another, is an assessment style that is novel to him. The basis by which answers, or student products look different, create a cognitive load by which he feels unfamiliar with how to assess the different products without any bias. However, as a philosophy, the participant perceives that it is incredibly important to provide students with autonomy and choice to work on projects and themes they are interested in and build on ill-defined problems as it is a representation of challenges in practice.

The assessment that was selected as influencing the lowest cognitive load were exams. This was as the participant perceived exams to be the tried-and-true method of assessment. Although open-ended projects may provide a more valid representation of knowledge, the rigidity of exams provided the participant with the comfort of knowing how to objectively assess the constructs being assessed. The exam assessment was described as being more real and less intense as this is how he has experienced assessment in his field during his own education. However, similar to the previous assessment, he felt a conflict between his practical and pedagogical self, in that, practically although exams felt more natural due to his experience and confidence with it, pedagogically he believed more open-ended projects would provide a better representation of what has been understood.

Michael's experience: High load quiz, low load essay

Participant 5, Michael, had the most teaching experience in the sample, with 30 years of teaching experience at higher education level. His general perception of teaching was that he

really enjoyed it, however, did not feel confident with integrating and using technologies in his practice. He felt that even though he enjoyed teaching and enjoyed using technologies as part of his lessons and assessments, he was unsure of whether he was using the tools in the correct manner, or in ways that utilized the complete potential of the tool. Michael's philosophy around assessment was the need to be straightforward. Within the assessment process, he indicated putting in most of his effort in the design stage, to create clear course outlines and assessment guidelines, with as little ambiguity as possible.

Michael's perceptions on the influence of Covid on his use of assessment was in contrast with the other participants in which he perceived the Covid restrictions to make the assessment process more comfortable for him. He indicated the clear need to familiarize himself with the new tools such as Zoom or Microsoft Teams after the sudden shift, however, he felt more comfort in working from home and having students join from their own homes. The participant also had technological support from a teaching assistant for some of his courses, who assisted with using the LMS, Brightspace to accommodate the new shift (i.e. connecting Zoom schedules and links to the system). Michael believed in having assessment material available online, as well as assessment submissions, as to make the platform available to all students. He strongly believed that making material available free and online takes a major step towards equitable assessment and the transition to online modes facilitated in that.

Michael selected online quizzes to influence the highest cognitive load on him. This was as prior to the pandemic, all quizzes were provided in person on paper. Each of the modules covered during the semester would have a quiz before the module and after the module for Michael to have an idea of the uptake of knowledge through a pre/post-test format. Due to his unfamiliarity and low confidence with technological tools and online programs, he perceived creating online quizzes (in cases where a teaching assistant was not available to him), more cognitively demanding compared to creating a quiz on a word document and printing a physical copy to be shared. This is also due to the novelty of the online quiz approach for Michael, he perceived navigating Brightspace to design what he intended to design was particularly difficult and demanding.

The assessment Michael selected as influencing the lowest cognitive load on him were essays to be submitted online. This was due to the familiarity of the assessment. Even prior to the pandemic students were expected to submit their essays to the LMS wherein he would receive

them online, grade them and provide feedback through the system. As it was not necessary to change the outline of the assessment or the design, it was considered to generate the lowest cognitive load. The participant described the cognitive demand with the essay assessment to be exactly the same during the pandemic as it was before the pandemic.

Maria's experience: High load presentation, low load essay

The final participant, Maria, had around 20 years of experience teaching at higher-education level. She described her teaching experience as atypical as she started as a part-time professor and teaching multiple different courses each semester without a steady stream of courses that were continuously assigned to her. She now works as the director of the overall school with her teaching role filling in any gaps with which teachers are required, exclusively teaching graduate students. Maria mostly used combinations of tests, essays, presentations and projects as a means to assess her students, working under the main philosophy that assessment should be continuous and build on one another. Similar to Susan, Maria preferred a revise and resubmit model wherein students were provided the leeway to make mistakes, revise their projects and submit their updated work with projects that are ongoing throughout the semester.

During the Covid-19 institutional closures, Maria found it difficult to adapt to the sudden changes. She had previous used Brightspace as a content management platform where she can store lesson content such as course outlines, readings, assessment resources etc. However, the functionality of the LMS had changed after the shift. Not only was Brightspace used for content management but all aspects of the lessons were shifted online. Previously, Maria was able to meet with students either during lesson breaks, after the class or during office hours where students would come to her with questions or feedback students wanted to clarify. However, with Zoom, less students would meet with her and she found that once students were offline, they really wanted to be offline as they were tired of being on the computer, which she related with as she felt the same.

The assessment selected as influencing the highest cognitive load on Maria were online presentations. This was due to the multiple elements she had to focus on during the assessment. The major stage of the assessment that was perceived as the most cognitively demanding was the implementation of the assessment. During implementation, Maria felt that she not only had to focus on the student on the screen, but she also had other students on the same screen (albeit

sometimes in smaller boxes). Additionally, she would also pay attention to the presentation materials (i.e. PowerPoint slides/ reports/ other resources) which was also on screen. While Maria pays attention to the multiple visual elements on the screen, she also needs to monitor the chat for any comments or questions students are permitted to share during presentations, to facilitate discussions after the presentation has ended. Although prior to the pandemic, Maria would write notes on the presentations while the presentations took place, she found it extremely difficult to write notes during the online presentations as she felt as though she had to concentrate more to process the information being presented.

The assessment Maria selected as influencing the lowest cognitive load on her were online essays. Similar to Michael, online essays were a form of assessment she was extremely familiar with. Students were asked to submit essays online through Brightspace, where she would download them, grade and provide feedback through the system prior to the pandemic. Regardless of the institutional closures, she perceived there to be very limited, if any, changes to this form of assessment. Due to her familiarity as well as confidence with the online assessment, she determined the online essay assessment as influencing the lowest cognitive load on her.

Research Question 1: What is the Process of using Online Assessments among Higher Education Teachers?

To address this paper's first research question, this section ties back to Laurillard's (2013) analysis of assessment being situated within the complex contexts, experiences and philosophies of the assessors and individuals being assessed. Although there may be a wide research scholarship behind assessment literature highlighting the theoretical and practical implications of such scholarship, how assessment is experienced in classrooms may vary between teachers. The profiles of each participant interviewed in this study may provide evidence for the situated character of assessment. The process of using assessment included common themes across each participant, all experienced and lived in different ways but functioning under the same context of limited choice during the pandemic. From the codes that emerged from the transcripts, the process of using online assessments in higher-education teachers included moments that tied to affect that was positive and/or negative, moments that required support, and moments that were heavy and sometimes light in terms of workload. Each of the sections below will not use examples from every participant, rather, examples from the

transcripts were selected because they are representative of the factor discussed. This may create a limitation with regards to the representation of every participant in this study, however, due to considerations of feasibility, examples from transcripts were specifically selected to aid the discussion of the factors below.

Affect

Each participant shared the affect they experienced when using online assessments with their students during the Covid-19 institutional closures. However, they experienced affect in various ways, tying to different elements of the assessment process. In terms of negative affect, Susan and Stanley expressed clear dissatisfaction with their experience using online assessments with their students. Throughout her interview, Susan shared multiple moments which depicted negative affect, aligning with the American Psychological Association (2022) definition of negative affect being emotions that stem from goals that have not been achieved, threats to an outcome, and general dissatisfaction with occurrences. However, negative affect, in Susan's case, was tied to the overall context of Covid-19 and the challenges that were brought forward due to the context.

> *I think it's inherently challenging to be teaching people at a time that is extremely stressful. You know, they're under a lot of stress, under a lot of pressure. There's like a lot of just literal problems that have been foisted on the people because of COVID. Then there's the fact of being forced to teach people online. Then there's the fact of just like rapidly changing circumstances. So kind of never knowing, oh, like, how long are we doing this for? What resources are really available? Then there's the fact of what I would describe as relatively poor technological and logistical support.*

Susan's clear dissatisfaction aligned with the limited choice brought on by the context of Covid while also touching on the stress and frustration influenced by the limited means to prepare for a future of unknowns.

> *I managed to make it work through, immense effort and becoming an expert in the technical specifications of Flip Grid, which is ridiculous and a complete waste of time and kind of exhausting.*

The negative affect, here, may further align with the dissatisfaction created by the unknowns, wherein Susan experienced a perceived demand to become acquainted with unknown tools, to use in circumstances that were further unknown.

In Stanley's case, the negative affect he experienced was not related to the unknowns of a context he was forced into, rather, the distance he felt as a teacher with his students.

> *I feel that the students and teachers have been sort of fighting as opposed to working together towards learning and it could just be my personality, of course, but it didn't used to be that way, which means that I don't think it's just my personality. I think there's something about learning and assessment that is becoming unpleasant.*

Not only did his assessment philosophies tie to teachers and students working together to learn and understand material, but the distance as an educator he felt with assessing students at higher-education level, went against his own philosophies around learning. This may have influenced a negative affect around using online assessments or assessments in general, with students. Stanley's outlook could potentially also tie with Susan's views that online assessment created a view of learning to be transactional.

> *It made assessment feel very transactional, like there's something very specific that we're here to do. We're going to check off that list, we're going to do those things and now we're going to say goodbye and we never get to see each other again.*

Negative affect in each case aligned with lacking the human connection between student and teacher. This collaboration was intended to serve the purpose of achieving goals that are negotiated and communicated with students, to include a student-centered process that would satisfy the student's needs as well as the teacher's experience.

Positive affect aligned with experiences of connection with students, conversely relating with the negative affect relating with the lack of connection, for example, as experienced by Stanley and Susan in the previous section. Positive affect was predominantly shared by Larry with regards to the continued communication and connection he had with students prior to assessment, during and after.

> *I've been quite fortunate that most students who clearly learn what we teach them, clearly are willing to share what we have taught and their skills. And sometimes when I'm able to follow their career, the ones who did well in our class have done also well and in the professional life. It makes me so happy to know that they are learning, and I played at least a small part in their learning which some come back to me to tell me they still use in their professional practice.*

Larry's positive experience may tie to Susan's negative perception of transactional assessments where students conduct the assessment, leave and teachers never hear from them again. The moments facilitating and tying to the human connection of assessment, may enhance the positive affect in the process of using online assessment, to provide teachers with not only a pedagogical purpose for using assessments, but an emotional connection to those who are being assessed (i.e. moving from a process that is transactional to relational).

In the context of online learning and assessment, this paper addressed the shift in literature between a solely cognitive process towards having a more affective influence (Brom et al., 2018; Plass & Kalyuga, 2019). However, in contrast to the current literature which provided evidence for affect being influenced by the design of technological tools and user interfaces that were easy to use, the participants shared moments in which affect was more tied to the human connection, rather than the tools used. Regardless of affective designs and user interfaces, the participants in this study seemed to be affectively influenced by:

A. Their perceptions of attachment with their students.
B. The relationships they could and/or could not create with their students through their use of assessment.

Support

A theme that emerged from each transcript was the experience each participant had with the types of support they received when using online assessments during the pandemic. To aid the reporting of this section, it is considered that support, although not an element discussed in this paper's literature review, could be linked to the existing knowledge stores and knowledge that builds when navigating through a specific context. This may align with TPACK in that the support teachers received could influence TPACK in facilitatory or inhibitory means. In terms of support, the author distinguished the theme into two codes encapsulating positive experiences with support and negative experiences with support. Positive experiences with support connected to experiences that facilitated an existing bank of knowledge. For example, Maria shared a specific instance during the shift to online modes that helped build her own confidence with technological tools.

> *We had a really good person who was with us for a bit who would have micro teaching sessions about how to optimize bright space, how to use Brightspace and would make little videos. So we have a little library of little videos about things.*

In terms of TPACK, this may not only facilitate the teacher's technological knowledge in general, as described by Crompton & Sykora (2021), and Kelly & McAnear, (2002) but could also facilitate the development of technological pedagogical knowledge (Koehler & Mishra, 2009). The supports were provided for Maria to assist her use of technological tools in practice, building on contextual knowledge (Mishra, 2018) to be considered during the pandemic.

Michael shared similar positive experiences with support, all of which played a role in building on his own knowledge, further connecting to TPACK.

> *I find it is actually great. Yeah, I mean, I'm not technically savvy. Look, I'm an old man, but I know where savvy people are, so I get some help. So, for example, at one point I hired a student, an undergraduate student, to help me appear like I'm technically savvy, but I'm not. I'm useless, but with his help, I was able to become a little more savvy. Very helpful.*

Here, not only did Michael address a deficiency he perceived in himself with regards to his limited technological knowledge, but with the supports he received, was able to gain some form of confidence with using technological tools. This highlights the potential importance of not only having the knowledge and developing the knowledge, but also knowing where to look to address the specific area of knowledge.

In terms of negative experiences with support, the participants shared moments that were conversely influenced compared to the positive experiences. Positive experiences may have been linked to types of knowledge that were facilitated with the use of such supports, however, negative experiences aligned with their limited knowledge and the limited support present to facilitate their knowledge. For example, Lance shared a specific moment with which the ambiguity of the institution's goals not only influenced his use of online assessments but there were limited means to expand on his own knowledge which could not only negatively impact his work, but his students as well.

> *Maybe I missed the communication but I think one thing that was really lacking was any information around are we expected to be doing this synchronously or are we expected to be doing a half synchronously? Half asynchronously like I don't feel like the expectations were clear, nor did they give us anything like here is how you can go about doing it. We were left in the dark to just figure it out and that was so scary because you don't just want to do right by your subject but you want to do right by your students.*

Susan shared similar views with regards to her own limited knowledge around what was appropriate and expected from the university. Here, teachers were having to navigate through a period of limited contextual knowledge and limited means to expand on other forms of knowledge that were functioning under the unknowns of the context.

> *It's a terrible idea, you know, and nobody could ever really give me an answer as to whether this was allowed or not and I just decided I didn't care. So it's like no one else really seemed to particularly care about what we were doing, either. Especially with the technological side, it was frustrating and I have basically no support to figure this out.*

Workload

Both affect and TPACK (connected to support), were concepts discussed in the theoretical framework and literature review of this paper. However, workload was a theme that emerged from the data being analyzed, that the author did not consider earlier on in the design of this study. Participants' lived experiences with using online assessments, especially during a pandemic, connected to the workload around the complexities of its use. Experiences with workload were shared only around either moments of high workload or low workload, where, for example, high workload indicated specific moments that pushed on the teacher's boundaries and limitations.

Lance shared his experience with high workload wherein the workload stemmed from his priority to maintain the academic integrity and rigor of the assessments shared with his students online. When situating assessment in a new context online and working from home, a context Lance was not familiar with for his exam assessment, a major aim was to maintain elements of the assessment that were maintained prior to the pandemic. However, in this sudden new context, teachers were expected to steadily maintain such priorities, with little experience and little time to prepare.

> *Now everyone's got it on their own laptop because that's how it is delivered and so the next year, students who are asking previous year students for their notes, it now includes last year's exam. So it adds that extra pressure on us to draft more. You know, we already were drafting new exams, but we were, you know, sometimes using, picking and choosing stuff from previous exams. But now it's like there's a lot more pressure to draft fresh questions and completely new exams each year.*

Larry shared similar experiences with high workload, aligning with the sudden shift to online modes, however, with regards to assessment resources rather than the assessment itself.

> *So I was forced the first year to spend a lot of time to actually developing very detailed online resources my students can refer to when they prepare for their final papers, specifically PowerPoint presentations, I had to make very detailed so*

> *everything's all in one place, like links, reports, articles, videos. It was a lot of pressure suddenly and also knowing they're less likely to come to you if they need help at that time, so needing to have things there if they need it.*

Although high workload was associated with the design of assessment, low workload was associated with the implementation of assessment. In Susan's experience, low workload was around a technological tool she used as a platform for her assessment.

> *That's pretty easy to use. You know, it was easy. It was really it was. It took me less time to put all the readings that I wanted as close readings for the entire semester into perusal than I did to set up just a fraction of the bright space page. I mean, it's very, very fast to use as the instructor. It's like, you know, just easier to tutor.*

In this case, Susan's low workload tied to the ease of use of the platform and user experience. When using a platform for the implementation of assessment with students, the teacher considered the time it took to use the tool as well how easy it is to manage the tool when students populate the platform. An alternative experience is in Stanley's case which connects the low workload not to a platform, rather having additional support.

> *I didn't have to make all of these decisions myself, but we had a T.A. who was excessively skilled at working with the platform which took a lot of effort and work off my plate so I could focus more on marking later on.*

In this paper, the process of using online assessment was found to involve affect, support and workload in the 6 participants it sampled. However, each of the three elements (affect, support and workload), may not always function in isolation. These elements showed a link to one another to create the process of using online assessment, as a dynamic and complex action. For example, negative experiences with support also aligned with an aspect of affect. In the cases of both Lance and Susan, their experiences with negative support also involved moments of negative affect where Lance felt fear and Susan felt frustrated. With regards to low workload,

Stanley's experience aligned with a positive experience with support, further depicting a process that may be interconnected, with one element having a potential influence on the next.

Chapter 7: Discussion

Research Question 2: How Does the Process of using Online Assessments in Higher Education Teachers Influence Cognitive Load?

Considering the interconnected qualities of the elements within the process of using online assessments, the second research question was addressed by looking at each coded section of the transcripts and seeing where codes overlapped with one another. The transcripts were coded at idea level where sections were coded according to any codes that were considered appropriate for a specific idea. Due to this, there were many instances where codes overlapped in sections. To answer this research question, this following section infers into the overlapping codes in the three interview sections that specifically focused on the assessments selected as influencing the highest cognitive load, lowest cognitive load, and the overall demands of online assessment.

Assessment Influencing the Highest Cognitive Load

Each assessment in this section was different to one another except for presentations (as selected by Larry and Maria). However, a commonality across all assessments selected in this section, is that each assessment needed to undergo changes to adapt to an online context (i.e. could not be used in the same ways as prior to the pandemic). The three main overlapping codes in this section were high workload, negative emotion and design. In the results section of this paper (i.e. reporting of the process of using online assessments), high workload was shared by participants in their description of the design of assessments. In this chapter, the overlapping of the codes 'design' and 'high workload' that emerged in the data analysis will be discussed. When considering the types of cognitive load, there were a few instances where participants shared moments that were demanding on them which could be related to extrinsic cognitive load. Maria shared a specific instance with her presentation assessment that was perceived as particularly demanding.

> *It was very, I would say, psychologically exhausting over a three hour period to be able to manage where your eyes went to go through your screens of students. Part of it was also to manage comments, the comment thing, people putting up their hands. Well, if there were too many people on the computer at once managing the*

multiple screens and then managing writing notes for feedback, and also that aspect around trying to make sense and so that people also learn from each other.

From an extrinsic cognitive load perspective, the information required for the teacher to use an assessment online, resulted in receiving multiple forms of information presented in ways that potentially influenced a particular strain on her. This aligns with previous research on extrinsic cognitive load which categorizes the construct as factors that function externally that influence strain on individuals (Sweller et al., 1998). This also extends to research done by Çakiroğlu & Aksoy (2017) in that having multiple overlapping elements on a screen that needs to be considered at a given time, resulted in an increase in cognitive load. Although this paper does not measure cognitive load in teachers, it provides the opportunity for teachers to reflect on what they perceive as influencing the highest cognitive load on them, with findings that may be consistent with previous research focusing on extraneous load.

Compared to instances that related with extraneous cognitive load, however, the participants were consistently tying more with intrinsic cognitive load. This was also consistent with the mean ratings from the cognitive load questionnaire (Table 4). The quantitative measure was only used in the preliminary questionnaire (Appendix A), as a means to inform the semi-structured interview (Appendix B). However, when the qualitative analysis presented results that aligned more with intrinsic load, the author retroactively interpreted the mean rating values. Table 4 showed that the highest mean values (representing a higher load) were reported in questions assessing intrinsic load, consistent with the qualitative inferences made by the author. Relating to findings by Paas & van Merriënboer (1994) and Sweller et al. (2011) intrinsic cognitive load was categorized as the load influenced by the inherent complexities of a task. The high workload shared by each participant was perceived as being influenced by the complexity of the assessment itself. Evidence of the inherent complexities may tie to Larry's and Lance's examples of high workload in designing their assessments. Lance had to consider the new context of students carrying the examination with them, with the possibility of sharing the exam with other students who take the course later. In addition to that, he had to also design the assessment, now, potentially bringing on a new set of complexities around constructing completely new exams each year.

Larry experienced such complexities in different ways by considering the need to prepare additional resources for students to refer to, prior to conducting their final assignment. As articulated by the participant, with this consideration came the demand of thinking on behalf of the students, with whom he was not acquainted. Due to the disconnect of the online system, there was a need to select and share as many resources he would deem helpful. When comparing to in-person modes, Larry was confident students would reach out to him for assistance with challenges or concerns with completing the assessment. However, with the sense of detachment of online lessons, the lack of familiarity with students influenced his perception that students would be less likely to reach out if they need support, potentially increasing the load and complexity of the task.

This section was also overlapped with negative emotion. In all instances where participants spoke about moments of high workload, participants also shared negative emotions around the assessment. These emotions were namely frustration, fear and stress. These findings are consistent with contemporary research around cognitive load having an affective influence (Brom et al., 2018; Plass & Kalyuga, 2019).

Assessment influencing the Lowest Cognitive Load

There were more commonalities in the assessments in this section wherein the assessments selected were either essays or participation (with the exception of Stanley's selection of exams). It is speculated that these assessments were selected as they were consistent with its use prior to the pandemic. In contrast with the high load assessments, the sections focusing on the assessments that were selected as influencing the lowest cognitive load in the transcript, showed an overlap in low workload, positive affect, and implementation. Similar to the assessments influencing the highest cognitive load, this section is consistent with the findings from the first research question. The process of using online assessment showed that instances of low workload may be related with the implementation of assessment, rather than design (which was potentially related with high workload). Relating with principles of CLT, instances of low workload, for example, in Susan's case of using an intuitively designed platform, may reduce the amount of extraneous load the teacher experiences. This not only resulted in taking less time to navigate through the platform as there may have been less overlapping elements to maneuver at a

given moment, but influenced a process that was described as easy on the participant i.e. perceived as less cognitively demanding.

Intrinsic load could relate with the reduced complexity of the assessment. When considering the examples of low workload, both Susan and Stanley spoke of the inherent ease of the task, based on two different factors. Susan spoke of the ease of use with regards to the platform. Stanley spoke around the support he received which reduced not only his workload but the complexity of using the assessment online. Stanley perceived himself to be less technologically savvy, which had the potential to influence cognitive load by increasing an extraneous load of navigating through multiple competing elements of an unfamiliar platform, and intrinsic load of the inherent complexities of using new technological tools for assessment. However, by using an external support person who was better equipped to address the technological concerns the teacher was unfamiliar with, it significantly reduced the perceived amount of stimuli to be processed.

In contrast with the previous section, the code low workload overlapped with positive emotions. In moments participants shared their experiences with low workload, they also shared elements of positive affect. These emotions were namely joy, confidence and relief. The overlapping codes being high workload and negative affect in the discussion of the assessments influencing the highest load; and low workload and positive affect in the discussion of the assessments influencing the lowest load, can be interpreted as having a converse relationship (i.e high cognitive load: high workload, negative affect; low cognitive load: low workload, positive affect). The speculated converse relationship that naturally emerged through the analysis of the transcripts, provided a potential for validity with regards to the influence of the process of using online assessments on cognitive load.

It can be argued that the process may not only influence the teachers' cognitive load, but vice versa. In instances that were high on workload and negative on affect, it may have influenced a higher cognitive load. However the experience of cognitive load may not be entirely unidirectional. For example, the existing cognitive load around the sudden shift and context of being forced into a work environment teachers did not want to be in, could have potentially influenced affect and workload. Here, not only could external input influence cognitive load, but cognitive load could also influence the processing of external input. The cognitive load around the tasks itself may have influenced the workload as well as the affect, with each factor building

on one another until teachers are able to generate the required cognitive resources to address the demands. Conversely, the low cognitive load around the assessment task, may have influenced a lesser need for work around the assessment, also influencing positive affect. Although this paper's second research question is presented as how does this process influence cognitive load? The process may not, in actuality, influence cognitive load, rather, there may be more of a relationship between the process and cognitive load which influences one another and facilitates as well as inhibits the next.

Overall Demands of Using Online Assessments

The theme of support was coded under the two categories of positive and negative support. However, it is important to note that positive support commonly overlapped with technological knowledge (linking with resources) and negative support was commonly overlapped with pedagogical knowledge (also linking with resources). Although there may have been positive support around technological knowledge/ resources, this may not always relate with lower cognitive load. Rather, teachers reported being overwhelmed with the amount of technological resources and tools that existed, as well as the supports provided by the university on the tools. Maria shared her experiences with positive support around potentially increasing her technological knowledge. However, although that would have been useful and positive for teachers who had the capacity to learn, for teachers who were already high on workload and negative emotion around the context of the covid closures, this positive support ultimately becomes a negative support, leading to a potential influence on cognitive load.

> *When they organized webinars and had all this information about some of the tools, I was just thinking how cool some of these stuff are, especially in Brightspace that I've never used. There isn't the time to do it. There isn't the time to learn it well enough so that you can feel confident. The fact that we actually got on and we can sort of put together a class in three days and stuff like that in the computer was pretty spectacular as it is. It's like why are you not helping with the million things we're actually doing, and just giving us more things to do?*

The negative experiences with support related to the limited chance to build on their pedagogical knowledge, also potentially resulted by the exhaustive technological support teachers received. An example from Stanley shows the pedagogical constraints of the technological support.

> *From an online assessment perspective, the process to have to follow the technologies the university, bless its soul, is always trotting out these new messages and these new approaches. Oh, there's a workshop to learn how to use it. I don't have time to do this and nobody has the time to do this. And fundamentally, we can't keep on changing our pedagogical, including assessment, approach every three years when somebody else has a great idea.*

Although each of these insights were not reflected in the research cited in this paper's review of literature, these findings still provide implications with regards to factors that could influence the complexities of using online assessments during the pandemic. The new insights that emerged from the data further reflect this paper's exploratory nature. This also poses the question of the institutional priorities with regards to using technologies. The teachers interviewed in this study did not claim to require new technologies to use, rather required adequate supports to adapt technologies they were already using to facilitate their existing pedagogical approaches and philosophies in a new context. Regardless of new technologies or new features in existing technologies, cognitive resources were still potentially exhausted with *how* to use the technologies rather than *what* technologies to use.

Conclusion of Results and Discussion

The common themes across research questions 1 and 2 were workload, emotion and support. Each example relating with high workload and negative emotion can be inferred as experiences that were novel to the teachers. Each participant experienced the complexities of a new context as well as the internal demands of an assessment in an environment, especially in the design stage that was not familiar to them. It is interesting to note that the design stage of assessment was coded more often in the highest cognitive load section since teachers most often related their high cognitive load experience to the assessment design rather than its

implementation. This could be as the design of the assessments needed to adapt to the new context, thereby requiring teachers to either start completely from scratch (for example in Susan's experience), or shift previously used assessments to new platforms, potentially influencing its design.

The high workload and negative emotion for the new context and design of assessments can be related with Feldon's (2007) study of teacher expertise and automaticity. Automaticity is when cognitive operations function with little to no conscious awareness, subsequently influencing less cognitive load as fewer mental resources are required to process input. Feldon commented on the likelihood of novice teachers performing in slower and effortful ways. Experienced teachers, in comparison, were perceived as executing instructional, assessment and classroom management routines with little or no cognitive monitoring of their actions. Although the teachers in this study may not have identified themselves as novices, the new conditions may have created a situation in which they could no longer execute usual routines or existing and established schemas. If pedagogical routines were viewed as mental scripts, the novel experience of emergency remote teaching may create an experience that goes off script, in some cases significantly. In the high cognitive load sections, it can be speculated that the design was often coded, as the new assessment or newly adapted assessment, went off the existing mental script, influencing a higher load.

The assessment influencing the lowest cognitive load was coded alongside low workload and positive emotion, conversely relating with the previous section. This section involved the implementation of the assessment rather than the design. This could be relating to the phenomenon discussed earlier by which the teachers did not feel the need to start from scratch, rather may have been able to replicate their previous assessments or somewhat replicate the process of using the assessment with students. Each teacher spoke of their low cognitive load assessment as influencing the lowest load as the assessment was used in the same method and means even prior to the pandemic (for example, submitting essays online). When relating with the view of pedagogical routines as mental scripts, these assessments may heavily align with the teacher's mental scripts wherein, although the teachers may have regarded themselves as experienced teachers, they were experienced in familiar teaching contexts. In a context that is extremely novel to not only teachers but students, administrative staff and the institution as a whole, it can be inferred that teachers may be similar to Feldon's idea of novice teachers,

requiring more explicit deliberation and forethought to their actions. This subsequently may align further with the need for pedagogical supports to build new routines and schema in new contexts. A potential implication could be to further study these teachers many years into the pandemic, to explore if their views on the assessments regarded as influencing the highest cognitive load remain similar. It can be speculated that with time and with the adequate creation of new scripts, routines and schemas, the load could potentially lessen.

With regards to institutional support, it is important to note that teachers did receive support from the institution, with some having positive experiences with support. However, this did not translate to lower reported cognitive load, nor did it always translate to positive affect. Stone & Baker-Eveleth (2013) investigated the influence of perceived satisfaction as well as perceived usefulness on the use of technologies (namely the continued use of electronic textbooks). The researchers found that perceived usefulness and perceived satisfaction with the tool predicted its use. Muñoz-Carril et al. (2021) build on Stone & Baker-Eveleth's findings to further investigate the influence of perceived usefulness and perceived satisfaction on perceived learning impact. In a teaching context, specifically the teachers sampled, although teachers received support, both papers cited in this section provide a potentially valuable insight into whether the teachers found the technological support useful and satisfying. Useful in a cognitive context could align with knowledge resources that add to the building of schema. If teachers were in the process of building pedagogical schema and adapting existing pedagogical scripts to facilitate new schema, technological support may not be perceived as useful, nor satisfactory no matter how much support they receive. This creates a potential implication for institutions to provide support by, first, determining what 'useful' means to teachers. A critical approach may be required to carefully consider the existing complexities faced by teachers, especially in a period of sudden turbulence, to provide resources that are not just useful in practice but feasible in context.

Chapter 8: Limitations and Implications for Future Research

Theoretical Implications and Limitations

According to Sweller et al. (2011) all three types of cognitive load have the potential to occur in online learning contexts to varying degrees depending on the complexity of input experienced by an individual. This in turn, provides a view of the presence of cognitive load being unidirectional and dependent on the complexities of input. While this study is exploratory and likely not generalizable in the absence of further study, the theoretical contribution is the key insight into cognitive load as a potentially multidirectional occurrence that is not only influenced by input but can also influence external processes. The online assessment context of this study also provides an extension of cognitive load research and theory by not focusing on learners and learning, rather teachers and assessment.

It is important to note, however, that this paper is limited in terms of the potential biases present in its analysis. The data analysis was conducted inductively using emerging codes and themes prevalent in the data. Each transcript was subject to interpretation which may have potentially influenced its analysis. However, the data was coded based on naturally occurring factors with rationales for the coding decisions made clear in the reporting process. Furthermore, a member checking process was undergone to check if the themes generated were consistent with the participants' experiences. Although the paper used naturally occurring codes that were interpreted by the principal investigator, the sections on the assessments influencing the highest and lowest loads naturally presented a converse relationship between the coded sections. When retrospectively aligning the qualitative analysis to the cognitive load rating in the preliminary questionnaire, the areas that showed the highest mean averages were focused on intrinsic load, consistent with the qualitative findings of this paper. This may suggest the potential validity with regards to the emerged codes and its interpretation, however, also creates the implication and need for further research in this area of study.

The paper also coded some sections using dichotomous classifications (i.e. workload: high/ low, support: positive/ negative, affect: positive/ negative). This can be criticized as providing an overly simplistic view of the constructs coded. As an example, in the case of affect, emotion may be determined as a highly dynamic construct, therefore reducing it to positive, negative and neither positive nor negative, may not provide a realistic and authentic view of the

code being analyzed. However, considering the scope of the study, the dichotomous relationships were deemed appropriate to answer the paper's research questions. This creates further implications for future research to potentially expand on this paper's findings, reflecting its dynamic complexities.

Practical Implications and Limitations

The relevance and contributions of this study to practitioners is that the pedagogies of practice, especially with the integration of technologies, may be inherently complex; requiring further exploration. Dalinger & Asino (2021) comment on the lack of research on cognitive load in teachers with the limited literature focusing mainly on novice teachers and teacher-trainees. The findings of this paper provide insight into not only the needs of teachers but the lived experiences of higher-education teachers during sudden institutional closures. The study provides a potential methodology for both exploring the use of technologies in assessment and its influence on cognition. In this study, even though there was some evidence of online assessments influencing an external load, which is consistent with previous research, the data was consistently tying more with intrinsic load (i.e. the inherent complexities of the task).

The study used retrospective accounts from higher-education teachers to explore the lived experiences of the teachers during the Covid-19 institutional closures. The data relied on participant memories and accounts that stood out to them, potentially not providing a completely authentic account of their complete experience as a whole. Although the unique pandemic circumstances may not be replicable, further research may be required to investigate the use of online assessment in teachers through introspective accounts in the moment. This may provide a more sophisticated view into their lived experiences while it is actually occurring.

The potential relationship between workload, support and affect is suggested by the findings of this paper. However, these findings were drawn from a sample size of six higher-education teachers from one Canadian institution. Future research that expands on this paper's findings to a larger sample, multiple institutions and different geographical contexts could serve in corroborating the data for a broader view. The complexities identified in this paper may provide the imperative need for further study at a larger scope, to develop strategies that support teachers in their use of technologies, beyond technical knowledge. This implication extends towards professional development programs as well, to highlight the potential need to shift focus

from technological to pedagogical support. The findings ultimately support the conclusion that regardless of the presence of digital platforms and features, the cognitive process of assessing online may reflect the *how* in practice rather than the *what* in availability.

Chapter 9: Conclusion

This study aimed to create in-depth profiles of educators in post-secondary level education, to explore the complexities of a teacher's use of technologies for assessment. Complexity was derived through the major theoretical pillars pertaining to this study which were online assessment, cognitive load and TPACK, all under the context of Covid-19 institutional closures. This thesis positioned itself as an exploratory study under the context of emergency remote teaching wherein teachers were forced into a new system of assessment, with limited choice in the administrative processes during the shift. With the sudden modality shift from in-person to online classrooms, higher-education teachers faced a new reality and with this new reality comes a variety of challenges and demands. The case study approach used in this paper draws on the multiple complexities and demands faced by teachers in the context of the institutional closures, potentially providing strands of evidence to further explore these complexities and ascertain the inner intricacies of using digital tools in practice.

The study proposed two research questions, however, the questions were not intended to limit the findings of the study. In alignment with its exploratory nature, the questions aimed to provide a focus for the information gathered and situate the data along the context of the study to realize their broader implications. The two research questions as articulated in the above sections are as follows:

1. What is the process of using online assessment among higher-education teachers?
2. How does this process influence cognitive load?

To answer these questions, the data was collected through a preliminary questionnaire wherein the six sampled teachers identified the assessments that were perceived as influencing the highest load on them, as well as the lowest load. Each of the two assessments identified by the teachers were shared with the investigator along with any assessment resources relating to the two assessments. Assessment resources were collected so as to build a more complete image of the teachers' lived experience for the creation of their profiles. The questionnaire was used as a means to refine and inform the development of the semi-structured interview which was the only data source analyzed in this study.

Further aligning with the study's exploratory nature, the paper employed an inductive process for data analysis, where codes were extracted directly from the interview transcripts,

using themes that emerged naturally from the data. From the data that emerged, each of the research questions were answered as follows:

1. What is the process of using online assessment among higher-education teachers?

The process of using online assessment included experiences that tied to affect (positive and/or negative), moments that required support and moments that were high and/or low in terms of workload. This showed that the use of online assessment could be emotional in its process, builds on support which could influence workload. Negative affect showed a potential affiliation with the context of Covid itself and the elements of the sudden shift (i.e. limited choice and limited preparation, limited human connection with students). Positive affect contrastingly aligned with moments of connection with students. Support aligned with positive as well as negative experiences with support received by teachers. Positive experiences with support showed a potential relationship with resources that helped facilitate new knowledge or build on existing knowledge, wherein negative experiences with support aligned with the limited means to build knowledge. High workload, similar to negative affect, showed a potential relation with the shift in assessment context, while low workload tied to the presence of support or a platform which was user-friendly enough to not require additional support.

2. How does this process influence cognitive load?

Interestingly, the second research question was drafted under the assumption that the process may/may not influence cognitive load, based on existing research indicating the influence of input on cognition. However, the insight presented by the findings showed that there may not be a unidirectional influence on cognitive load. Rather, the load may also influence the process, potentially suggesting a relationship between the two that could inhibit and/ or facilitate the other.

This insight further reflects the exploratory nature of this paper, as although current literature presents cognitive load as being influenced by external input, there may be internal complexities that also influence the processing of external input. Previous research on cognitive load in teachers have found that online task management and managing multiple communication channels such as an online chat and video, to extensively burden working memory when teaching (Feldon, 2007; Kear et al., 2012). However, when assessing, this paper finds that the

burden on working memory may lie within the intricacies of assessment itself, especially in the context of emergency remote teaching. Subsequent to this small-scale study, more in-depth data of teachers using online assessments during the pandemic, is clearly required. Although researchers may not be able to re-create the unique pandemic context, the insights from this study may be valuable for any teaching situation in which teachers are expected to use digital tools with little to no preparation and prior notice. Consequently, this paper could be extended to include a larger sample studied across a longer period of time to further expand on the lived realities of teachers in their reflective and critical use of technologies in practice.

Appendices
Appendix A

Preliminary Questionnaire

1. Demographic questions
    a. Age
    b. Gender
    c. For how many years have you been teaching at higher-education level?
    d. Roughly how many online courses have you taught?

2. Online assessment questions
    a. How often did you use online assessments before the Covid-19 pandemic?
        1. Never
        2. Rarely
        3. Sometimes
        4. Often
        5. Always
    b. How often do you use online assessments currently?
        1. Never
        2. Rarely
        3. Sometimes
        4. Often
        5. Always
    c. In general, how satisfied or dissatisfied are you with your experience with using online assessments?
        1. Very satisfied
        2. Somewhat satisfied
        3. Neither satisfied nor dissatisfied
        4. Somewhat dissatisfied
        5. Very dissatisfied
    d. Briefly explain your answer to question 2. c)
    e. What types of online assessments do you commonly use? (eg: e-portfolio, presentation, essay, quiz, discussion, reflections etc.)

3. Assessment selection: Think of the online assessments you have used during the Covid-19 pandemic (note: sections 3a. and 3b. will each have its own 5-item cognitive load survey).

Cognitive Load: Mental effort required to process information and is typically increased when unnecessary demands are imposed on an individual.
For example: When you hear two people speaking to you at the same time, the increased cognitive load may result in you only processing fragments of what each person is saying.

a. Highest Cognitive Load

i. Please provide the name and a brief description of an online assessment you have used that you think required the highest cognitive load from you as the teacher.
ii. Why do you consider this assessment as requiring the highest cognitive load?

b. Lowest Cognitive Load

i. Please provide the name and a brief description of an online assessment you have used that you think required the lowest cognitive load from you as the teacher.
ii. Why do you consider this assessment as requiring the lowest cognitive load?

Adapted version of Klepsch et al., (2017) Cognitive Load Questionnaire

Type of Load	Questionnaire Item
Intrinsic Cognitive Load	In the use of the online assessment, many things needed to be kept in mind simultaneously In providing feedback online, many things needed to be kept in mind simultaneously
Intrinsic Cognitive Load	The use of the online assessment was very complex The provision of feedback online was very complex
Extrinsic Cognitive Load	During the use of the online assessment, it was exhausting to share the important information with students During the provision of feedback online, it was exhausting to share comments on student work
Extrinsic Cognitive Load	The use of this assessment as an online assessment was very inconvenient in the assessment of learning The provision of feedback was very inconvenient through an online platform
Extrinsic Cognitive Load	During the use of the online assessment, it was difficult to recognize and link the crucial information required to use the online platform for assessment During the provision of feedback online, it was difficult to recognize and link the crucial information required to use the online platform for feedback

Note: The original survey has been adapted to suit the online assessment context and teacher's perspective. Each item has been divided to provide a measure for the use of the online assessment as well as the provision of feedback online on a 5-point Likert scale ranging from 'completely agree' to 'completely disagree'.

Appendix B

Interview Guide

Note: The following questions are items designed using Archambault & Crippen's (2009) measure of TPACK as a framework.

Introduction (Estimated time 5 minutes)
Thank you so much for agreeing to talk with me. This interview is a part of my Master's thesis where I will be exploring the mental (i.e. cognitive) load on teachers using online assessments in higher-education. The goal of this research is to develop profiles of educators using online assessments in post-secondary level education during the Covid-19 pandemic.
We've scheduled 1 hour for this interview. What's important to me is that you get the opportunity to share your experience as fully as you wish. I would be happy to schedule additional time, if you want. I will be asking you about two assessments you have selected in the online questionnaire as having the highest and lowest cognitive load as well as your experience using these assessments during the Covid-19 restrictions. If there are questions you do not want to answer, just let me know and I will skip them. You are welcome to take a break at any point during this interview.
Please take a moment to carefully read through the letter of information and the informed consent form. These describe the nature of the study, what I plan to do with the data, and how your responses will be kept confidential. Signing it means you agree to participate in the study and agree to have the interview recorded.
Do you have any questions or concerns before we get started? If not I will start the recording now and ask if you verbally consent to participate in this study.

START RECORDING: *This is participant [number/ pseudonym]. Today is [date] at [time]*
I'd like to start our conversation with you telling me about your background. I'll be asking questions about your work experience and how Covid-19 has influenced your work.
In the questionnaire, you indicated that you have been teaching at higher-education level for roughly [answer to preliminary questionnaire 1. c)] years. Is that correct?

Opening questions (estimated time: 5 minutes)
In general, how has your experience been teaching in higher education thus far?
How has your experience been assessing students at higher education thus far?
How would you describe the process of assessment [from design to implementation to providing feedback]?
What did the assessment process generally look like in your courses before covid? (i.e. sequence of events). Has this changed after Covid?
What factors did you normally consider before creating an assessment before Covid? (i.e. class number/ diversity/ accessibility of resources/ time etc.). Has this changed after Covid?

Covid-19 related questions (estimated time: 10 minutes)
In the questionnaire, you indicated that you taught roughly [answer to 1. d)] online courses, did you use an LMS for all of these courses? What LMS did you use? Generally, how would you describe your experience with using an LMS for the online courses?

Were all of these courses carried out after the Covid-19 restrictions took place?
Do you believe the pandemic influenced your use of online assessments? How did the Covid-19 pandemic influence (or not influence) your use of online assessments? Can you elaborate or give some examples?
How did the Covid-19 pandemic influence how you provided feedback to your students? Why do you believe that is?
Did you come across any technical challenges? If so how did you troubleshoot them?
Did you have any kind of additional support when using online assessments and providing feedback (example: having a TA)? How did the additional support effect the online assessment process?

Assessment A (estimated time: 15 minutes)
In the questionnaire, you indicated [answer to 3. a)] as having the highest cognitive load, can you tell me a little about this assessment? What are the students expected to do? How did you determine this assessment as suitable for assessing the concept you wanted to assess?
Why did you list it as having the highest cognitive load?
In general, how did you feel while using this assessment with your students? How did you feel providing feedback during this assessment? Did you experience any emotions?
You mentioned these emotions [list emotions mentioned] how would you categorize these emotions (positive/ negative/ both/ neither)? Why would you categorize them as such?
Have you used this assessment face-to-face i.e. not online? Would you say your experience with this assessment was different when it was not online? Why?

Assessment B (estimated time: 15 minutes)
In the questionnaire, you indicated [answer to 3. d)] as having the lowest cognitive load, can you tell me a little about this assessment? How did you determine this assessment as suitable for assessing the concept you wanted to assess?
Why did you list it as having the lowest cognitive load?
In general, how did you feel while using this assessment with your students? How did you feel providing feedback during this assessment? Did you experience any emotions?
You mentioned these emotions [list emotions mentioned] how would you categorize these emotions (positive/ negative/ both/ neither)? Why would you categorize them as such?
Have you used this assessment face-to-face i.e. not online? Would you say your experience with this assessment was different when it was not online? Why?

Closing (estimated time: 10 minutes)
In the last section, I would like to discuss your perceptions of using online assessments as a whole.
Are there any challenges or considerations you believe to be unique to online assessments?
Online assessment could be really demanding: What do you perceive to be the demands (if any) of online assessment? (leading with cognitive demands)
What do you perceive to be the demands of providing feedback on online assessments?
How did you meet the overall demands of online assessments?
What supports – inside and/ or outside of the institution have helped you meet the overall demands of online assessments?
What can the institution do to better support your use of online assessments?

Before we close, is there anything else you would like to tell me about your experiences using online assessments during the Covid-19 pandemic?

We've reached the end of the interview. I want to express my sincere gratitude for spending this time with me and sharing your thoughts and experiences. What you have shared will really help me to understand and explore the influence of online assessments on a teacher's cognitive load. Thank you!

References

Akinyode, B. F., & Khan, T. H. (2018). Step by step approach for qualitative data analysis. *International Journal of Built Environment and Sustainability*, *5*(3). https://doi.org/10.11113/IJBES.V5.N3.267

American Psychological Association. (2022). *APA Dictionary of Psychology*. https://dictionary.apa.org/positive-affect

Andrzejewska, M., & Skawińska, A. (2020). Examining Students' Intrinsic Cognitive Load During Program Comprehension – An Eye Tracking Approach. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *12164 LNAI*, 25–30. https://doi.org/10.1007/978-3-030-52240-7_5

Anmarkrud, Ø., Andresen, A., & Bråten, I. (2019). Cognitive Load and Working Memory in Multimedia Learning: Conceptual and Measurement Issues. *Educational Psychologist*, *54*(2), 61–83. https://doi.org/10.1080/00461520.2018.1554484

Appel, T., Sevcenko, N., Wortha, F., Tsarava, K., Moeller, K., Ninaus, M., Gerjets, P., & Kasneci, E. (2019). Predicting cognitive load in an emergency simulation based on behavioral and physiological measures. *ICMI 2019 - Proceedings of the 2019 International Conference on Multimodal Interaction*, 154–163. https://doi.org/10.1145/3340555.3353735

Archambault, L., & Crippen, K. (2009). Examining TPACK Among K-12 Online Distance Educators in the United States. *Contemporary Issues in Technology and Teacher Education*, *9*(1), 71–88.

Ayres, P. (2006). Using subjective measures to detect variations of intrinsic cognitive load within problems. *Learning and Instruction*, *16*(5), 389–400. https://doi.org/10.1016/J.LEARNINSTRUC.2006.09.001

Bates, T. (2018). The 2017 national survey of online learning in Canadian post-secondary education: methodology and results. *International Journal of Educational Technology in Higher Education*, *15*(1). https://doi.org/10.1186/S41239-018-0112-3

Beach, P. (2017). Self-directed online learning: A theoretical model for understanding elementary teachers' online learning experiences. *Teaching and Teacher Education*, *61*, 60–72. https://doi.org/10.1016/J.TATE.2016.10.007

Brom, C., Stárková, T., & D'Mello, S. K. (2018). How effective is emotional design? A meta-analysis on facial anthropomorphisms and pleasant colors during multimedia learning.

Educational Research Review, *25*, 100–119. https://doi.org/10.1016/J.EDUREV.2018.09.004

Brünken, R., Plass, J. L., & Leutner, D. (2003). Direct measurement of cognitive load in multimedia learning. *Educational Psychologist*, *38*(1), 53–61. https://doi.org/10.1207/S15326985EP3801_7

Çakiroğlu, Ü., & Aksoy, D. A. (2017). Exploring extraneous cognitive load in an instructional process via the web conferencing system. *Behaviour and Information Technology*, *36*(7), 713–725. https://doi.org/10.1080/0144929X.2016.1276964

Candela, A. G. (2019). Exploring the function of member checking. *Qualitative Report*, *24*(3), 619–628. https://doi.org/10.46743/2160-3715/2019.3726

Carpenter, T. P., Fennema, E., Peterson, P. L., & Carey, D. A. (1988). Teachers' Pedagogical Content Knowledge of Students' Problem Solving in Elementary Arithmetic. *Journal for Research in Mathematics Education*, *19*(5), 385. https://doi.org/10.2307/749173

Charmaz, K. (2006). Theoretical sampling, saturation, and sorting. *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*, 96–122. http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Theoretical+Sampling,+Saturation,+and+Sorting#0

Chen, C. M., & Wu, C. H. (2015). Effects of different video lecture types on sustained attention, emotion, cognitive load, and learning performance. *Computers and Education*, *80*, 108–121. https://doi.org/10.1016/J.COMPEDU.2014.08.015

Cheng, L., Rogers, W. T., & Wang, X. (2008). Assessment purposes and procedures in ESL/EFL classrooms. *Assessment and Evaluation in Higher Education*, *33*(1), 9–32. https://doi.org/10.1080/02602930601122555

Cochran, K. F., Deruiter, J. A., & King, R. A. (1993). Pedagogical Content Knowing: An Integrative Model for Teacher Preparation. *Journal of Teacher Education*, *44*(4), 263–272. https://doi.org/10.1177/0022487193044004004

Constantinidis, C., & Klingberg, T. (2016). The neuroscience of working memory capacity and training. *Nature Reviews Neuroscience*, *17*(7), 438–449. https://doi.org/10.1038/nrn.2016.43

Cook, A. E., Zheng, R. Z., & Blaz, J. W. (2009). Measurement of Cognitive Load During Multimedia Learning Activities. *Https://Services.Igi-*

Global.Com/Resolvedoi/Resolve.Aspx?Doi=10.4018/978-1-60566-158-2.Ch003, 34–50. https://doi.org/10.4018/978-1-60566-158-2.CH003

Crompton, H., & Sykora, C. (2021). Developing instructional technology standards for educators: A design-based research study. *Computers and Education Open*, *2*, 100044. https://doi.org/10.1016/j.caeo.2021.100044

Dalinger, T., & Asino, T. I. (2021). Design of an Instrument Measuring P-12 Teachers' Cognitive Load and Intent to Adopt Technology. *TechTrends*, *65*(3), 288–302. https://doi.org/10.1007/S11528-020-00574-5

de Jong, T. (2010). Cognitive load theory, educational research, and instructional design: Some food for thought. *Instructional Science*, *38*(2), 105–134. https://doi.org/10.1007/S11251-009-9110-0

DeLeeuw, K. E., & Mayer, R. E. (2008). A Comparison of Three Measures of Cognitive Load: Evidence for Separable Measures of Intrinsic, Extraneous, and Germane Load. *Journal of Educational Psychology*, *100*(1), 223–234. https://doi.org/10.1037/0022-0663.100.1.223

Dixson, D. D., & Worrell, F. C. (2016). Formative and Summative Assessment in the Classroom. *Https://Doi-Org.Proxy.Bib.Uottawa.ca/10.1080/00405841.2016.1148989*, *55*(2), 153–159. https://doi.org/10.1080/00405841.2016.1148989

Dong, Y., Chai, C. S., Sang, G.-Y., Koh, H. L., & Tsai, C.-C. (2015). Exploring the Profiles and Interplays of Pre-service and In-service Teachers' Technological Pedagogical Content Knowledge (TPACK) in China. *Educational Technology & Society*, *18*(1), 106.

Doreleyers, A., & Knighton, T. (2020). *COVID-19 Pandemic: Academic impacts on postsecondary students in Canada*. https://www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00015-eng.htm

Farhady, H. (2021a). Learning-oriented assessment in virtual classroom contexts. *Journal of Language and Communication* . https://www.academia.edu/download/72978019/6._Typesetted_1.8.21.pdf

Farhady, H. (2021b). Learning-Oriented Assessment in Virtual Classroom Contexts. *Journal of Language and Communication (JLC)*, *8*(2), 121–132. https://journalfbmk.upm.edu.my/ojs3/index.php/jlc/article/view/439

Feldon, D. F. (2007a). Cognitive load and classroom teaching: The double-edged sword of automaticity. *Educational Psychologist*, *42*(3), 123–137. https://doi.org/10.1080/00461520701416173

Foster, N. L., Rawson, K. A., & Dunlosky, J. (2018). Self-regulated learning of principle-based concepts: Do students prefer worked examples, faded examples, or problem solving? *Learning and Instruction*, *55*, 124–138. https://doi.org/10.1016/J.LEARNINSTRUC.2017.10.002

Gibbs, G., & Simpson, C. (2005). Conditions under which assessment supports students' learning. *Learning and Teaching in Higher Education*, *1*, 2004–2009. https://eprints.glos.ac.uk/3609/

Gipps, C. v. (2011). Beyond Testing: Towards a theory of educational assessment. *Beyond Testing: Towards a Theory of Educational Assessment*, 1–166. https://doi.org/10.4324/9780203182437/BEYOND-TESTING-CLASSIC-EDITION-CAROLINE-GIPPS

Gudmundsdottir, S. (1990). Values in Pedagogical Content Knowledge. *Journal of Teacher Education*, *41*(3), 44–52. https://doi.org/10.1177/002248719004100306

Hamer, J., & Smith, J. (2021). *Online and blended delivery in Further Education: A literature review into pedagogy, including digital forms of assessment: June 2021*. https://dera.ioe.ac.uk/38117/1/online_and_blended_delivery_in_further_education.pdf

Hancock, D. R., & Algozzine, R. (2017). *Doing case study research : a practical guide for beginning researchers* (3rd ed.). New York, NY : Teachers College Press.

Hosseini, M., Nimehchisalem, V., Hosseini, M., & Nimehchisalem, V. (2021). Self-Assessment in English Language Teaching and Learning in the Current Decade (2010-2020): A Systematic Review. *Open Journal of Modern Linguistics*, *11*(6), 854–872. https://doi.org/10.4236/OJML.2021.116066

Hsin, Y., & Paas, F. (2015). Effects of computer-based visual representation on mathematics learning and cognitive load. *Educational Technology and Society*, *18*(4), 70–77. https://ro.uow.edu.au/sspapers/1941/

Jiang, D., & Kalyuga, S. (2020). Confirmatory Factor Analysis of Cognitive Load Ratings Supports a Two-Factor Model. *The Quantitative Methods for Psychology*, *16*(3), 216–225. https://doi.org/10.20982/TQMP.16.3.P216

Kalyuga, S. (2011). Cognitive Load Theory: How Many Types of Load Does It Really Need? *Educational Psychology Review*, *23*(1), 1–19. https://doi.org/10.1007/S10648-010-9150-7

Kalyuga, S., & Liu, T.-C. (2015). Guest editorial: managing cognitive load in technology-based learning environments. *Educational Technology & Society*, *18*(4), 1–9. https://doi.org/10.1007/978-1-4419-8126-4

Kasim, N. N. M., & Khalid, F. (2016). Choosing the right learning management system (LMS) for the higher education institution context: A systematic review. *International Journal of Emerging Technologies in Learning*, *11*(6), 55–61. https://doi.org/10.3991/IJET.V11I06.5644

Kear, K., Chetwynd, F., Williams, J., & Donelan, H. (2012). Web conferencing for synchronous online tutorials: Perspectives of tutors using a new medium. *Computers and Education*, *58*(3), 953–963. https://doi.org/10.1016/J.COMPEDU.2011.10.015

Kelly, M. G., & McAnear, A. (2002). National educational technology standards for teachers : preparing teachers to use technology. In *International Society for Technology in Education*.

Klepsch, M., Schmitz, F., & Seufert, T. (2017). Development and Validation of Two Instruments Measuring Intrinsic, Extraneous, and Germane Cognitive Load. *Frontiers in Psychology*, *8*(NOV), 1997. https://doi.org/10.3389/fpsyg.2017.01997

Klepsch, M., & Seufert, T. (2020). Understanding instructional design effects by differentiated measurement of intrinsic, extraneous, and germane cognitive load. *Instructional Science*, *48*(1), 45–77. https://doi.org/10.1007/S11251-020-09502-9

Koehler, M., & Mishra, P. (2009). What is Technological Pedagogical Content Knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60–70.

Koh, J. H. L., Chai, C. S., & Tsai, C. C. (2013). Examining practicing teachers' perceptions of technological pedagogical content knowledge (TPACK) pathways: A structural equation modeling approach. *Instructional Science*, *41*(4), 793–809. https://doi.org/10.1007/S11251-012-9249-Y

Korbach, A., Brünken, R., & Park, B. (2017). Measurement of cognitive load in multimedia learning: a comparison of different objective measures. *Instructional Science*, *45*(4), 515–536. https://doi.org/10.1007/S11251-017-9413-5

Laurillard, D. (2013). Rethinking university teaching: A conversational framework for the effective use of learning technologies. *Rethinking University Teaching: A Conversational*

Framework for the Effective Use of Learning Technologies, 1–268. https://doi.org/10.4324/9781315012940

Lee, H., Plass, J. L., & Homer, B. D. (2006). Optimizing cognitive load for learning from computer-based science simulations. *Journal of Educational Psychology*, *98*(4), 902–913. https://doi.org/10.1037/0022-0663.98.4.902

Leppink, J., Paas, F., van der Vleuten, C. P. M., van Gog, T., & van Merriënboer, J. J. G. (2013). Development of an instrument for measuring different types of cognitive load. *Behavior Research Methods*, *45*(4), 1058–1072. https://doi.org/10.3758/s13428-013-0334-1

Leppink, J., & van den Heuvel, A. (2015). The evolution of cognitive load theory and its application to medical education. *Perspectives on Medical Education*, *4*(3), 119–127. https://doi.org/10.1007/s40037-015-0192-x

Li, J., Antonenko, P. D., & Wang, J. (2019). Trends and issues in multimedia learning research in 1996–2016: A bibliometric analysis. *Educational Research Review*, *28*. https://doi.org/10.1016/J.EDUREV.2019.100282

Lincoln, Y., & Guba, E. G. (1985). The Disturbing and Disturbed Observer. *Naturalistic Inquiry*, 92–109, 357–367.

Majooni, A., Masood, M., & Akhavan, A. (2018). An eye-tracking study on the effect of infographic structures on viewer's comprehension and cognitive load. *Information Visualization*, *17*(3), 257–266. https://doi.org/10.1177/1473871617701971

Miller, C. M. L., & Parlett, M. R. (1974). *Up to the mark : a study of the examination game*. Society for Research into Higher Education.

Mishra, P. (2018, September 10). *The TPACK diagram gets an upgrade | Punya Mishra's Web*. https://punyamishra.com/2018/09/10/the-tpack-diagram-gets-an-upgrade/

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054. https://doi.org/10.1111/J.1467-9620.2006.00684.X

Muñoz-Carril, P. C., Hernández-Sellés, N., Fuentes-Abeledo, E. J., & González-Sanmamed, M. (2021). Factors influencing students' perceived impact of learning and satisfaction in Computer Supported Collaborative Learning. *Computers & Education*, *174*, 104310. https://doi.org/10.1016/J.COMPEDU.2021.104310

Mutlu-Bayraktar, D., Cosgun, V., & Altan, T. (2019). Cognitive load in multimedia learning environments: A systematic review. *Computers and Education*, *141*. https://doi.org/10.1016/J.COMPEDU.2019.103618

Paas, F. G. W. C., & van Merriënboer, J. J. G. (1994). Instructional control of cognitive load in the training of complex cognitive tasks. *Educational Psychology Review*, *6*(4), 351–371. https://doi.org/10.1007/BF02213420

Paulson, F., & Paulson, P. (1994). *Assessing portfolios using the constructivist paradigm.* https://eric.ed.gov/?id=ED376209

Phelps, R. (2011). *Standards for Educational & Psychological Testing phelps - Google Scholar*. American Psychological Association. https://scholar.google.com/scholar?q=Standards+for+Educational+%26+Psychological+Testing+phelps&hl=en&as_sdt=0,5

Plass, J. L., & Kalyuga, S. (2019). Four Ways of Considering Emotion in Cognitive Load Theory. *Educational Psychology Review*, *31*(2), 339–359. https://doi.org/10.1007/S10648-019-09473-5

Popham, J. W. (2004). Why Assessment Illiteracy Is Professional Suicide.: EBSCOhost. *Educational Leadership*, *62*(1), 82. https://web-p-ebscohost-com.proxy.bib.uottawa.ca/ehost/pdfviewer/pdfviewer?vid=0&sid=d10add61-794d-4cf5-ac91-078fbf118c68%40redis

Prawat, R. S. (1989). Promoting Access to Knowledge, Strategy, and Disposition in Students: A Research Synthesis. *Review of Educational Research*, *59*(1), 1–41. https://doi.org/10.3102/00346543059001001

Rahman, M. S. (2020). The Advantages and Disadvantages of Using Qualitative and Quantitative Approaches and Methods in Language “Testing and Assessment” Research: A Literature Review. *Journal of Education and Learning*, *6*(1), 102. https://doi.org/10.5539/JEL.V6N1P102

Rowntree, D. (2015). *Assessing students: How shall we know them?* https://www.taylorfrancis.com/books/mono/10.4324/9781315798462/assessing-students-derek-rowntree

Seaman, J., Allen, I., Group, J. S.-B. S. R., & 2018, undefined. (2018). Grade increase: Tracking distance education in the United States. *ERIC*. https://eric.ed.gov/?id=ED580852

Sharma, R., Kawachi, P., & Bozkurt, A. (2019). The landscape of artificial intelligence in open, online and distance education: Promises and concerns. *Asian Journal of Distance Education*, *14*(2). https://doi.org/10.1080/01587919.2019.1681894

Shulman, L. S. (1986). Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher*, *15*(2), 4–14. https://doi.org/10.3102/0013189X015002004

Snyder, B. (1970). *The hidden curriculum*. https://philpapers.org/rec/SNYTHC

Stone, R. W., & Baker-Eveleth, L. (2013). Students' expectation, confirmation, and continuance intention to use electronic textbooks. *Computers in Human Behavior*, *29*(3), 984–990. https://doi.org/10.1016/J.CHB.2012.12.007

Sweller, J. (1988). Cognitive Load During Problem Solving: Effects on Learning. *Cognitive Science*, *12*(2), 257–285. https://doi.org/10.1207/S15516709COG1202_4

Sweller, J. (2018). Measuring cognitive load. *Perspectives on Medical Education*, *7*(1). https://doi.org/10.1007/s40037-017-0395-4

Sweller, J. (2020). Cognitive load theory and educational technology. *Educational Technology Research and Development*, *68*(1), 1–16. https://doi.org/10.1007/S11423-019-09701-3

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive Load Theory*. 71–85. https://doi.org/10.1007/978-1-4419-8126-4

Sweller, J., van Merriënboer, J. J. G., & Paas, F. (2019). Cognitive Architecture and Instructional Design: 20 Years Later. *Educational Psychology Review*, *31*(2), 261–292. https://doi.org/10.1007/S10648-019-09465-5

Sweller, J., van Merrienboer, J. J. G., & Paas, F. G. W. C. (1998). Cognitive Architecture and Instructional Design. *Educational Psychology Review*, *10*(3), 251–296. https://doi.org/10.1023/A:1022193728205

Tarmizi, R. A., & Sweller, J. (1988). Guidance During Mathematical Problem Solving. *Journal of Educational Psychology*, *80*(4), 424–436. https://doi.org/10.1037/0022-0663.80.4.424

United Nations. (2020). *Education during COVID-19 and beyond*. https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/08/sg_policy_brief_covid-19_and_education_august_2020.pdf

Wallace, R. M. C. (2004). A framework for understanding teaching with the internet. *American Educational Research Journal*, *41*(2), 447–488. https://doi.org/10.3102/00028312041002447

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and Validation of Brief Measures of Positive and Negative Affect: The PANAS Scales. *Journal of Personality and Social Psychology*, *54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063