Exploring the Relationship between Online Formative Quizzes and Students' Self-regulated Learning in Online Learning Environments

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Abstract

Online learning requires higher levels of self-regulated learning (SRL) in students. Although a theoretical link between formative assessment and SRL has been claimed, there has been little research on the relationship between online formative assessment and SRL on how students use online assessment. The purpose of this study is to examine online graduate and undergraduate students' SRL and their use of formative versus summative quizzes, and their effects on student engagement, achievement, and course satisfaction. A mixed-methods design was used to study undergraduate and graduate students in online courses that included both formative and summative quizzes. Key findings indicated that: 1) Undergraduate students reported greater anxiety, spent more time on formative quizzes, and earned significantly higher final marks than did graduate students, although graduate students outperformed undergraduate students on summative quizzes; 2) SRL predicted students' effort on formative quizzes, scores on summative quizzes, and the value they placed on both formative and summative quizzes; 3) There were four significant predictors of academic achievement: time spent on formative quizzes, scores on summative quizzes, previous online experience, and educational level. The SRL of undergraduate, but not graduates, significantly predicted course satisfaction; 4) Graduate students found that formative quizzes were more useful and better at directing their learning, whereas undergraduate students found summative quizzes to be more useful and had a positive effect on their SRL. Results are discussed in terms of their implications for future research investigating formative assessment practices, and for practice in designing online formative quizzes, and for how instructors can successfully implement formative assessment.

Résumé

L’apprentissage en ligne exige de l’étudiant de niveaux supérieures d’apprentissage autorégulé (AAR). Bien qu'un lien théorique entre l’évaluation formative et l’AAR ait été revendiqué, peu de recherches existent sur la relation entre l’évaluation formative en ligne et l’AAR sur la manière dont les étudiants emploient l’évaluation en ligne. Cette étude a pour objectif l'analyse virtuelle de l’AAR des étudiants du premier et deuxième cycle et de leur utilisation d’évaluations sommatives et formatives, ainsi que les effets sur l’engagement, le rendement, et la satisfaction des étudiants. Une méthode hybride a été employée ayant pour but l’examination des étudiants du premier et deuxième cycle dans des cours virtuels comprenant les évaluations formatives et sommatives. Les résultats principaux indiquent le suivant: 1) Les étudiants du premier cycle ont signalé de plus grands niveaux d’anxiété, ont passé plus de temps sur les évaluations formatives, et ont obtenu des résultats finaux notamment plus élevées que les étudiants de deuxième cycle, bien que ces derniers aient obtenu de meilleurs résultats que les étudiants de premier cycle sur les quiz sommatifs ; 2) L’AAR a permis de prédire l'effort qu’ont mis les étudiants par rapport aux évaluations formatives, leurs résultats obtenus dans les sommatives et la valeur qu'ils accordent aux deux ; 3) Il existe quatre facteurs prédictifs significatifs contribuant à la réussite académique : le dévouement du temps aux épreuves formatives, les résultats des sommatives, l'expérience préalable quant à l’apprentissage en ligne, et le niveau d'éducation. L’AAR de seuls les étudiants du premier cycle ont prédit la satisfaction du contenu des cours; 4) Les étudiants de deuxième cycle ont trouvés que les épreuves formatives leurs ont étés plus utiles en tant que l’orientation de leur apprentissage, tandis que les étudiants de premier cycle trouvaient les sommatives plus bénéfiques, ayant effet positif sur leur AAR. Les résultats sont discutés selon leurs implications en recherches futures sur les pratiques d’évaluations formatives, de même que sur la conception et la création d’évaluations en ligne et pour la manière dont les éducateurs peuvent mettre en œuvre avec succès l’évaluation formative.

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Life's journey has so far led me to this point and let's see where my next chapter leads me…

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CHAPTER 1 — Introduction

Background of the Study

Higher education is undergoing a radical transformation in the twenty-first century. The most significant driver of change has been advancements in information and communication technology (ICT), which has redefined higher education by altering the traditional landscape of what, when, where, and how to learn (Bransford et al., 2000). Another key driver of change in higher education is a more diverse and complex student body. Whether willingly or unwillingly, postsecondary institutions in Canada must adapt to the changing landscape and the diverse needs of a changing learner population.

The most profound change, along with the increased use of technological innovations to increase access to higher education, is the urgency and acceleration of online learning (Boudreault et al., 2013; Martel, 2015). Online learning and blended learning (traditional face-to-face instruction combined with online learning activities) had moved from the fringe to the mainstream in Canadian postsecondary institutions as an alternative or supplement to traditional face-to-face learning even before the coronavirus disease (COVID) epidemic prevented most university courses from being taught face-to-face. In 2015, nearly 13,000 online courses were offered by 93 % of Canadian postsecondary institutions, accounting for 8.3 % of total course offerings at those institutions (Martel, 2015). More than 361,000 students, or 29 % of all Canadian university students, enrolled in online courses in 2015, with more than 1000 new online courses expected to be added each year (Martel, 2015). According to the 2018 survey of online learning in Canadian public post-secondary education, almost all Canadian colleges and universities offered online courses, and online enrolments have increased at a rate of 10 -15 % per year, with over 1.5 million fully-online credit course registrations, indicating that online learning has become a core method of delivery for Canadian universities and colleges (Canadian Digital Learning Research Association, 2018). Thus, online learning is one of the driving forces to achieve the goal of increasing the quantity and accessibility of postsecondary education in Canada, allowing post-secondary institutions to gain more momentum while relieving

the pressure of infrastructure (Canadian Digital Learning Research Association, 2021).

In the context of online learning, face-to-face structured seat time is completely replaced by online components, requiring learners to assume more responsibility for their learning. A key element leading to success in online learning environments is self-regulated learning (SRL), which reinforces student control, making it more personalized and adaptable to individual needs (Greene et al., 2011; Liaw & Huang, 2013; Sun & Rueda, 2012). According to empirical research, self-regulated learners not only have more confidence and perseverance, but also find the learning experience more enjoyable (Pintrich & Zusho, 2002; Zimmerman, 2000). Academic self-regulation is teachable, and all types of students can learn to more effectively monitor and regulate their own learning (Zimmerman, 2002). Thus, it becomes even more critical for learners to exercise a high level of SRL skills in online learning environments due to the relatively autonomous nature and the physical absence of the instructor in the online section (Azevedo et al., 2010; Rowe & Rafferty, 2013; Shen et al., 2011; Whittaker, 2015). Such distinctions between traditional and online learning environments have significant educational implications for instructors, making instructional design for supporting SRL even more important in online learning environments than in traditional contexts.

Due to the rapid growth of online learning, the higher education perspective has shifted from teacher-as-authoritarian knowledge transmission to learner-autonomy knowledge construction, which places the learner at the center of the learning process and the instructor as a facilitator of this individual learning process (Bruner, 1986; Fosnot, 2005; Philips, 1995; Piaget, 1977; Schunk, 2011; Steffe & Gale, 1995; Vygotsky, 1978). This shift in pedagogical paradigm from passive acquisition of knowledge through teacher transmission to active construction of knowledge by learners emphasizes equipping students to become more proactive and accountable for their learning pace, direction, and academic achievement (Winne, 2013). Thus, SRL serves as the foundation for learner-autonomy knowledge construction, in which learners are responsible for their own learning and teachers guide learners in their SRL processes by designing and implementing an effective learning environment (Boekaerts et al., 2000). SRL also facilitates deep learning and higher levels of cognitive thinking, which builds up a link between prior knowledge and new learning (Ramsden, 2003). Higher education imposes distinct demands on contemporary

learners requiring that they efficiently and effectively construct knowledge, and that they have the consciousness and capability for SRL in formal educational settings, due to the vast amount of information available at their fingertips (Bjork et al., 2013). Furthermore, SRL is the foundation for becoming a lifelong learner (Zimmerman, 2001), which aligns with higher education's goal of assisting students in transitioning from self-regulated learners in academic settings to lifelong learners in the future workplace.

With this shift in the concept of instruction and learning, there has been a parallel shift in assessment in higher education. Assessment, as a link between instruction and learning, is at the heart of higher education, uniting students and teachers and serving as a critical tool for reinforcing instruction and improving learning in both traditional and non-traditional learning environments (Bransford et al., 2000; Costa et al., 2010). Traditional assessment has been criticized for its overuse of summative assessment, which is usually done after instruction and makes assessing students' learning during instruction difficult (Reid & McLoughlin, 2002). Furthermore, traditional assessment lacks variety and learner autonomy, as instructors have absolute control over assessment practices, which limits student-centered learning and prevents students from taking ownership of the learning (Nicol & Macfarlane-Dick, 2006; Vaughan, 2015). It is crucial to highlight the role that the learners themselves play in the assessment process. Furthermore, traditional assessment feedback is delayed and given after learning. Thus, online learning must be restructured to create a learner- and assessment-centered environment in which students take greater responsibility for evaluating their learning process as instruction is ongoing (Bloxham & Carver, 2014; Gikandi et al., 2011; Rushton, 2005).

Formative assessment, as an indispensable component of an ongoing instructional process, should be used to fill this gap in higher education by empowering students to be self-regulated learners (Butler & Winne, 1995; Chappuis & Chappuis, 2008; Clark, 2012; Mao & Peck, 2013; Nicol & Macfarlane-Dick, 2006; Paris & Paris, 2001). Although most research has focused on summative assessment, which is concerned with grades and learning outcomes, the importance of formative assessment has gradually been recognized, with its goal of linking learning and instruction and promoting higher levels of student engagement by assisting students in identifying learning gaps and assessing their own learning (Dixson & Worrell, 2016; Pachler et al., 2010). Formative assessment is specifically designed to encourage self-reflection

and SRL by providing immediate and ongoing feedback. Thus, formative assessment monitors students while they are in the learning trajectory with a focus on the assessment process, and helps fill critical gaps between the actual and desired level of performance (Kincal & Ozan, 2018; Nicol & Macfarlane-Dick, 2006). Formative assessment is a process that is designed to continuously facilitate learning and instruction by developing SRL skills to plan, monitor, and reflect on learning that learners can use for lifelong learning. Research has consistently found that when learners are effectively formatively assessed in traditional learning environments, they participate more actively in their learning by consciously regulating the process of their learning (Black & Wiliam, 2009; Bose & Rengel, 2009; Chappuis & Chappuis, 2008; Clark, 2012; Nicol & Macfarlane-Dick 2006; Organisation for Economic Co-Operation and Development [OECD], 2005; Pintrich, 2004). Extensive empirical research has shown that formative assessment helps students identify the learning gaps (Bennett, 2011; Nicol, 2007; OECD, 2005; Williams & Ryan, 2000), promotes students' reasoning skills (Bulunuz et al., 2016; Moeed, 2015), supports mastery learning and engages students with valuable learning experiences (Gikandi et al., 2011), and improves academic achievement and retention (Bakula, 2010; Black & Wiliam, 2009; Eshun et al., 2014; Hannah et al., 2014; Hattie, 2012; Marzano, 2006; Smith, 2005; Yorke, 2003). Despite the numerous well-documented benefits of formative assessment, more research is required to investigate and strengthen the theoretical foundation of formative assessment in order to integrate formative assessment into practice (Panadero et al., 2018).

With the growing popularity of online learning and the prevalence of learning management systems in universities, a variety of online formative assessments have emerged and been widely used. As technology advances, online formative assessment has been well received by students, with the added benefit of allowing greater independence and flexibility for students in terms of the time and place in which they play active and key roles in the assessment process (Peat & Franklin, 2002; Velan et al., 2002). Furthermore, online formative assessment has the potential to facilitate the learner-centered assessment by delivering continuous feedback for learners to monitor their learning, supporting learners to take more control of their learning, and providing instructors with a more comprehensive picture of learner's current learning progress (Gikandi et al., 2011; Ludwig-Hardman & Dunclap, 2003; Sorensen & Takle, 2005). Feedback acts as a catalyst for fostering SRL by triggering the active

cognitive processing and students' engagement, thereby providing opportunities to bridge the gap between current and desired performance (Chou & Zou, 2020; Embo et al., 2014; Hattie & Timperley, 2007). Recent studies have demonstrated that feedback can be used to provide students with monitoring opportunities (Biggs, 2012; Embo et al., 2014; Hatziapostolou & Paraskakis, 2010; Orsmond & Stephen, 2013), assist students in improving their academic achievement (Aslam & Khan, 2020; Belski & Belski, 2014; Nicol & Macfarlane, 2006; Strijbos et al., 2010), elicit reflections and self-efficacy that facilitate students' SRL (Chou & Zou, 2020; Duijnhouwer et al., 2010; Hamer et al., 2015; Nicol, 2010; Orsmond & Stephen, 2013), as well as keeping them motivated and engaged and encouraging positive motivation and interaction between instructors and students (Aslam & Khan, 2020; Blair & McGinty, 2012; Carless et al., 2011; Espasa & Menses, 2010; Hendry et al., 2011; Toit, 2012). Thus, online formative assessment with prompt and ongoing feedback has the potential to promote SRL in online learning environments of higher education (Clark, 2012; Fukuda et al., 2022; Gipps, 2005; Mahlberg, 2015; Nicol & Macfarlane-Dick, 2006; Ogange et al., 2018; Panadero et al., 2018).

One of the most common and widely used types of online formative assessments is the online formative quiz. In such cases, students can take online formative quizzes whenever and wherever they want, and as many times as they want (Cigdem & Oncu, 2015). Students have more opportunities to decode feedback messages and then actively construct an understanding of them with the immediate feedback provided by online formative quizzes, allowing them to gain a better view of their learning progress and fill learning gaps (Bulkley et al., 2010; Costa et al., 2010; Nadeem & Alfalig 2020; Pachler et al., 2010). It is critical to investigate the relationship between online formative quiz and students' SRL. Specific factors influencing students' SRL while taking online formative quizzes should be investigated, as well as the interactions between SRL and those factors in relation to students' academic achievement and students' perceptions of online formative quizzes. Given the importance of SRL in online learning (Bol & Garner, 2011; Cho & Shen, 2013; Lee et al., 2020; Sadi, & Uyar, 2013), it is critical to justify research aimed at improving student SRL through the study of online formative quizzes in higher education.

Purpose of the Study

As online learning becomes more popular in higher education, the demands on postsecondary students to demonstrate a high level of SRL in online learning environments are greater than in traditional classroom settings (Artino & Stephens, 2009; Greene et al., 2011; Rowe & Rafferty, 2013; Sun & Rueda, 2012; Wong et al., 2019). Studies across a number of disciplines have indicated that the challenge of post-secondary education is that not all the students have developed the ability to self-regulate their learning in online learning environment and a lack of SRL skills results in less participation in online activities and poor academic performance (Adam et al., 2017; Azevedo & Cromley, 2004; Dabbagh & Kitsantas, 2005; Whittaker, 2015; Zimmerman & Schunk, 2001). Thus, a study that explores how to promote students' SRL in online learning environments is valuable. The use of online formative assessment can be an alternative method of facilitating SRL in the current context. The benefit of online formative assessment is its accessibility without regard to time and setting, the efficiency of quizzing a large number of students without the need for instructors, and prompt feedback, all of which help to bridge the gap between teaching, learning, and assessment in higher education (Cigdem & Oncu, 2015; Gikandi et al., 2011; McCarthy, 2017; Miller, 2009; Nicol, 2007).

Central to this research are the attempts to elucidate the relationship between online formative assessment and SRL in online learning environments. Given the wide range of online formative assessments available, this study focuses on online formative quizzes. Online formative quizzes are intended to provide students with ongoing feedback to help them improve learning, as opposed to summative quizzes, which are used to help evaluate student learning at the end of an instructional unit (Gamage et al., 2019; Maclean & McKeown, 2013). Online formative quizzes allow students to develop SRL skills, evaluate learning at their own pace, take control of their own learning, retake the quiz as many times as they want, and create a safer, less stressful learning environment. Therefore, the intersection of online formative quizzes and SRL merits further empirical investigation.

The purpose of this study is to examine students' use of online formative quizzes versus summative quizzes, as well as to investigate the conditions under which online formative quizzes may be more effective as instruments to facilitate students' SRL in online learning environments. The study also investigated how demographic variables

affected students' SRL and their effort on formative quizzes. The study sought to explore undergraduate and graduate students' experiences with online formative quizzes, then used the data to determine whether there was a difference in the perceptions between undergraduate and graduate students, and whether the interaction between students' SRL and demographic variables affected their academic achievement and course satisfaction, and finally identified whether they approached SRL differently in online learning contexts.

Statement of the Problem

The early 1990s saw the start of research into the relationship between formative assessment and SRL. A body of academic literature has stated the critical role of formative assessment in improving student learning and promoting SRL in traditional learning contexts (Black & William, 1998a; Bose & Rengel, 2009; Butler & Winne, 1995; Clark, 2012; Hattie, 2009; Hattie & Timperley, 2007; Leenknecht et al., 2021; Nicol, 2010; Nicol & Macfarlane-Dick, 2006). However, the literature identifies a number of critical gaps in effectively implementing formative assessment to facilitate SRL in an online learning environment.

The first gap is the lack of fully developed theoretical foundation for formative assessment (Black & Wiliam, 2009). It has been shown that the lack of a solid theoretical foundation makes it difficult to apply in practice and limits effort to identify the effects of formative assessment on SRL in online learning contexts (Bennett, 2011; Taras, 2010). This issue can be traced back to the lack of a universally accepted definition of formative assessment. Despite the fact that the term "formative assessment" has been in use for more than a decade, it is still an umbrella term that encompasses many definitions (Bennett, 2011; Black & Wiliam, 2009; Heritage, 2007; Johnson & Burdett, 2010; Marzano, 2006; O'Connor, 2002; OECD, 2005; Spector et al., 2016). Concerns have been raised about such an umbrella term, such as a lack of critical formative assessment features, a lack of clarity about the relationship between formative and summative assessment, and a lack of an adequate theoretical framework (Briggs et al., 2012; Ponte et al., 2009; Stiggins et al., 2004; Yan et al., 2021). Therefore, it is beneficial to go beyond the broad definition of formative assessment. Although the benefits of formative assessment and online learning are widely acknowledged, the conceptualization of formative assessment in an online

learning environment is hampered by a weak theoretical foundation for formative assessment. It is also difficult to summarize the efficacy of online formative assessment and explain why some online formative assessment techniques promote SRL while others do not.

Second, while previous research has shown that SRL improves learners' motivation and academic achievement in both traditional and online learning environments, few studies have focused on the role of formative assessment in promoting SRL in online learning environments. Examination of the specific relationship between formative assessment and SRL was initially performed by formative assessment researchers who extended the assessment research to encompass SRL. With the involvement of SRL researchers, the literature is shifting toward more theoretical research in the field (Andrade & Brookhart, 2016; Panadero et al., 2018). SRL has been proved to be one of the key outcomes of assessment implementation, which not only empowers students as self-regulated learners but also contributes to improved learning gains. Given the various SRL models, it would be beneficial to investigate which SRL model is more effectively aligned with formative assessment in online learning environments, as well as which formative assessment helps students most to self-regulate their learning in online learning environments. As a result of the widespread use of online assessment in higher education, high-quality and in-depth research on SRL in the literature of online formative assessment is desperately needed.

Third, there is lack of empirical research on the effects of online formative assessment on SRL (Bose & Rengel, 2009; Gikandi et al., 2011; McLaughlin &Yan, 2017; Pachler et al., 2010; Panadero et al., 2018). Although the theoretical link between formative assessment and SRL has been claimed (Black & Wiliam, 2009; Clark, 2012; Hattie & Timperly, 2007; Nicol & Macfarlane-Dick, 2006; Panadero & Alonso-Tapia, 2013), there is a need to examine this relationship in real online courses so that it is explicitly supported by findings from empirical research (Brown & Harris, 2013; Panadero et. al., 2017). Formative assessment is primarily in the hands of teachers in traditional learning environments, with students having little involvement in the assessment process (Panadero et al., 2016). Thus, online formative assessment should be more learner-centered in order to provide more opportunities for learners to participate in monitoring their own learning. The primary goal of formative assessment is to help students clarify their learning objectives, judge the

gaps between their current and desired levels of performance, and facilitate reflection (Brown & Harris, 2013; Nicol & McFarlane-Dick, 2006; Panadero et al., 2019). Furthermore, little is known about the mutual relationship between online formative assessment and the effect of SRL in combination with other variables on how students use online formative assessment. This mutual influence deserves further investigation.

Finally, there is lack of research exploring whether online formative quizzes support students in developing SRL skills in online learning contexts (Bose & Rengel, 2009; Gikandi et al., 2011; McLaughlin &Yan, 2017). There is no universally held conclusion concerning the effects of formative assessment on SRL because online formative assessment takes a variety of forms. Because of their accessibility, immediate feedback, self-pacing, and variety, online formative quizzes are one of the most popular forms widely used in online courses. There is compelling evidence that immediate feedback helps students be better prepared for class, provides a better understanding of learning gaps, guides students toward more productive engagement in learning activities, and reduces test anxiety (Bennett, 2011; Black, 2015; Carless et al., 2011; Elmahdi et al., 2018; Kingston & Nash, 2011; Stiggins & Dufour, 2009). Thus, online formative quiz can enable students to take charge of their own learning. However, there is a lack of empirical research on whether the use of online formative quizzes facilitates SRL, and which type of feedback is more supportive than another. The issue of possible variations in the relationship between formative quizzes and SRL must be thoroughly investigated in order to identify the factors that amplify or diminish the effect of online formative quizzes on SRL. Furthermore, little is known about the differences between undergraduate and graduate students' perceptions and experiences with online formative quizzes. Therefore, more emphasis should be placed on interpreting the different variations across educational levels and contexts. This study aimed to fill those gaps in the literature by focusing on the effectiveness of online formative quizzes in promoting SRL in online learning environments of Canadian universities.

Significance of the Study

As innovative modes of instructional delivery, online learning has become a promising trend and has grown exponentially in postsecondary institutions in Canada because of its ability to make learning more accessible, flexible, and affordable, as

well as its potential to provide opportunities for traditional Canadian universities to address the challenges of meeting the needs of increasing enrollment with tighter budgets (Canadian Digital Learning Research Association, 2021; Canadian Council on Learning, 2011; Contact North, 2016; Matheos, 2011; Waldman & Smith, 2013). In comparison to the traditional learning, the ability to effectively self-regulate one's learning is more important than ever before because learners' SRL skills determine to a great extent the learning potential and successful implementation of online learning in higher education (Bannert & Reimann, 2012; Cobanoglu & Yurdakul, 2014; Endedijk et al., 2014; Ishtaiwa & Abulibdeh, 2012; López-Pérez, et al., 2011; Monteiro & Morrison, 2014; Owston, et al., 2013; Wong et al., 2019; Yan et al., 2014). Furthermore, studies across a number of disciplines have found that not all the students have developed the ability to self-regulate their learning in online learning environment and the lack of SRL skills results in less participation in online activities and poor academic performance (Azevedo & Cromley, 2004; Dabbagh & Kitsantas, 2005; Whittaker, 2015; Zimmerman & Schunk, 2001). Thus, the findings of this study will contribute to a better understanding of the complexities of online learning in higher education, particularly online assessment, as well as the reciprocal relationship between online assessment and SRL.

Recognizing that the complexity of online learning, the shift of pedagogical paradigm, as well as the demands of higher education, researchers call for the instructional redesign with a focus on the SRL (Bliuc et al., 2010; Castro & Tumibay, 2021; Ishtaiwa & Abulibdeh, 2012; Laurillard, 2014; López-Pérez et al., 2011; McKenzie et al., 2013; Monteiro & Morrison, 2014; Owston et al., 2013; Roscoe, 2012; Rowe & Rafferty, 2013; Waldman & Smith, 2013). The empirical studies of SRL interventions have demonstrated that post-secondary students benefit academically when a variety of effective instructional strategies for encouraging SRL are incorporated into the instructional design of traditional face-to-face learning environments (Belski & Belski, 2014; Cheng & Chau, 2013; Ifenthaler, 2012; Kistner et al., 2010; Panadero & Romero, 2014; Torenbeek et al., 2013). Exploring how SRL is incorporated into the instructional design of online courses becomes more critical for supporting the learners' acquisition of SRL skills and potentially impacts the learners most. Thus, this study provided evidence and insights for instructional design by linking instruction with assessment in online learning environment that focuses on the development of students' SRL skills.

Despite a substantial amount of research on the effectiveness of formative assessment, there is little evidence to support the links between online formative assessment and students' SRL. Identifying and analyzing the effectiveness of online formative assessment in promoting SRL serves as a starting point in determining what specific steps should be taken to foster students' SRL skills and improve learning experiences in online courses. The purpose of this research was to add to the body of knowledge about online formative quizzes, filling a knowledge gap that currently exists. This study provided evidence of the conditions under which formative quizzes were used to facilitate students' SRL in post-secondary online courses. To guide the development and use of formative online quizzes in higher education, a comparison of students' use of online formative and summative quizzes, the effects of demographic variables and educational level on SRL and students' effort on online quizzes, and students' perception on online quizzes were investigated. Furthermore, this study suggested future research directions that should be pursued to advance the use of online formative assessment.

Formative assessment is inadequately theorized, and there is a lack of a solid theoretical foundation, which has resulted in ambiguity in this field (Andrade et al., 2019; Carless, 2007; Taras, 2010). Despite widespread acceptance of formative assessment's educational benefits, these claims are unsubstantiated due to a lack of a theoretical framework. However, the goals and benefits of formative assessment are valuable to higher education and deserve a solid theoretical foundation to back them up. This study established a theoretical foundation by linking formative assessment with SRL, which distinguished formative assessment from other forms of assessment and enriched formative assessment.

This study also contributes to the development of formative assessment methodology. Because the majority of empirical studies on formative assessment were quantitative, employing a mixed method to investigate the relationship between students' SRL and online formative assessment represents a novel approach to formative assessment research. By combining quantitative and qualitative data, the breadth and depth of understanding, as well as corroborating formative assessment, are increased, while the weaknesses inherent in using one method alone was mitigated. A mixed-method lens also allows for a more accurate examination of formative assessment in online learning environments by approaching it from different perspectives and using different methods.

This research benefits a wide range of people. First, the study's direct beneficiaries are instructors and students. Students benefit from the findings of this study because they receive timely feedback on how to monitor and change their own learning behaviors, as well as acquire better SRL skills (Cramp, 2011; Lee et al., 2010; Nadeem & Alfalig, 2020; Nicol, 2010). Instructors benefit from embedding online formative assessment into courses in order to foster a climate conducive to reflective learning and assist students in making significant gains in learning (Asamoah et al., 2022; Coll et al., 2013; Timmers & Veldkamp, 2011). The findings contributed to new pedagogical practices for instructors to utilize online formative assessment in online instructional environments. Second, instructional designers benefit from recognizing which specific self-regulation instructional strategies positively impact online students and can incorporate these activities into online course design. Furthermore, it benefits those in the field of education, such as administrators and legislators, by providing valuable insight into the impact of online formative assessment on students' SRL in online learning environments. The study's findings should also help institutions in increasing student retention, improving student satisfaction, and developing better online programs and support services to foster more effective online learning environments.

Furthermore, the findings of this study have implications for learning that extend beyond the classroom. As citizens of a globalized and rapidly changing world, modern postsecondary students require sharp lifelong learning skills in order to remain globally competitive. (DiFrancesca et al., 2016). SRL skills prepare them for lifelong learning by allowing them to adapt and grow while affecting individual development and social change within themselves and the world around them. Therefore, the importance of understanding the relationship between formative assessment and SRL in resolving problems caused by today's limited understandings should not be underestimated.

To sum up, the benefits of this study include the advancement of the current theoretical model of online learning, as well as the inclusion of online formative assessment within broader and more comprehensive pedagogical theories. The findings of this study will contribute to our current understanding of online components in designing online learning environments and helped us improve those practices by evaluating the effectiveness of online formative quizzes so as to guide the development of further research. Furthermore, this study brings about the discovery of

the new meaning of online quiz so as to enrich the online learning experience, as well as provided us with credibility and validity of implementing online formative quizzes to facilitate SRL in online learning environments.

CHAPTER 2 — Literature Review

This chapter presents the rationale for conducting research to determine the relationship between online formative assessment and self-regulated learning (SRL) in the context of higher education. The theoretical framework that combines learning theory and the self-regulated learning model is presented first, followed by the purpose of assessment and an examination of the distinctions between formative and summative assessments. Then the evolution of formative assessment was explored, focusing on how formative assessment evolved from instruments used to evaluate curriculum program to instruments widely used today to support learning. The forms of formative assessment are then examined. Next, empirical research on the characteristics, effects, and challenges of online formative assessment are presented in order to expand on the definition of effective formative assessment in online learning. Finally, concerns about online quizzes are raised in order to demonstrate how online quizzes influenced and were influenced by students' SRL.

Theoretical Framework

There is no single learning theory that claims to be the sole explanation for formative assessment's contribution to the improvement of SRL in the context of online learning environments. This is understandable given that formative assessment is a complex and dynamic process with numerous facets awaiting further investigation. In fact, there is no need for a stand-alone theory to unify the field, but rather a model that incorporates various theories and frameworks to guide the design and implementation of formative assessment in online learning. The extensive literature has yielded a wide range of theories and models that can be used to build a solid theoretical foundation for this research.

The current study falls under a broad theoretical category that combines learning theory and the self-regulated learning model. The learning theory used in this study was social constructivism, which served as an overarching and underpinning theory to unify the theoretical and conceptual framework that guided this study. The purpose of conceptualizing formative assessment within a model of SRL was to create environments in which students were encouraged to monitor and regulate their own learning in online learning environments (Asghar, 2012; Black & Wiliam, 2009;

Nicol & Macfarlane-Dick, 2006; Panadero et al., 2018). The SRL model associated with this study was Zimmerman's model of SRL. A blended theoretical foundation not only put this study in a broader context, but also contextualized the concept of formative assessment in the light of relevant theories (Black & Wiliam, 2009).

Social Constructivism

Social constructivism is based on Vygotsky's constructivist theory, which provides a theoretical foundation for bridging the gap between the establishment of a constructivist learning environment centered on the learner and the social learning environment that promotes idea exchange and collaborative knowledge development (Marín et al., 2000). Constructivism places the learner at the center of the learning process, but the social aspect of learning must also be considered in the online learning environment. Formative assessment integrates cognitive explanations of learning and social effects on learning into a functional theoretical framework by situating individual knowledge construction in the context of social interactions between students and instructors (Fosnot, 2005). As an overarching framework for this study, social constructivism theoretically underpins online formative assessment.

The Nature of Learning. Social constructivism begins with a set of shared assumptions about reality and knowledge. The first assumption is that reality is constructed by human activity. The second assumption is that knowledge is a human product that is constructed by the interaction between people and their surroundings (Amineh & Asl, 2015; Gredler, 1997; Schunk, 2000). Social constructivism reveals the nature of learning in accordance with these two assumptions.

First, social constructivists consider learning to be a social process rather than something that occurs solely within an individual (Kukla, 2000). Learning is a social process in which knowledge is constructed through social interaction with teachers, peers, and others (Burr, 2015; Loyens & Gijbels, 2008; Semple, 2000; Vygotsky, 1978). Second, learning is viewed as an active rather than passive process in which each learner actively constructs their own knowledge and meaning based on experience and social interactions (Vygotsky, 1978). Social constructivism emphasizes the process of learning rather than the product. Third, learning is an active process of making meaning (Bruner, 1986). According to the assumptions of social constructivism, knowledge cannot be simply transmitted from the outside. Learners must actively construct their sense of the reality, and then knoweldge is created to make sense of their experience, the experience of others, and the world (MacLellan &

Soden, 2004). Fourth, learning is a process by which individuals construct meaning in contexts that are meaningful to them (Liu & Lan, 2016; Schunk, 2011; Semple, 2000). Social constructivists highlight the significance of learning context in knowledge construction, asserting that learning is most effective when it is situated within a meaningful context (Vygotsky, 1978). Finally, learning is a cyclical process in which prior knowledge serves as the starting point for learning and the learner constructs new knowledge by accessing prior knowledge and making connections between prior and new information (Bush, 2006; Phillips, 1995).

The Role of Learner and Instructor. The social-constructivist viewpoint has influenced the pedagogical dimension of online learning over the last decade. Social constructivism represents a paradigm shift in learning, moving away from the ability to remember and repeat information and toward actively constructing knowledge through social interaction and experience (Amineh & Asl, 2015; Semerci & Batdi, 2015). As to social constructivism, the focus of learning is on the empowerment of the learner, in which learners are given the ownership of what they learn, how they learn, and how they assess their own learning. Social constructivism shifts the emphasis from teacher-centric information and knowledge dissemination to learner-centered learning, with the goal of acquiring higher learning skills (So & Brush, 2008; Vygotsky, 1978). Learner-centered learning places the learner at the center of the learning process and requires their active participation in the online learning environments (Blum-Smith et al., 2021; Kennedy & Hinkley, 2009; Schunk, 2011). Due to the physical absence of instructors and the relatively autonomous nature of online learning environments, learners must take more responsibility for their own learning at their own pace (Liaw & Huang, 2013; Rowe & Rafferty, 2013; Whittaker, 2015; Zheng et al., 2020).

Although learners play the most active role in the learning process, instructors play a critical role in social constructivism. Online learning creates a platform for instructors and learners to interact with one another more frequently. The instructors, as facilitators, are expected to actively engage learners in the construction of meaningful knowledge via a well-designed online learning environment (Fosnot, 2005; Philips, 1995; Zheng et al., 2020). In contrast to traditional face-to-face learning environments, instructors are not physically present to direct learning in online learning environments. Most online courses are designed and planned ahead of time by instructors. When online courses begin, instructors must devote more time to

guiding students through their online learning experiences, engaging them in active learning, and assisting students in constructing meaning knowledge based on their current knowledge through social interaction (Bush, 2006). Additionally, instructors must make a concerted effort to promote motivation and reflection, as well as provide tools for higher levels of critical thinking (Martin & Bolliger, 2018; Yengin et al, 2010).

Implications for SRL. According to social constructivism, learning is a self-regulating process in which learners proactively develop self-regulation strategies to construct their own learning rather than passively receiving it (Loyens & Gijbels, 2008; Schunk, 2011; Vygotsky, 1978). It differs from the traditional and passive role of learners, in which what they learn is externally regulated by the teacher and the environment (Fosnot, 2005; von Glasersfeld, 1995). Learners in social constructivism learn to self-regulate by controlling the learning process and environment. The social constructivist perspective on learners' roles is consistent with the findings of recent online learning studies, which show that students need more control over their learning process (Rowe & Rafferty, 2013; Shea et al., 2013; Tsai et al., 2013; Usta, 2011; Wang et al., 2013). In online learning environments, learners should self-regulate their own learning by planning, monitoring, and evaluating the learning process in the absence of a physical classroom and the physical presence of the instructor (Carter et al., 2020; Puzziferro, 2008; Samruayruen et al., 2013; Semerci & Batdi, 2015; Tsai, 2013; Wong et al., 2019).

Implications for Online Formative Assessment. Participation of learners in online formative assessment is consistent with social constructivism. Unlike traditional face-to-face learning, the nature of online learning allows learners from a variety of backgrounds, learning experiences, and cultures to end up on the same online course. Thus, online learners are more likely to be exposed to a wide range of learning experiences from which they generate knowledge and construct meaning. Because social constructivism views learning as a cyclical process, the assessment must be reflective and accurate in order to accurately represent the nature of learning (Gipps, 1999; Semerci& Batdi, 2015). Thus, as the integral component of learning and instruction, the assessment should align with the desired learning outcome by bridging the gap between current performance and specific learning goals. Furthermore, the assessment should examine the learning process in greater depth and diversity. Formative assessment, as opposed to summative assessment, is not used for

grading and provides opportunities for learners to assess their own learning with low risk and high reward, and then pursue next steps to progress toward the learning goal. It is a continuous process that has the potential to promote greater learning by focusing on the quality of the learning process rather than its outcome (Ogange et al., 2018; Torrance, 2012). Using social constructivism as an underpinning theory, formative assessment creates a learning environment in which assessment is integrated into the learning process rather than being treated as a separate entity.

Social constructivism underlines that learners play an important role in the learning process and should actively participate in the entire learning process; as a result, learners must actively participate in the assessment of their own learning (Elwood, 2006). In this sense, online formative assessment underscores learner involvement in the assessment process. Learners actively construct meaning through online formative assessment by evaluating what they have learned during learning and making connections with new knowledge, resulting in greater autonomy and motivation for learners and facilitating a meaningful learner-centered and interactive learning climate (Khan & Khan, 2019; Klenowski, 2009). Despite the lack of physical interaction, online learners are empowered to participate in a variety of online interactions with instructors and peers, such as virtual discussion boards, virtual study groups, and real-time chats, as they take responsibility for their learning. Such social interactions among instructors, learners, and peers foster social connections, learning support, and feedback without regard for time or space constraints, which is critical to the transformation of learning from external to internal knowledge (Eun, 2009).

According to social constructivism, learning is viewed as a social activity, and knowledge is dependent on context. Thus, the assessment should not be an individual activity. Instructors, as facilitators, should consider the learners' current level of knowledge and provide feedback to help the learners achieve the desired level of knowledge and thus progress toward autonomy (Gibbs & Simpson, 2004; Pokomy & Pickford, 2010; Sadler, 1989; Zheng et al., 2020). Feedback is one of the most important factors in the process of formative assessment, especially in online learning, due to the physical and temporal separation of instructors and learners. Thus, instructors need to provide meaningful and appropriate guidance to engage learners in reflection and inquiry, and then learners use quality feedback to direct their subsequent learning and thus bridge the gap in their learning (Chen et al., 2021; Clark, 2012; Khan & Khan, 2019; Yengin et al., 2010). Online formative assessment differs

from traditional formative assessment in that it provides immediate, timely, and continuous feedback to guide future learning. Online formative assessment is used to determine where learners are in their learning process. It then relays information about learners' current understanding to the instructor, which allows the instructor to plan and adjust the following activities.

Zimmerman's SRL Model

There is a body of literature that has emphasized the importance of developing SRL skills in the process of formative assessment (Black & Wiliam, 2009; Bose & Rengel, 2009; Clark, 2012; Granberg et al., 2021; Hattie & Timperley, 2007; Nicol, 2009; Nicol & Macfarlane-Dick, 2006; Panadero et al., 2018). SRL has provided a solid theoretical foundation for bringing together various studies on formative assessment (Black & Wiliam 2009). Because both social constructivism and the SRL model emphasize learners' active participation in the learning process, their combination creates a model of formative assessment and thoroughly explores how SRL can be actualized and reinforced by online formative assessment (Clark, 2012).

Overview of Zimmerman's Model. Given the wide range of learning science, there are multiple sound and competing models of SRL, such as Boekarets's (1996) model, Efklides' (2011) model, Pintrich's model (2000), Winne and Hadwin's (1998) model, and Zimmerman's (2000) model, all of which have contributed to our understanding of self-regulation. Zimmerman (2000) proposed one of the most widely accepted and cited. Although the background theories and components differ, Zimmerman's model shares some common assumptions with other models. The first assumption underscores SRL's constructive nature. Learners actively construct their knowledge from the internal and external worlds, rather than being passive recipients of information (Pintrich, 2000). Second, learners have the ability and potential to monitor and control their own learning, which includes cognitive, motivational, and social factors (Pintrich, 2000). Thus, SRL skills can be developed and learned. The third assumption is that self-regulated learners use goals or standards to assess their performance, evaluate their learning, and determine whether or not their self-regulation is effective. Finally, it is assumed that self-regulatory processes serve as mediators between personal factors and performance outcomes. Personal and environmental factors influence learning, but so does the learner's self-regulation of cognition, motivation, and behavior, which mediates the relationship between the individual, learning context, and performance (Pintrich, 2000).

Self-regulated learners, according to Zimmerman (1989), "are metacognitively, motivationally, and behaviorally active participants in their own learning" and "utilize specified strategies in their learning process to achieve academic goals based on perceptions of self-efficacy" (p. 329). Zimmerman (1990) identified three aspects of self-regulated learning. First, self-regulated learners are proactive, incorporating self-regulation processes in three stages: forethought, performance, and self-reflection (Zimmerman, 2001). Second, self-regulated learning is a self-directed feedback loop with three cyclical phases. It starts with forethought, then moves on to the performance phase, and finally to the self-reflection phase. The feedback from each phase influences the next phase and is used to make adjustments for the next tasks (Zimmerman, 1989). Thirdly, learning and motivation are interdependent processes. Motivation is the driving force behind the initiation of self-regulated learning processes which, in turn, results in higher motivations (Zimmerman, 1990).

The model is divided into three major phases that function cyclically. Forethought is the first phase of Zimmerman's (2001) model, in which learners assess the results from previous performance on related tasks, set goals, and plan for the task. Forethought, preceding learning, serves as the preparation for active learning and has a direct impact on how the learner performs and evaluates the learning during the performance phase. The performance phase takes place during the learning and is the actual process of deploying strategies to achieve the goals set in the forethought phase and monitoring one's learning performance (Zimmerman, 2001). The self-reflection phase occurs after learning and refers to the process by which learners react to their performance and evaluate their goals and behaviors (Zimmerman, 2002). The results of self-reflection feed into the subsequent forethought phase for future tasks, creating a cyclical feedback loop.

Implications for Online Formative Assessment. According to Clark (2012), formative assessment is evaluation for self-regulated learning. SRL and formative assessment have a mutually reinforcing dynamic (Black & Wiliam, 2009; Bose & Rengel, 2009; Carless et al., 2011; Chappuis & Chappuis, 2008; Clark, 2012; Espasa & Menses, 2010; Hattie & Timperley, 2007; Mao & Peck, 2013; Nicol & Macfarlane-Dick, 2006; Panadero et al., 2018). On the one hand, online formative assessment raises learners' awareness of the learning gap and provides opportunities for them to become deeply involved in their own learning process, as well as consciously monitor and regulate their effort, empowering learners to self-regulate their learning and

promoting a higher level of SRL (Nadeem & Alfalig, 2020; Nicol & Macfarlane-Dick, 2006). Self-regulated learners, on the other hand, are equipped with the skills to engage in deep learning and thus actively construct their understanding of feedback messages, as well as to develop critical thinking in order to adjust their activities to achieve their learning goals (Adam et al., 2017; Black & Wiliam, 1998b; Davis & McGowen, 2007; Zimmerman, 2000). Thus, formative assessment helps learners to make some adjustments during the learning process, which motivates learners to self-regulate more actively. As a result, self-regulated learners have a more enjoyable learning experience and exert more effort to make further progress in future learning (Bose & Rengel, 2009; Wong et al., 2019). Furthermore, online formative assessment lays the foundation for learning beyond the school years and has the potential to support lifelong learning in the future workplace, which is consistent with SRL's purpose of empowering learners to become professional lifelong learners (Granberg et al., 2021; Pandadero et al., 2018).

Online formative assessment, unlike other forms of assessment, takes place during the learning process and is intended to promote online learning by involving learners in monitoring and evaluating the learning process (Brown & Harris, 2013; Nicol & McFarlane-Dick, 2006; Panadero et al., 2019). Formative assessment is distinguished from other types of assessment by its direct relationship to SRL. Thus, this research focused on the aspects of Zimmerman's model that are most closely related to online formative assessment, which includes two sub-phases: self-monitoring and self-evaluation. Self-monitoring, also known as metacognitive monitoring, occurs when learners reflect on their learning process by comparing what they are doing to the assessment criteria (Zimmerman, 2002). Self-monitoring occurs during performance, whereas self-evaluation occurs after the task is completed (Winne & Hadwin, 1998). Self-evaluation is a critical step for self-regulation because it influences not only all stages of the self-regulatory process but also learning recursively (Zimmerman & Moylan, 2009). Self-evaluation is also the act of reflecting on one's performance during the learning process (Zimmerman & Moylan, 2009). This reflection enables learners to repeat the process if it was done correctly or to correct themselves if it was not. The flexibility of formative online assessment allows learners to have a high level of control over the assessment process. Consider online formative quizzes: learners can choose when, where, and how many times they want to take the quiz, and then complete it at their own pace (Black, 2015; Cohen &

Sasson, 2016; Kingston & Nash, 2011; Ogange et al., 2018).

The self-monitoring and self-evaluation processes serve as a bridge between SRL and online formative assessment (Zimmerman, 2001). Formative online assessment is a process in which learners monitor and evaluate their own learning. When learners receive timely feedback designed to promote learning during performance, they feel less anxious and more motivated to improve by decoding external feedback, internalizing it, and facilitating critical reflection on their own learning process (Abney et al., 2017; Bose & Rengel, 2009; McMillan & Hearn, 2008). Then they must perform a valid assessment of their learning by identifying discrepancies between actual and ideal performance, and then decide how much feedback to apply (Panadero & Alonso-Tapia, 2013). Following that, learners use SRL skills to adjust their future learning activities in order to bridge the gaps (Boud, 2002; Mao & Peck, 2013). Another unique feature of online formative quizzes is that learners can retake the quiz without being graded, motivating them to improve their learning. Given that SRL is a cyclical process, feedback influences the forethought phase of the next quiz, during which learners make adjustments to better regulate their learning (Panadero et al., 2019). As a result, SRL relies on self-monitoring and self-evaluation of formative assessment to support learning; formative assessment, in turn, influences each phase of SRL (Zimmerman & Moylan, 2009).

Furthermore, this study is linked to Zimmerman's model's self-motivation beliefs, specifically intrinsic motivation. According to studies, there is a positive relationship between formative assessment and motivation in traditional learning environments (Brookhart, 2007; Black & Wiliam, 2009; Cauley & McMillan, 2010; McMillan 2004). According to Zimmerman (2011), learners who have intrinsic motivation have higher persistence, deeper learning, and better transfer than those who have extrinsic motivation, which is consistent with the requirements of online learning. Formative assessment, unlike summative assessment, does not include a grade, which may prevent students from relying too heavily on external motivators (such as grades) and superficial approaches to learning (Cook & Babon, 2017; Gibbs & Simpson, 2004; Rushton, 2005). Without a grade, learners experience less test anxiety and are more motivated to return to the content, interact with instructors, and attempt the assessment more times (Black & Broadfoot, 2004; Stiggins & Dufour, 2009). Therefore, formative assessment is a continuous process that supports learning and teaching rather than a measurement instrument.

A number of studies have found a direct link between formative assessment feedback and the SRL process (Carless et al., 2011; Granberg et al., 2021; Espasa & Menses, 2010; Furnborough & Truman, 2009; Hattie & Timperley, 2007; Tsai, 2013). Feedback is essential for formative assessment and learners' SRL (Clark, 2012). On the one hand, learners fully benefit from formative assessment feedback when they self-regulate their own learning (Clark, 2012). Feedback, on the other hand, serves as a catalyst for SRL by providing learners with opportunities to become more involved in their learning, such as planning, monitoring, and reflection, in order to progress learning and become more self-regulated (Biggs, 2012; Butler & Winne, 1995; Carless et al., 2011). The immediate feedback feature has been stated as one of the biggest benefits of online formative quizzes (Clark, 2012; Zerr, 2007). One of the most significant advantages of online formative quizzes has been identified as the ability to provide immediate feedback (Clark, 2012; Yilmaz et al., 2020). The immediate feedback helps learners gauge their learning and gain a better understanding of learning gaps through the SRL process, allowing them to make adjustments to improve their learning (Bennett, 2011; Cotton, 2017; Ogange et al., 2018; Williams & Ryan, 2000). The second critical feature is the opportunity to re-attempt, which provides learners with the opportunity to succeed by retaking the quizzes. This feature sends the message that making mistakes is normal and part of the learning process. This feature also creates a feedback loop in which learners make mistakes, receive feedback, and retry. Thus, feedback is not the end of the story; rather, it assists learners in evaluating and tracking their learning progress, leading to increased confidence, engagement, and motivation (Elmahdi et al., 2018; Zerr, 2007). The third feature is asynchronous feedback, which allows learners to reflect on external feedback and generate internal feedback in order to increase effort to achieve learning objectives (Bose & Rengel, 2009; Sadler, 1989). Self-regulated learners respond more positively to external feedback than less self-regulated peers, use formative feedback to monitor and assess the learning process, and then use SRL strategies to internalize the feedback to advance future learning (Black & Wiliam, 2009; Butler & Winne, 1995; McCarthy, 2017; McLaughlin & Yan, 2017; Zimmerman, 2002).

Purposes of Assessment

Assessment is critical in formal higher education because assessment-centered learning environments provide learners with opportunities to develop and improve their learning skills (Bransford, Brown, & Cocking, 2000). Assessment can serve many different purposes, but the two most important are: to evaluate academic achievement and to support learning (Gikandi et al., 2011; Maclean & McKeown, 2013). It is critical to design and develop appropriate assessment in a way that reflects learning objectives and improves learners' learning, engagement, and satisfaction (Carless, 2007; Lewis et al., 2019; Raupach et al., 2013). For the purposes of this research, I started with the two most important assessments: formative and summative assessment.

Formative versus Summative Assessment

Formative and summative assessment are the two most common types of assessment. Both assessments are important in higher education, but they serve different functions. Their primary differences can be found in their characteristics, implementation, and effects.

Characteristics. The primary distinction is the assessment's nature and purpose. Formative assessment is diagnostic in nature and aims to improve learning. It intends to promote learning by providing related information to assist students in identifying and adjusting learning gaps, to assist instructors in steering subsequent instruction in response to what students require, to acquire a higher level of autonomy over their learning, and to foster self-regulation skills (Black & Wiliam, 2009; Bhat & Bhat, 2019; Dolin et al., 2018; Nicol, 2007; Wiliam, 2010). Summative assessment, on the other hand, is evaluative in nature and is used to assess a student's progress. It evaluates learning by measuring performance, comparing it to the standard, and certifying students' achievement (Bhat & Bhat, 2019; Brookhart, 2004; Gikandi et al., 2011; Kibble, 2017; Maclean & McKeown, 2013; Nicol & Macfarlane-Dick, 2006).

The second distinction can be found in learning theories. Formative assessment is closely associated with the constructivist view of learning, which holds that learning is learner-centered and that learners actively construct their own knowledge. As a result, formative assessment underscores the learner's active role in assessment and focuses on the learning process (Ahmad et al., 2020; Brookhart, 2004). Summative assessment, on the other hand, is more associated with a behaviorist view of learning.

As a result, learning is more teacher-centered, with teachers possessing knowledge and students passively receiving that knowledge. Summative assessment is used to determine whether or not the set target was met by comparing students' performance to the predetermined requirement, focusing on the final product of learning (Ahmad et al., 2020; De Vos & Belluigi, 2011).

The third distinction is in the assessment's format and content. Formative assessment can take many forms and has numerous applications. It can be formal or informal, written or spoken, basic or complex. Formative assessment, by implementing more assessment formats, is able to provide students and instructors with more and richer information in order to improve learning and teaching (Bhat & Bhat, 2019; Dixson & Worrell, 2016). Formative assessment is also criterion-referenced, which means that performance is directly compared to the learning goal or a set of criteria. Rather than comparing students' performance, formative assessment seeks to identify and assist students in bridging the learning gap between current learning and the desired goal. Formative assessments typically contain less content than summative assessments due to their timing and frequency. Summative assessment, on the other hand, is primarily formal and standardized, and is used to measure an individual's relative performance within a group. As a result, summative assessment can be norm-referenced by ranking and comparing performance with others, ranging from failing to excellent and creating competition among students. Formal, written, or verbal summative evaluation is possible. Depending on the format of the assessment, the same assessment, such as a quiz, can be used as summative or formative. The differences in the purpose and implementation of the assessment determine whether it is formative or summative (Dolin et al., 2018; Kibble, 2017; Maclean & McKeown, 2013).

Implementation. First, the timing of implementation varies. Because formative assessment is an ongoing process, it is appropriate that it occurs during the learning process rather than at the end. Formative assessment is embedded within instruction to adapt instruction to meet students' needs during the learning process to fulfil the purpose of promoting learning. It occurs frequently during the course of instruction (Gikandi et al., 2011; Dolin et al., 2018) whereas summative assessment occurs after the learning has occurred. Summative assessment is typically administered at the end of an instructional unit, midterm, or course to provide information for grading and evaluating performance. Formative assessment occurs more frequently than

summative assessment to collect information on students' current level of learning and to adjust instruction and learning to help students fill in the learning gap and reach the desired learning goal (Dixson & Worrell, 2016; Stull et al., 2011).

Second, formative assessment is not carried out in the same manner as summative assessment. Formative assessments are typically open-book, with no invigilation, less time limitation, and no or few grade points (Krasne et al., 2006). Summative evaluation, on the other hand, is closed-book, invigilated, time-limited, and marked. As a result, formative assessment is lower risk and places less emphasis on grade, allowing students to actively participate in the assessment without fear of being penalized for mistakes. Summative assessment primarily grades students and informs them of their position or ranking in relation to their peers.

Third, feedback is another distinction between summative and formative assessment. Formative assessment promotes learning by providing ongoing feedback in a non-threatening learning environment so that both students and instructors gain information to make changes in the learning process (Brookhart, 2004; Dixson & Worrell, 2016; Maclean & McKeown, 2013). Although summative assessment does not exclude feedback, it rarely provides feedback and instead only provides students with a grade or score (Bälter et al., 2013; Dolin et al., 2018; Marden et al., 2013).

Finally, students and teachers play different roles in summative and formative assessment (Black & McMillan, 2012). According to constructivism, formative assessment is student-centered, with students actively participating in the assessment. Students can thus assess their own learning in some forms of formative assessment, such as self-evaluation and peer evaluation. Students who take more responsibility for the assessment receive feedback from the assessment and use the information to adjust their ongoing learning activities. Teachers' roles are to help students identify and close gaps in their learning. Summative assessment, on the other hand, is teacher-centered, with teachers controlling the entire assessment process. Students are measured and judged based on whether or not they have absorbed the knowledge imparted by teachers.

Effects on learning. Because of their characteristics and implementation, formative and summative assessment have varying effects on students' learning. The goal of formative assessment is to provide feedback to students and teachers in order to improve learning and motivation by assisting students in identifying and closing learning gaps. In contrast to summative assessment, formative assessment focuses on

the learning process rather than grades, so students are more likely to set mastery-oriented goals and be intrinsically motivated (Cauley & McMillan, 2010; Gikandi et al., 2011; Lau, 2016). Thus, students are more likely to take a deep approach to learning, relate new ideas to prior knowledge, and actively construct their own knowledge. Formative assessment, which shifts from grades to feedback, aims to create a constructive learning environment in which students are willing to seek help and collaborate with peers. Because formative assessment is an ongoing process, students use this continuous feedback to identify problems early on and make adjustments while learning. At the same time, teachers use the data to improve their instruction. Low-stakes formative assessment fosters a positive learning environment in which students are eager to seek assistance and collaborate with their peers (Clark, 2008). Students take on more responsibility for their learning during formative assessment. However, because formative assessment does not have the same weight as summative assessment, students may not take it seriously.

Summative assessment, on the other hand, produces a grade or score, which is used to measure academic achievement by comparing and ranking students against their peers. Summative assessment results have a significant impact on whether students pass or fail the course. As a result, summative assessment is regarded as a critical factor in the decision-making process for admission or graduation in higher education. Students are more likely to engage in surface learning and develop performance-oriented goals (Bhat & Bhat, 2019; Gikandi et al., 2011; Lau, 2016; Munzur, 2014). They place more emphasis on grades by memorizing information and using rote learning, rather than developing a deep understanding or mastery of subject material. As a result, summative assessment motivates students extrinsically. Students are more hesitant to seek assistance or collaborate with peers in order to demonstrate competence in comparison to their peers (Black & Wiliam, 2009; Dixson & Worrell, 2016). Students not only exhibit high levels of test anxiety due to the high stakes, but they also have a greater temptation to cheat. As a result, summative evaluation may not accurately reflect learning.

Summary

There are various types of assessment in the field of education. However, formative and summative assessments are the most commonly used. Despite significant differences in purposes, characteristics, implementation, and effects, formative and summative assessment are not mutually exclusive and share some

characteristics. Both types of assessment are necessary for evaluating student learning and serve important functions in higher education. Both assessments are well-planned and designed by instructors to effectively measure a student's learning by gathering some useful and important information to fulfil its specific purpose. Both help to improve students' learning outcomes and assist them in future learning (Dixson & Worrell, 2016). Both can be used in a classroom, a school, or a district. Formative assessment is designed to promote learning by providing feedback to bridge the learning gap, allowing students to be better prepared for summative assessment at the end of the term. Overall, both formative and summative assessment must be used in tandem to monitor students' learning progress, provide constructive feedback, and judge against the standards (Bhat & Bhat, 2019; Stull et al., 2011). A balanced assessment system should include both forms of assessment in order to collect comprehensive information and provide the most complete picture for students and teachers, as well as focus on both the process and outcome of learning.

Evolution of Formative Assessments

The first step in investigating the relationship between formative assessment and SRL is to understand the evolution of formative assessment, which identifies and describes the history and nature of formative assessment using existing literature. Formative assessment can be derived historically by first understanding the dominant learning theories that underpin the antecedents and current practices of formative assessment in the context of higher education.

As the dominant learning theory in the first half of the twentieth century, behaviorism emphasized the role of assessment in measuring the ability to memorize and recall isolated facts (Ahmad et al., 2020; Narciss, 2008). Within the behaviorist learning paradigm, assessment was distinct from instruction and learning. Scriven (1967) coined the term "formative" in the context of evaluating the effectiveness of a curriculum program. To clarify the change in school curriculum based on Cronbach's work (1963), Scriven (1967) proposed two different ways of evaluating and identified formative evaluation as the opposite of summative evaluation.

Bloom (1968) was the first to apply Scriven's (1967) formative evaluation to classroom teaching, employing formative evaluation as a tool to improve teaching and learning. Bloom and his colleagues linked formative evaluation to educational

objectives, and expanded the definition of formative evaluation to include providing feedback to students and guiding their correction (Bloom et al., 1971). Bloom claimed that the ultimate goal of formative evaluation was to assist instructors in making subsequent instructional decisions that would improve students' summative evaluation performance (Bloom et al., 1971). This assertion was supported by Fiel and Okey (1974) and Block and Burns (1976). Bloom's formative evaluation, while intended to improve learning, reflected a cognitivist perspective on learning. Unlike behaviorism, cognitivism places an emphasis on cognitive orientation and encourages mental processing. Thus, cognitivists use feedback to guide students through the correction process, whereas behaviorists use feedback to modify learning behavior.

In the 1980s, some authors used the terms formative evaluation and formative assessment interchangeably. Both terms included measurement and criterion components, which were important in learning environments. This interchangeable usage, however, has caused some confusion and ambiguity. More recently, researchers have distinguished between assessment and evaluation. The primary distinction is that the term *evaluation* is associated with making a judgement about value or performance, whereas the term *assessment* is used to gauge the value or performance in order to improve the quality of learning (Brookhart, 2004; Gikandi et al., 2011; Pereira et al., 2016; Struyven et al., 2005). Thus, evaluation is product-oriented, whereas assessment is process-oriented. Formative assessment gradually replaced formative evaluation.

This widespread use of formative assessment coincided with the transition of learning theory from a cognitivist to a constructivist perspective. The emphasis on instruction shifted from teaching to learning with the rise of constructivism. Though constructivism evolved from cognitivism, it distinguished itself by emphasizing the active role of learners in knowledge construction rather than passively transferring information. Although Bloom (1969) proposed that formative evaluation and grading be separated, current formative assessment, which is based on social constructivism, excludes grading in order to empower learners to improve their own learning by interacting with instructors and using feedback to direct their subsequent learning and develop skills (Clark, 2012).

Outside of the United States, assessment researchers responded to changes in learning theories by focusing on the role of classroom assessment. Sadler (1989), an Australian assessment researcher, highlighted the role of the student in the formative

assessment process. Students, according to Sadler (1989), should actively participate in the assessment by determining the gap between their current performance and the goal, using feedback to monitor the quality of their own learning, and then moving forward to close the gap. In the United Kingdom, a group of educational assessment researchers also formed the Assessment Reform Group in 1989 with the goal of promoting formative assessment practices. Paul Black and Dylan Wiliam of the Assessment Reform Group published two seminal articles on the relationship between formative assessment and learning in 1998. They discovered that formative assessment is one of the most effective instructional methods for significantly improving students' academic achievement (Black & Wiliam, 1998a). Black and Wiliam (1998b) emphasized the importance of feedback in modifying learning and teaching activities to achieve higher levels of achievement. In contrast to Sadler, Black and Wiliam (1998b) proposed that students can measure their own learning progress, whereas Sadler (1989) stated that the assessment should be compared to the reference standard. The Assessment Reform Group is also credited with coining the phrase "assessment for learning" to distinguish between formative and summative assessment. The phrase "assessment for learning" emphasizes the critical role of assessment as a powerful tool for feeding into learning and thus improving learning. Thus, these two terms assessment for learning and formative assessment have very similar meanings.

Formative assessment has become an active area of research since the publication of Black and Wiliam's (1989a) seminal study on the subject, resulting in a significant increase in studies on the impact of formative assessment on learning (Bennett, 2011; Dunn & Mulvenon 2009; Hattie & Timperley, 2007; Irons & Elkington, 2021; Nicol & Macfarlane-Dick, 2006; Stiggins, 2005; Taras, 2005; Torrance & Pryor, 2001; Yorke, 2003). The concept of online formative assessment emerged as a result of the convergence of formative assessment, information technology, and the Internet. The shift from traditional paper-based assessments to fully online assessments has had a significant impact on learning and instruction. Modern technologies enable online assessment to be used in a variety of design and form without regard for time or space constraints. The emergency of online assessment, on the other hand, is much broader than simply using the internet in the assessment process. Online formative assessment is more accessible, flexible, and cost-effective, and it provides a large number of students with continuous feedback throughout the learning process, all of which

promotes interactions among students, instructors, and peers while also bridging gaps between instruction and learning in higher education.

With a noticeable shift in learning theory from behaviorism to social constructivism, the approach to assessment has shifted from evaluating students' ability to memorize facts to measuring students' competency, and finally to improving learning (Ahmad et al., 2020; Reid & McLoughlin, 2002). Traditional assessment has been criticized for limiting students' autonomy and student-centered learning, as well as for overusing summative assessment and providing feedback after learning. The goal of assessment in the twenty-first century differs greatly from previous eras. Formative assessment is an essential component of an effective learning environment and has been at the heart of formal higher education for many years (Bransford et al., 2000; Elmahdi et al., 2018; Gikandi et al., 2011). The primary goal of online formative assessment is to support learning and knowledge construction by identifying learning gaps, providing timely feedback while learning, actively participating in the assessment process, and providing guidance for future learning (Chen et al., 2021; Clark, 2012; Heritage, 2007; Spector et al., 2016).

Forms of Formative Assessment

To fully realize the potential of formative assessment, it is necessary to investigate the various forms of formative assessment, which provides a solid foundation for a more in-depth understanding of this research. Although there are many different forms of formative assessment, they all aim to support learning by addressing student learning gaps, facilitating learner-centered learning, encouraging student-instructor interaction, and improving learning through feedback (Black & Wiliam, 2018; Gikandi et al. 2011; Spector & Yuen, 2016).

Torrance and Pryor (2001) distinguish two types of formative assessment: convergent and divergent formative assessment based on the type of questions teachers ask during instruction. Convergent formative assessment attempts to determine whether students know or understand the information (Pryor & Crossouard, 2008; Torrance & Pryor, 2001). Convergent formative assessment is characterized by meticulously planned and closed questions that adhere to the established curriculum and provides feedback to students to correct mistakes with only one right answer (Ateh, 2015; Huang, 2011). As a result, teachers give assessments that strictly

conform to their expectations, while students, as passive recipients, are only assessed and rarely engage in interactive discussion. Divergent formative assessment is based on a more constructivist view of learning, with the goal of determining what learners have learned and what they have not grasped (Charteris, 2016; Pryor & Crossouard, 2010; Torrance & Pryor, 2001). Divergent formative assessment, as opposed to convergent assessment, is distinguished by open-ended questions and provides a variety of explanatory feedback rather than correcting errors, and is better suited to evaluating higher-order thinking skills (Charteris, 2016). Teachers view disagreement and mistakes as natural parts of the learning process and place a premium on student participation in the assessment process as well as interaction between students and teachers (Ateh, 2015). Students take an active role in their own evaluation as both initiators and recipients. As a result, students and teachers collaborate to conduct divergent formative assessments with the goal of gaining insights into current understanding and prompting metacognition. Although convergent and divergent formative assessment emphasize on different types of questions, they both contribute to students' understanding, therefore, teachers should use both forms of questions to elicit a wide range of students' knowledge to improve learning.

Formative assessment can be conducted in both formal and informal forms (Arrafii & Sumarni 2018; Bell & Cowie, 2001; O'Keeffe et al., 2020; Ruiz-Primo, 2011; Zhao, 2018). Formal formative assessment is planned and designed in advance by the teacher to collect information to monitor students' learning (Dabbagh & Kitsantas, 2012). The teacher assigns the written assessment to the students who are required to respond in writing, and then the teacher evaluates the tasks and provides feedback (Asamoah et al., 2022). Thus, formal formative assessment refers to paper-and-pencil tests, such as quizzes, exercises, and assignments (Griffin et al., 2016; Woolfson, 2018). Informal formative assessment, on the other hand, is unplanned and unpredictable, involving assessment dialogues and conversations that take place during the instruction (O'Keeffe et al., 2021; Ruiz-Primo, 2011). Informal formative assessment occurs when teachers become aware of a student's misunderstanding as a result of an unexpected question or incorrect response, and then the teacher assesses student understanding through class discussion and dialogue and provides prompt feedback (Woolfson, 2018). Thus, informal formative assessment is typically used to assess student learning during an ongoing learning activity, such as a discussion, portfolio, video or oral presentation, and interviews (Oz, 2014). Informal formative

assessment is more flexible and spontaneous, as well as more effective in encouraging students' participation and monitoring their thinking while learning (Enders et al., 2021; López-Pastor & Sicilia-Camacho, 2015; Zhao, 2018). However, informal formative assessment required extensive expertise and time from teachers to design and implement (Eshun et al., 2014; Menendez et al., 2019; Oz, 2014). Given that formative assessment occurs on a continuum from informal to formal, formative assessment in higher education should combine both formal and informal formative assessments to support learning and improve formative assessment reliability and validity, rather than substituting one for the other (Asamoah et al., 2022; Aji & Hartono, 2019).

According to the degree of formality, formative assessment can be classified into three forms: on-the-fly assessment, planned-for interaction, and curriculum-embedded formative assessment (Heritage, 2007; Shavelson et al., 2008). Formality refers to the amount of planning that teachers put into gathering data and providing feedback to students (Bell & Cowie, 2001; Shavelson, 2006). On-the-fly formative assessment is an improvised interaction between the teacher and students when the teacher recognizes appropriate opportunities, for example a misconception, and started a conversation spontaneously during the learning process (Harrison et al., 2018; Shavelson et al., 2008). On-the-fly formative assessment aims to probe students' thinking in real time in order to evaluate where students are in their learning, determine on the next steps to advance their learning, and implement a formative intervention (Nieminen et al., 2020). In contrast to informal and unplanned on-the-fly formative assessment, planned-for interaction formative assessment is designed ahead of time to elicit student responses (Lyon et al., 2019). The teacher asks those deliberate planned questions in order to conduct a discussion with students in order to identify students' learning gaps (Heritage, 2007). Curriculum-embedded assessment is inserted into the curriculum at specific points when an important learning sub-goal must be met (Hondrich et al., 2016; Hopster-den Otter et al., 2019; Shavelson et al., 2008). The goal of curriculum-embedded formative assessment is aligned with the curriculum to inform teachers about what students know and what they don't know so that they can provide timely feedback (Decristan et al., 2015; Shavelson et al., 2008). Curriculum-embedded assessment, unlike the previous two formative assessments, is formal and planned in advance by curriculum developers, rather than leaving the burden of planning solely on the teacher (Tang & Jones, 2014).

Reinholz and Gillingham (2017) divide formative assessment into three forms based on when student thinking is assessed: reactive, active, and proactive. Reactive assessment, like curriculum-embedded assessment, occurs after instruction, with the goal of eliciting student thinking following a lesson and providing feedback to close students' learning gaps and modify future lessons (Reinholz & Gillingham, 2017). Active formative assessment, like on-the-fly assessment, occurs during instruction, eliciting student thinking while learning and providing prompt feedback, necessitating the teacher's quick response as student thinking emerges (Reinholz & Gillingham, 2017). The information gathered actively can be used immediately to modify the instruction as it unfolds, but it also places a greater emphasis on the teacher's ability to respond quickly. Proactive formative assessment, like planned-for interaction, occurs prior to instruction, making it more flexible and usable before, during, and after a lesson (Reinholz & Gillingham, 2017). The information gathered proactively can assist the teacher in thoughtful lesson planning and strengthen active assessment. Teachers, on the other hand, must be equipped with advance knowledge of student thinking in order to implement proactive formative assessment and elicit student thinking (Lyon et al., 2019; Reinholz & Gillingham, 2017).

As online learning becomes more widely adopted and implemented in higher education, online formative assessment is becoming more popular in the educational field which can be delivered asynchronously or synchronously using computer-based online tools, mobile phones, and online platforms (Fuller et al., 2022; Webb & Gibson, 2015). Online formative assessment has some advantages over traditional paper-and-pencil assessment, including greater flexibility in terms of time and location of assessment, immediate feedback, and non-threatening testing environment (Khan & Jawaid, 2020; Spector et al., 2016). With unprecedented assessment opportunities provided by technological advancements, technology-enhanced assessment (TEA) appears to innovate formative assessment practices. TEA employs a variety of technologies to support the delivery of assessment by encouraging the interaction with students and engaging students differently with prompt feedback (O'Leary et al., 2018; Sweeney et al., 2017). With the collection of an increasingly amount of accessible data through, there are opportunities to investigate what learning and feedback is taking place and to provide personalized assessment with real-time feedback (Lee et al., 2012; Luthfiyyah et al., 2021). TEA aims to positively shape

formative assessment and support learner-centered learning, high-level skills, and SRL (Devedzic & Devedzic, 2019; Poth, 2018).

Bennet (2015) classified TEA into three phases based on the level of technological involvement. In the first phase, online formative assessment simply displays traditional paper-and-pencil assessment on the computer screen, however, all items are chosen and administered by computers in a fixed linear order, regardless of student performance level (Bennet, 2015). Online formative assessment becomes flexible and efficient, allowing students to complete their assessment without regard for time or location, try multiple times, and receive prompt feedback during the learning. In the second phase, online formative assessment presents questions in an adaptive manner to maximize the interactions between students and questions, such as adaptive formative assessment (Bennet, 2015). Rather than assigning the same items to all students, adaptive formative assessment is customized in such a way that the item is adaptively selected by the computer based on the student's response to the previous item, resulting in each student's items being unique (Becker-Blease & Bostwick, 2016; Griff & Matter, 2013; Louhab et al., 2018). Thus, it is possible to efficiently collect individually customized data, providing diagnostic feedback to each student in order to provide a more meaningful, accurate, and reliable assessment, and providing insight to the teacher as to where the student is struggling and which specific student requires more assistance during the learning process (Choi & McClenen, 2020; Krouska et al., 2018). With the integration of artificial intelligence, online formative assessment in the final phase can be seamlessly woven into the instructional and learning process to support learning of important content and key competencies (Bennet, 2015). Stealth assessment is embedded into the highly interactive and immersive computerized tasks, such as games, to accurately measure students' knowledge and skills with maintaining their engagement in gameplaying (Shute, 2011; Shute et al., 2021). Students' anxiety is greatly reduced or removed because the assessment is invisible to them while engaging in games (Shute & Kim, 2014). As such an ongoing and unobtrusive assessment, stealth assessment aims to improve learning and inform instruction by extracting multifaceted dynamic data and responding with immediate and meaningful feedback (Shute & Kim, 2014; Shute & Ventura, 2013).

Features of Online Formative Assessment

With the convergence of formative assessment and technological affordances in higher education, the use of formative assessment in the context of online learning provides a new venue for strengthening and deepening the relationship between assessment, instruction, and learning in higher education. In the literature, terms such as formative e-assessment (Hodgson & Pang, 2012; Pachler et al., 2010), web-based formative assessment (Costa et al., 2010; Henly, 2003; Wang, 2008), computer-based formative assessment (Peat & Franklin, 2002; Bull et al., 2006; Miller, 2009), and technology-enhanced formative assessment (Beatty & Gerace, 2009; Lee et al., 2012) are used to describe online formative assessment (Baleni, 2015; Gikandi et al., 2011; Kibble et al., 2011; Lin & Lai, 2013; McLaughlin & Yan, 2017; Yilmaz et al., 2020).

The effectiveness of formative assessment has been widely acknowledged and well documented (Bose & Rengel, 2009; Bulunuz et al., 2016; Clark, 2012; Eshun et al., 2014; Gikandi et al., 2011; Hannah et al., 2014; Miller, 2009; Nicol & Macfarlane-Dick 2006;). Therefore, it is critical to investigate the characteristics and effects of online formative assessment to bridge the learning gap and support independent, meaningful, and high-order learning through online formative assessment. Online formative assessment, as a new type of assessment, cannot simply be copied from traditional formative assessment. Instead, it must offer distinct benefits over traditional formative assessment, the most important of which are flexibility, instant scoring, efficiency, reduced test anxiety, and feedback (Cigdem & Oncu, 2015; Gikandi et al., 2011; McLaughlin & Yan, 2017; Perera-Diltz & Moe, 2012; Reid & McLoughlin, 2002). These features give students greater control over their assessments and a deeper understanding of online tools, engage students in more meaningful learning experiences, and guide future learning. Furthermore, online technology allows for the modification of more assessment tools into formative assessment to evaluate student learning based on the purpose of the online course.

Flexibility

Online formative assessment allows for greater flexibility in terms of time and location (Cigdem & Oncu, 2015; Hannah et al., 2014; Marden et al., 2013; Miller, 2009; Ogange et al., 2018). Traditional paper-and-pencil formative assessment requires students to take the assessment at the same time and place with only one attempt. However, some undergraduate and graduate students must work and have family responsibilities. Online formative assessment gives students more control over

their assessments, allowing them to gauge their learning at their convenience and to balance study, work, and family commitments. Students have the option of attempting the assessment multiple times, allowing them to retake the assessment without penalty. Online formative assessment also has the potential to provide assessment modifications to meet students' special needs without the need for additional staff or equipment (Lyng & Kelleher, 2019). A larger font, screen reader, and voice-to-text application, for example, can assist students with disabilities or dyslexia in completing the assessment. Thus, online formative assessment allows students to benefit from the flexibility of measuring their understanding whenever and wherever they want, which is beneficial for adapting to the diversity of needs among today's postsecondary students and promoting independent learning in higher education.

Instant and Accurate Scoring

When compared to traditional paper tests, the results of automated-scoring online formative assessment are immediately available (Çekiç & Bakla, 2021). Although immediate scoring is not the goal of the assessment, they do provide students with a better understanding of what they have learned, enabling them to adjust their progress and learning strategies as they progress through the learning process (McLaughlin & Yan, 2017). The automated scoring process saves teachers time and effort, allowing them to focus on planning and feedback. Teachers can guide students to improve their learning by making real-time instructional adjustments based on their students' immediate scores. This feature also reduces the possibility of human error and increases grading accuracy, making the assessment more objective and accurate than traditional formative assessment.

Efficiency

Online formative assessment is more efficient in terms of time, resources, and cost than traditional paper-and-pencil assessment. Instead of commuting to campus, students can take the assessment at home or anywhere that is convenient for them, saving time and money on transportation (Angus & Watson, 2009; Hannah et al., 2014; Yilmaz et al., 2020). The online formative assessment feature also enables instructors to assess student learning more quickly and efficiently, saving time spent administering and manually grading assessments. Thus, instructors have a better understanding of their students' current understanding and can concentrate on analyzing their learning gaps, providing effective feedback, and other ways to support student learning (Griffin & Rankine, 2010; Nicol, 2007; Ogange et al., 2018). As

colleges and universities face the enormous challenge of rising costs and decreasing funding, implementing online formative assessment is extremely beneficial in removing costs such as hiring invigilators, printing exam paper and answer sheets, scanning the answers, storing exam paper, and staff overheads (Thurlow et al., 2008). This feature saves time and money for online courses with large class sizes.

Non-threatening Learning Environment

Online formative assessment fosters a non-threatening atmosphere for students to assess their learning (Marden et al., 2013; Ogange et al., 2018). First, students have more control over the assessment environment, such as the timing, location, and pace of the assessment. During a window of availability, students take the assessment whenever they are ready and choose a location where they feel safe and comfortable, free of the distractions that are common in traditional in-class assessment (Stowell & Bennett, 2010). Second, the majority of online formative assessments are not graded or invigilated. As a result, online formative assessment is low-stakes and allows students to attempt multiple times. The paper-and-pencil test causes stress in the majority of students, who exhibit a variety of physiological and emotional symptoms. Additionally, test anxiety creates significant barriers to learning and performance (Sung et al., 2016). According to empirical studies, students reported less test anxiety when taking online formative assessments (Cardozo et al., 2020; Cigdem & Oncu, 2015; Khanna, 2015; Stowell & Bennett, 2010). Such positive assessment experiences are beneficial for promoting test-enhanced learning, which results in long-term knowledge retention and transfer in a variety of contexts (Hinze & Rapp, 2014; Khanna, 2015). The non-threatening nature of online formative assessment fosters a bias-free learning environment in which students can make mistakes without fear of being judged or ridiculed and can focus on their learning goals rather than performance goals (Nicol, 2010).

Feedback

Timely and ongoing feedback is an essential component of online formative assessment. Sadler (1989) classified feedback into two types: information for students about their learning and information for instructors about student learning. The first type of feedback is designed to assist students in closing the learning gap and improving their learning. However, one of the most significant limitations of traditional formative assessment is that, due to the large number of students in undergraduate courses, it is nearly impossible to provide one-on-one feedback to each

student (Marden et al., 2013). The online learning environment provides viable alternatives for providing immediate and frequent feedback to students while avoiding additional administrative costs and workload for teachers (McCarthy, 2017). Students receive automatically generated feedback based on their responses to each item as soon as the assessment is submitted. In contrast to traditional formative assessment, the immediacy of feedback assists students in identifying their learning weaknesses so that they can bridge gaps in their understanding and steer their learning to achieve the intended goals (Hattie & Timperley, 2007). Furthermore, timely and frequent feedback is required to foster student engagement and independent learning (Higgins & Bligh, 2006; Yilmaz et al., 2020; Zimmerman & Labuhn, 2012).

Although most studies focus on student feedback, feedback for instructors is critical in online learning. The second type of feedback is intended to inform instructors about the next steps of instruction. Online formative assessment, in contrast to traditional assessments, provides instructors with timely information on students' current progress. This feature allows instructors to monitor students' learning in real time, giving them a better understanding of what students have learned and the effectiveness of current instructional activities (Bulkley et al., 2010; McLaughlin & Yan, 2017). A more accurate and comprehensive picture of each student's learning assists instructors in identifying, analyzing, and solving problems by modifying instructional practices (Asamoah et al., 2022; Shirley & Irving, 2015).

As a result, feedback benefits both students and teachers. This aspect of online formative assessment promotes learner-centered learning. Students play an important role in evaluating their own progress and changing their learning strategies based on timely feedback. As facilitators, instructors use feedback to tailor instruction to the needs of their students.

Summary

To summarize, the above characteristics of online formative assessment empower students to assess their learning in more meaningful ways that are flexible, efficient, and learner-centered. While higher education has undergone a dramatic shift from teacher-centered to learner-centered, online formative assessment, with its flexibility and efficiency, offers a viable option for creating a learner-centered learning environment. In online formative assessment, students have more control over evaluating their learning process, while teachers conduct periodic checks on learning and diagnose issues to facilitate student learning (Nicol, 2009). Frequent assessment

with timely feedback and instant scoring has the potential to foster more meaningful interactions among students, teachers, and peers in online higher education, facilitating critical thinking and deep learning (Akyol et al., 2009; Gikandi et al., 2011; Nagandla et al., 2018; Spector et al., 2016). Furthermore, online formative assessment has the potential to motivate students to take ownership of their learning (McKenzie et al., 2013; Stull et al., 2011; Veugen et al., 2022). Transforming these potentials into real-world effects of online formative assessment necessitates instructors being aware of the challenges they face before designing more appropriate and effective formative assessment.

Issues of Formative Online Quizzes

In higher education, quizzes are commonly used to assess students' learning. In comparison to the exam, the quiz is a short assessment with a high frequency to evaluate a small part of instruction over a short period of time. With the advent of ICT, online quizzes were introduced and widely used in online and blended courses, with the potential to be available at any time at the students' convenience (Ogange et al., 2018). Online quizzes can be used as formative assessments to assess how a student is learning and identify learning gaps, or as summative assessments to assess how much a student has learned using grades (Brown et al., 2015; Cohen & Sasson, 2016; Hope & Polwart, 2012; McLaughlin & Yan, 2017).

Online quizzes are an important form of formative assessment that can be used at various points throughout the course: before instruction as an incentive to get students prepared, or after instruction to gauge their learning. In comparison to summative online quizzes, online formative quizzes have lower stakes and are more effective at providing timely and ongoing feedback on students' learning progress to encourage greater engagement (Abney et al., 2017; Cook & Babon, 2017). Students can retake the quiz as many times as they want without fear of failing. Students can adjust their learning strategy after receiving immediate feedback in order to address learning gaps and master the knowledge.

Although the advantages of online formative quizzes are well known, some issues limit their effectiveness (Biggs, 2012; Lyng & Kelleher, 2019; Milner et al. 2015). Furthermore, because of the lack of accountability, issues relating to online formative quizzes have not been well documented. Thus, this section includes a review of the

literature on a) the effects of online formative quizzes on learning; and b) the challenges of designing online formative quizzes, particularly specific factors influencing the effectiveness of online formative quizzes.

Effects of Online Formative Quizzes

While online formative quizzes have grown in popularity in higher education, the issues of relative effect on students' online learning have become a focus of research. Despite the fact that a number of studies have attempted to investigate the effects of online formative quizzes on learning outcomes, engagement, and retention, the literature does not provide a definitive answer (Chen et al., 2021; Cohen & Sasson, 2016; Marden et al., 2013).

Effects on Learning Outcome. Several studies have attempted to investigate the impact of online formative quizzes on students' performance in higher education; however, results vary greatly, and some studies even contradict one another.

Positive Learning Outcome. Numerous studies have found that using online quizzes as a formative assessment tool improves learning outcomes in blended and online learning environments. Results in blended learning environments show that incorporating online formative quizzes into traditional instruction results in higher levels of satisfaction and significantly improved final exam scores (Cohen & Sasson, 2016; McLaughlin & Yan, 2017; McKenzie et al., 2013). Empirical studies indicate that using online formative quizzes improves students' academic achievement, as has been demonstrated across a variety of disciplines, such as biology (Enders et al., 2021; Orr & Foster, 2013), computer science (Bälter et al., 2013), economics and finance (Ćukušić et al., 2014; Hope & Polwart, 2012; Massoudi et al., 2017), education (Joyce, 2018), geography (Cook & Babon, 2017; Wilson et al., 2011), law (Admiraal et al., 2014; Ozarslan & Ozan, 2016), math and science (Hannah et al., 2014; McLaughlin & Yan, 2017), medicine and health science (Brown et al., 2015; Cohen & Sasson, 2016; Kibble, 2017), physiology (Brown et al., 2015; Marden et al., 2013; Kerr et al., 2016), psychology (Gikandi et al., 2011; Johnson & Kiviniemi, 2009; Khanna, 2015; McDaniel et al., 2012; Pennebaker, 2013; Stull et al., 2011; van Camp & Baugh, 2014), statistics (Brown & Tallon, 2015). Because each study's context is unique, the features of online formative quizzes that are likely to contribute to improved performance differ.

Most online formative quizzes are given on a regular basis, such as daily or weekly, which is difficult to implement on a large scale using traditional assessment

methods. Thus, some researchers claim that frequent quizzes are one of the possible contributors to improved performance, as they encourage students to study more frequently in order to keep up with the course (Chen et al., 2021; Marcell, 2008; Orr & Foster, 2013; Pennebaker, 2013; Roediger & Butler, 2011;). Studies have shown that students who completed frequent online quizzes had significantly better learning outcomes than those who did not, whether on a daily (Lyle & Crawford, 2011; Pennebaker, 2013; Yang et al., 2022) or weekly (Admiraal et al., 2014; Bälter et al., 2013; Chen et al., 2021; Cook & Babon, 2017) basis. Pennebaker (2013) discovered that students who took daily online quizzes with immediate feedback performed significantly better not only in the semester they took the online course, but also in subsequent semester classes. Admiraal et al. (2014) used a weekly online quiz in a MOOC and found that it was the best predictor of the final exam. In addition to improving performance, frequent online quizzes provide a structure for learning, promote course engagement, and help to reduce students' test anxiety, resulting in higher course satisfaction (Chen et al., 2021; Marcell, 2008; Nikou & Economides, 2016; Ozarslan & Ozan, 2016). Importantly, students who take frequent online quizzes reported putting more effort into the course and increasing the frequency of study, giving them the impression that they had learned more (McLaughlin & Yan, 2017; Roediger & Butler, 2011). Students taking online formative quizzes are thus encouraged to study at their own pace in accordance with the course objective (Enders et al., 2021; Salas-Morera et al., 2012).

According to some studies, the timing of online formative quizzes is another factor in improved performance (Brown et al., 2015; Brown & Tallon, 2015; Hope & Polwart, 2012; Orr & Foster, 2013; Stull et al., 2011; van Camp & Baugh, 2014). The majority of online formative quizzes take place after the lecture, but a pre-lecture online quiz with one attempt and no grade has a significant impact on student academic achievement (Brown & Tallon, 2015; Stull et al., 2011). Despite the fact that the number of hours students spent studying did not differ, students who completed the pre-lecture online quiz felt better prepared for the exam and performed better than those who did not (Brown & Tallon, 2015). Online quizzes taken prior to the exam also have a positive correlation with the exam grade (Brown et al., 2015; Hope & Polwart, 2012; Orr & Foster, 2013; van Camp & Baugh, 2014). Brown et al. (2015) examined the effect of taking an online quiz on exam grade before and after each chapter. Students who participated in online quizzes prior to the completion of

each chapter improved their performance on the final exam, whereas students who participated in online quizzes after the completion of each chapter did not improve their performance. Hope and Polwart (2012) and van Camp and Baugh (2014) proved that administering an online quiz prior to an exam is an effective way to improve students' academic performance. Orr and Foster (2013) noticed that the benefit of pre-exam online quiz is not limited to students who succeed on the online quiz, but that students who do not succeed on the online quiz improve their performance on the final exam. Thus, online formative quizzes have the advantage of encouraging students to study harder for exams.

The online quiz allows for the delivery of timely feedback to students, which accounts for the increase in student exam score (Cigdem & Oncu, 2015; Cook & Babon, 2017; Ogange et al., 2018; van der Kleij et al., 2012; Wilson et al., 2011). According to previous research, students who receive immediate feedback outperform those who take the same exam with delayed feedback (Almalki & Elfeky, 2022; Bhagat & Spector, 2017; Stiggins, 2010). Online quizzes not only provide students with immediate feedback, but also allow students to use the feedback to close the gap between their current and desired levels of performance. Furthermore, van der Kleij et al. (2012) discovered that immediate feedback increases student attention more than delayed feedback. As a result, timely feedback from an online quiz integrates formative assessment into the online learning process. According to Ogange et al. (2018), students who received prompt feedback were more engaged in online learning and had better learning outcomes. However, research on what types of feedback support student learning is limited.

No Effect on Learning Outcome. The literature, on the other hand, does not unanimously support the positive learning benefits of online quizzes, leading to the opposite conclusion that online formative quizzes do not improve learning outcomes (Anakwe, 2008; Bell et al., 2015; Galizzi, 2010; Hannah et al., 2014; Kennelly et al., 2011; Maclean & McKeown, 2013; Nagandla et al., 2018; Palocsay & Stevens, 2008; Petrović et al., 2017; Portolese et al., 2016).

There are several possible explanations for the literature's contradictory findings regarding online quizzes predicting academic success. First, there is no unambiguous evidence that the amount of time spent on online quizzes improves student performance (Bell et al., 2015; Brothen & Wambach, 2004; Daniel & Broida, 2004; Hannah et al., 2014; Portolese et al., 2016). According to Brothen and Wambach

(2004), the amount of time spent on online quizzes has a negative impact on student performance. This result can be explained by students using the textbook to answer the quiz question rather than using effective learning strategies to understand the content. Daniel and Broida's (2004) findings supported this conclusion and highlighted the limitation of online quizzes, which allow students to complete the quiz without learning by looking up answers in a textbook or on the internet. Recent empirical studies have also suggested that more time spent on online quizzes is detrimental to learning because students focus on finding the correct answer rather than constructing knowledge (Bell et al., 2015; Hannah et al., 2014; Nagandla et al., 2018; Portolese et al., 2016).

Second, the lack of an effect on learning outcomes could be explained by a student factor. Students who study full-time and work part-time make up the majority of those enrolled in higher education. This type of student is constantly struggling to strike a balance between study and work. Although the online formative quiz increased their participation in the course, it had no effect on the students' final grade (Galizzi, 2010; Snowball & Mostert, 2013). Furthermore, the majority of students attend college or university to obtain credentials. They are often more concerned with grades than with learning. Optional or ungraded online formative quizzes may not motivate students to change their learning strategy and increase their dedication to studying (Galizzi, 2010). Thus, the demographic background of students may influence the outcome and result in variation in the effects of online quiz on learning outcome.

Third, the design of the online quiz could be another explanation. The design of the online quiz results in heterogeneity in its effects on learning outcomes. The findings do not specify whether the graded or ungraded online formative quiz contributes to the final grade. Ungraded online quizzes, according to some researchers, are associated with better performance because students have lower test anxiety and are more engaged in active retrieval to produce test-enhancing learning (Khanna, 2015; Khanna & Cortese, 2016; Salas-Morera et al., 2012; Yang et al., 2021). However, the findings are inconclusive as to whether ungraded online quizzes should be used less frequently and whether they affect final grades significantly (Johnson & Kiviniemi, 2009; Maclean & McKeown, 2013; McKenzie et al., 2013; Yang et al., 2021). Furthermore, the findings show that there is no significant difference in academic performance between online and in-class quizzes (Anakwe,

2008; Galizzi, 2010; Kennelly et al., 2011; Lee et al., 2010). The literature also revealed conflicting findings regarding the time limit of online formative quizzes (Brothen & Wambach, 2004; Brown et al., 2015; Evans & Culp, 2015; Hadsell, 2009; Johnson & Kiviniemi, 2009; Marden et al., 2013; Zainuddin et al., 2020). Johnson and Kiviniemi (2009) found a positive correlation between online quiz questions and exam scores when the online quiz had no time constraint. Marden et al. (2013) compared the effect of four types of online quiz on students' performance, which differed in terms of whether the quiz was timed or untimed, invigilated or unsupervised, credit amount, and number of attempts. Only online quizzes with no time limit and multiple unsupervised attempts were associated with improved learning outcomes and had the strongest formative focus. Evans and Culp (2015) compared the final exams of students who completed timed quizzes to those of students who took unlimited quizzes and discovered that time limits had no effect on their learning outcomes. However, some researchers reported that a time limit on an online quiz was associated with higher exam grades because the time limit encouraged students to prepare more before the quiz and reduced the time spent looking up answers during the quiz (Brothen & Wambach, 2004; Hadsell, 2009).

Effects on Engagement. There is substantial evidence in the literature that online formative quizzes are effective at increasing student engagement in online and blended courses (Cook & Babon, 2017; Ćukušić et al., 2014; Galizzi, 2010; Gamage et al., 2019; Gikandi et al., 2011; Hope & Polwart, 2012; Kibble et al., 2011; Maclean & McKeown, 2013; Marden et al., 2013; McLaughlin & Yan, 2017; Nagandla et al., 2018; Ogange et al., 2018; Ozarslan & Ozan, 2016; Wilson et al., 2011). A high level of engagement was found to be effective in encouraging students to be more prepared for the course and to take more responsibility for their studies (Cook & Babon, 2017; Kibble et al., 2011; McLaughlin & Yan, 2017). Furthermore, greater student involvement in their own assessment indicates that students are developing independent learning skills and taking a more proactive role in their learning, which promotes a learner-centered learning environment and a positive online learning experience (Clark, 2012; Ćukušić et al., 2014; Gikandi et al., 2011; Nagandla et al., 2018). However, there are conflicting findings regarding whether increased engagement with online formative quizzes improves academic performance. Urtel et al. (2006) and Galizzi (2010) found that the implementation of online quizzes increased participation but had no effect on final grades. However, studies show that

there is a positive relationship between higher final grades and better engagement in online formative quizzes (Cook & Babon, 2017; Gamage et al., 2019; Hope & Polwart, 2012; Kibble, 2017; Marden et al., 2013; Nagandla et al., 2018; Wilson et al., 2011). Furthermore, McDowell et al. (2011) conducted an in-depth analysis and discovered that participation in online formative assessment is beneficial for students to take deeper approaches and have more interactions with peers and instructors.

Effects on Retention. The literature has shown that online quiz has a positive effect on promoting long-term retention (Bell et al, 2015; Butler, 2010; Carrillo-de-la-Peña & Pérez, 2012; Khanna, 2015; Larsen et al., 2013; Lyle et al., 2020; McDaniel et al., 2012; McKenzie et al., 2013; Orr & Foster, 2013; Roediger & Butler, 2011; Stone & Springer, 2019). Traditional quizzes have primarily been defined as a tool for assessing students' performance. However, as online quizzes gain popularity at many universities and colleges, this orientation is shifting, and online quizzes are becoming active instruments of educational intervention to enhance learning, rather than neutral tools for evaluation (Larsen et al., 2013). Students can use online formative quiz as a learning tool to practice retrieval and increase retention because of the unique features of online formative quiz, such as frequent testing, multiple attempts, low stakes, and feedback (Roediger & Butler, 2011; Stone & Springer, 2019). First, previous research has shown that frequent testing of online quizzes can be used as an effective tool to aid in knowledge acquisition and retrieval, producing better retention than rereading the same information for an equivalent period of time (Bell et al, 2015; Butler, 2010; Carrillo-de-la-Peña & Pérez, 2012; Little et al., 2012; McKenzie et al., 2013; Orr & Foster, 2013). McKenzie et al. (2013) demonstrated that repeated retrieval practice with online quizzes increases retrieval variability through frequent testing and multiple attempts for each test. Moreover, taking frequent online quizzes spreads out the test over time, encouraging students to increase their study time and adjust their strategies for recalling and retrieving information from memory throughout the course (Carrillo-de-la-Pea & Pérez, 2012). Increased retrieval variability and effort result in better long-term retention than taking a single quiz (McDaniel et al., 2012). Second, previous research suggests that test anxiety reduces the testing effect of quizzes by directing students' cognitive resources toward emotional regulation while taking the quizzes (Hinze & Rapp, 2014). Khanna (2015) found that online formative quizzes with low stakes allow students to engage in active retrieval rather than regulating test anxiety. Third, while a quiz without feedback promotes long-term retention, a quiz

with feedback improves the benefits of testing and the spacing effect of tests (Healy et al., 2017; Larsen et al, 2008;). After a retrieval attempt, whether successful or unsuccessful, students receive feedback that includes information about the correct answer, which improves retrieval efficacy by correcting errors or confirming correct answers (Roediger & Butler, 2011). Fourth, the format of the quiz is an important factor in successful active retrieval practice. Although Bell et al. (2015) claim that testing and spacing effects appear in multiple-choice items of an online quiz, research has shown that short-answer tests lead to better retention than multiple-choice tests because short-answer items require students to exert more effort on retrieval (Larsen et al., 2013; McDaniel et al., 2012; Smith & Karpicke, 2014). Finally, online quizzes improve students' ability to apply their knowledge in various contexts (Butler, 2010; Larsen et al., 2013). The transfer benefit of an online quiz, on the other hand, is evidenced from laboratory-based studies. It is unclear whether using online quizzes in real online or blended courses will result in the same benefits of knowledge transfer found in laboratory settings. Finally, an online formative quiz can be used as a learning tool if it is repeated frequently with an interval between each attempt and is followed by feedback after each retrieval. Under these conditions, an online formative quiz provides an effective method of learning and fosters deep learning for students, resulting in long-term retention of the information (Butler, 2010; Wallihan et al., 2018).

Challenges of Online Formative Quizzes

The design of online formative quizzes is an understudied aspect of assessment literature (McKenzie et al., 2013). There are some design challenges that must be overcome before online formative quizzes can be implemented and used.

Feedback. The development of feedback is one of the challenges of online formative quizzes. According to the literature, feedback was critical in achieving the formative function of online quizzes to promote student learning. Unlike traditional assessments, online formative quizzes can provide immediate and timely feedback as soon as the answer is submitted. According to studies, students benefit more from immediate feedback than from delayed feedback (Almalki et al., 2022; McKenzie et al., 2013; Pennebaker 2013; Wang & Fu, 2020). Furthermore, timely feedback increases the benefits of the testing effect in order to promote long-term retention (Jang & Marshall, 2018; Roediger & Butler, 2011; van der Kleij et al., 2012;). Thus, an online formative quiz is intended to create a learning-assessment-feedback loop to

contribute to effective learning; however, it comes in a variety of types and levels, which may affect its effectiveness in providing students with quality feedback (Cigdem & Oncu, 2015; Cook & Babon, 2017).

According to the literature, there are three types of written feedback: 1) knowledge of results (KR), in which students are only told whether an answer is correct or incorrect; 2) knowledge of correct response (KCR), which displays the correct answer; 3) elaborated feedback (EF), which includes a detailed explanation and references (Shute, 2008). In terms of feedback complexity and length, KR has the shortest feedback with the lowest complexity, indicating whether or not there is a learning gap. EF has the most detailed and complex feedback, which informs not only the existing gap but also how to bridge it. Previous research has shown that both KCR and EF are more effective than KR at improving learning (Miller, 2009; van der Kleij et al., 2012). In addition, it was discovered that ER is more effective than KCR at increasing students' comprehension and retention (Attali & van der Kleij, 2017; Lee et al., 2010; Mertens et al, 2022). However, Bälter et al. (2013) discovered that quizzes with KR feedback improves learning.

There are four types of feedback: self-level feedback, task-level feedback, process-level feedback, and regulation-level feedback (Hattie & Timperley, 2007). Feedback at the self-level focuses solely on the learner's characteristics rather than the task, and thus is ineffective for improving learning. The purpose of feedback at the task level is to inform the task whether the answer is correct or incorrect and to provide the correct answer. Feedback at the process level is intended to provide students with the steps they must take to complete the task. Feedback at the regulation level is about the learner's self-regulation. Hattie and Timperley (2007) recommended for feedback at the process and regulation levels to facilitate learning.

Although the literature has shown that KCR and ER feedback have positive effects at the task, process, and regulation levels, there is no unambiguous evidence as to what types of feedback are deemed useful by students and effective to support learning and incorporate online formative quizzes into the learning process (van der Kleij et al, 2012). As is well known, when there is a learning gap, students require feedback (Hattie & Clarke, 2018; Stobart, 2008). However, many factors, such as the type of feedback, the difficulty and length of the quiz, and student characteristics, influence student willingness to put in the time and effort required to implement the feedback and, as a result, feedback effectiveness (Timmers et al., 2013). In addition,

student needs time and resources to process and apply feedback. Thus, students play an important role in meaning construction by processing feedback mindfully (Nicol & McFarlane-Dick, 2006).

Item Design. Another issue is item design, which includes the number of items, difficulty level, and format. Formative assessment, like summative assessment, requires a number of items to gauge student learning and help students fill in the learning gaps. The number of items, however, is determined by the difficulty of the items and the format of the quiz. There is no agreement on how many items should be included in the quiz. Some researchers believed that reducing the number of items resulted in higher quizzes participation, whereas others believe that reducing the number of items would reduce students' learning (Hill et al., 2008). Second, the item's difficulty level is influenced by its cognitive level and distractors. Each question on the quiz corresponds to a specific cognitive level: remember, understand, apply, analyze, evaluate, and create (Cook & Babon, 2017). The first three levels are classified as lower-order thinking skills, while the remaining three are classified as higher-order thinking skills (Hopper, 2009). The more difficult the item, the higher the cognitive level (Rüth et al., 2022). Third, it has been demonstrated that the number and quality of distractors in summative assessment determine the item's difficulty level (D'Sa & Visbal-Dionaldo, 2017). As a result, instructors must create items that are neither too difficult nor too easy. Furthermore, the number of items and the level of difficulty vary depending on the context, so it may differ from one course to the next. Because online formative quizzes are low-stakes and frequent, a good quiz should assess learning more accurately, which makes item design more time-consuming and complex in order to accurately measure learning and their level of competency in applying what they are learning.

Format of Quiz. Due to the increasing number of students, limited resources, and the availability of the internet, multiple-choice questions (MCQs) have been widely used in online formative quizzes (Lee et al., 2021; Nicol, 2007). MCQs, as opposed to open-ended questions, can be administered quickly and accurately, with immediate feedback, in online courses. Some learning management systems provide feedback to students while they are still taking the quiz (Perera-Diltz & Moe, 2014). The delivery of MCQs becomes more flexible with the help of a computer network, and students can complete them at a time and location that suits their needs. The advantage of online MCQs include flexibility, time efficiency, and fairness, as well as rapid data

analysis, reliability and validity, and the elimination of personal error and teacher bias (Escudier et al., 2011; Shraim, 2019). However, traditional MCQ criticism has cast a shadow on their use in online quizzes, with the main concern being that traditional MCQs are perceived to focus on lower-order thinking and encourage surface learning (Hope & Polwart, 2012; Stanger-Hall, 2012). Furthermore, there is skepticism that traditional MCQs do not promote long-term retention or active learning (Chan et al., 2006). Although much attention has been paid to the limitations of MCQs, the limitations can be overcome by properly constructing the items. According to several empirical studies, carefully designed MCQs can assess higher-order skills and trigger the retrieval process (Little et al., 2012; Zaidi et al., 2018). Furthermore, when the items are linked to specific pedagogical goals, MCQs can be used to support learners' SRL (Nicol, 2007). As a result, future research should look into how to design MCQs to broaden the range of skills assessed (Perera-Diltz & Moe, 2014; Zhang & Henderson, 2016).

Time Limit. There is no unanimity on whether the online formative quiz should have time limits (Brothen & Wambach, 2004; Dobson, 2008; Hadsell, 2009; Johnson & Kiviniemi, 2009; Malik et al., 2019; Marden et al., 2013; Orr & Foster, 2013;). Summative assessments usually have a time limit for students to finish the exam. According to some studies, the time limit of an online quiz is related to better learning outcomes (Dobson, 2008; MacKenzie, 2019; Orr & Foster, 2013). The time limit encouraged students to be more prepared ahead of time by reducing time spent looking up answers in other resources during the quiz. Other researchers, however, reported that the time limit undermines the formative nature of online quizzes by allowing students to search for the answers without reading the assigned chapters and preventing students from taking more time to process the information during the quiz (Johnson & Kiviniemi, 2009; MacKenzie, 2019; Marden et al., 2013). Johnson and Kiviniemi (2009) allowed students to take the online quiz at their leisure and discovered a positive relationship between quiz questions and exam scores. Marden et al. (2013) compared four types of quiz models and discovered that only online quizzes with no time limit are associated with a significant improvement in exam performance. Furthermore, there is no conclusive evidence that more time spent on online quizzes results in better learning outcomes (Hannah et al., 2014; Portolese et al., 2016). Johnson et al. (2009) discovered that students who spent more time on online quizzes performed better on exams. However, Hanna et al. (2014) and

Portolese et al. (2016) found that spending more time on online quizzes has a negative effect on students' performance.

Number of Attempts. When compared to traditional assessments, online assessments allow for multiple attempts. However, it is important to consider how many times students should be allowed to attempt an online formative quiz. Because the goal of formative assessment is to improve learning, students should be given opportunities to try and fail until they achieve success (Gikandi et al., 2011). However, no conclusion is reached regarding the number of attempts. Some researchers advocated for an unlimited number of attempts so that students could test their knowledge repeatedly (DeSouza & Fleming, 2003; Gamage et al., 2019; Marden et al., 2013; Robbins, 2021). DeSouza and Fleming (2003) compared students who took unlimited online quizzes to students who took traditional paper-and-pencil quizzes and found that students with unlimited attempts outperformed their counterparts in the traditional one-attempt quiz. Marden et al. (2013) concluded that only online quizzes with unlimited attempts and no time limit are associated with higher exam scores and reflect the core of formative quizzes after comparing four types of quiz models. Several studies have also found that unlimited online quiz attempts improve learning outcomes by improving students' mastery of course knowledge and reducing test anxiety (Bälter et al., 2013; Cohen & Sasson, 2016). More attempts may improve students' long-term retention by allowing them to retrieve the information repeatedly (McKenzie et al., 2013; Rivers, 2021; Roediger & Butler, 2011).

However, others advocate limiting the number of attempts (Anthis & Adams, 2012; Admiraal et al., 2014; Brothen & Wambach, 2004; Cohen & Sasson, 2016; Hannah et al. 2014; Kibble, 2007; MacKenzie, 2019; Ozarslan & Ozan, 2016). Students in Kibble's (2007) study were given only two attempts and improved their grades. Anthis and Adams (2012) compared four groups of students and discovered that the number of attempts had no effect on final scores, but the amount of time spent on the online quiz was negatively correlated with their final scores. Furthermore, Hannah et al. (2014) discovered that while unlimited attempts caused low-achieving students to spend more time on their quizzes in order to get better grades, it did not help them catch up with their high-achieving counterparts in the final exam. Admiraal et al. (2014) and Ozarslan and Ozan (2016) concluded that the number of attempts is not significantly related to student achievement. MacKenzie (2019) conducted a study

that compared students with limited attempts versus students with unlimited attempts in online formative assessment and discovered that limited attempts on formative quizzes correlated with exam scores while unlimited attempts did not.

Credit as Incentive. Researchers have not agreed on whether extra credit should be awarded as an incentive for students to complete online formative quizzes. According to previous studies, no extra credit should be given (Clark, 2012; Cook & Babon, 2017; Khanna, 2015; Khanna & Cortese, 2016; Salas-Morera et al., 2012). Participation in online formative quizzes without extra credit by students is a good indicator of independent learning and self-regulation skills (Kibble, 2007; Nicol, 2007). The results of quizzes would be a better predictor of students' academic achievement (Clark, 2012). Voluntary completion emphasizes mastery learning by encouraging higher levels of student engagement and continuous effort throughout the learning process; however, the emphasis was shifted to the quick fix when the motivation was to achieve higher grades (Cook & Babon, 2017; Salas-Morera et al., 2012). If online formative quizzes are changed from voluntary to extra credit, students will complete the quiz in order to achieve a higher grade, and the core of formative online quizzes will shift from intrinsic motivation to extrinsic rewards, resulting in superficial learning (Cook & Babon, 2017). Khanna and Cortese (2016) compared students who took quizzes with and without credit. Students who completed quizzes without extra credit not only outperformed those who received credit, but they also felt more positive about the quizzes and engaged in more active retrieval practice to improve retention.

However, empirical studies have shown that quizzes that are not mandatory or awarded extra credit have a very low participation rate, despite the fact that formative quizzes are well-known for their effectiveness (Johnson, 2006; Kibble et al., 2011; Lowe, 2015; McKenzie et al., 2013; Sundstrom et al., 2016). As a result, awarding a small credit not only increases participation but also makes formative assessment more effective in increasing student learning (Brown et al., 2015; Dobson, 2008; Ennis, 2020; Kibble, 2007; Kibble et al., 2011). Extra credit can be given as a reward for participation or for high scores on the final exam (Brown et al., 2015; Ennis, 2020). Kibble (2007) compared different groups that received or did not receive credit for participation or performance. When 0.5 % credit was given for each quiz, participation increased dramatically from 52 % to 87 %. Similarly, McKenzie et al.

(2013) discovered that when the quiz score contributed 10 % of the final mark, participation increased from one-third to nearly 100 %.

Summary

In conclusion, the literature reviewed in this section, which examined the effects and challenges of online formative quizzes, is relevant and useful. The results of online formative quizzes on learning outcomes are mixed. It's not surprising that the literature is divided on whether online formative quizzes improve academic performance because the context of each study differs across countries, disciplines, and time periods. Only experimental research design can determine whether online formative quizzes improve student performance (Johnson, 2006). However, implementing true experimental designs in real-world online classes by randomly assigning students in a study is nearly impossible. Besides, results vary depending on the characteristics of the online quiz in each study, such as the inclusion of feedback, the type of feedback, the item format, the time limit, multiple attempts, and the use of credit as an incentive. For example, in contrast to an in-class quiz, students were required to take an online quiz at the same time in a computerized room, which differs from a standard online test in which students can take the quiz at any time and from any location (Anakwe, 2008). Furthermore, the questions in the online quizzes and final exams are in a different format (Kennelly et al., 2011). Student and instructor factors may influence how students perform on the online quiz. Due to the aforementioned challenges, designing an online formative quiz to help students spend more time and effort on learning is extremely difficult. Thus, the literature's contradictory findings provide some guidance for future research into why those findings are conflicting regarding the effect of online formative quiz on learning outcome and whether specific factors within the design of online formative quiz play a critical role in achieving the desired learning outcome. Among these issues and challenges, it is incorrect to blame a single factor for affecting the effectiveness of an online formative quiz, but rather the complex interplay of those factors. When developing an effective formative assessment for online learning, the findings of the literature have a significant impact. The relationship between formative online assessment and self-regulated learning was investigated using empirical evidence in the following section.

Formative Assessment and SRL in Online Learning Environments

SRL in Online Learning Environment

SRL has its origins in the 1960s, when the term "self-regulation" first appeared in educational literature (Chen, 2002; Zimmerman & Schunk, 2011). The concept of SRL then emerged in the context of educational research in the 1980s, developed, and became well-known in the 1990s (Boekaerts et al., 2000; Dinsmore et al., 2008). Over the last three decades, SRL has been identified as one of the most important competencies for success in most 21st-century learning environments (OECD, 2013; Zimmerman, 2008). A substantial body of literature, as well as several meta-analyses, have clearly demonstrated significant relationships between the use of SRL and academic achievement in traditional learning environments (Dignath et al., 2008; Cohen, 2012; Kitsantas et al., 2008; Richardson et al., 2012; Panadero, 2017; Pintrich & Zusho, 2002; Richardson et al., 2012; Robbins et al. 2004; Schmitz & Wiese, 2006; Schneider & Preckel, 2017; Zimmerman, 2008). Empirical studies have shown that self-regulated learners are more likely to persevere during the learning process (Handoko et al., 2019; Pintrich & Zusho, 2002; Zimmerman, 2000). SRL skills not only assisted students in shifting from surface level processing strategies to deep learning strategies (Ning & Downing, 2015; Panadero et al., 2021; Zimmerman, 2001), but also in reducing underachievement and procrastination (Schmitz & Wiese, 2006). Self-regulated learners who are effective are able to manage their learning by utilizing different SRL skills for cognitive challenges (Cassidy, 2011; Koivuniemi et al., 2017; Wong et al., 2019). Previous research has also discovered that SRL is regarded as a cornerstone of life-long learning (Anthonysamy et al., 2020; Lüftenegger et al., 2012).

Online learning has emerged as a new platform in higher education as information technology has advanced. As online learning becomes more popular as a mode of instruction, there has been an increase in the number of studies, including meta-analyses, examining SRL in online settings (Adam et al., 2017; Anthonysamy et al., 2020; Araka et al., 2020; Broadbent & Poon, 2015; de Bruijn-Smoldersa et al. 2015; Lee et al., 2019; Tsai et al., 2013; Wong et al., 2019). Results suggested that students should be more responsible for their own learning in online learning environments than in traditional learning environments because teachers are not physically present with students (Broadbent, 2017; Kizilcec et al., 2017). Thus,

learning SRL skills is a must for students who want to succeed in an online environment that requires a high level of learner autonomy (Albelbisi & Yushop, 2019; Kauffman, 2015; Lehmann et al., 2014; Papamitsiou & Economides, 2019). Numerous studies have shown that the positive correlation between SRL strategies and academic performance in traditional settings also holds true in online settings (Azevedo et al., 2013; Bernacki et al. 2015; Broadbent, 2017; Cazan, 2014; Cheng & Chau, 2013; Delen et al. 2014; Li et al., 2018; Sadi & Uyar, 2013; Sonnenberg & Bannert 2015; Taub et al. 2014; Tuysuzoglu & Greene, 2015; Zheng, 2016). In SRL studies conducted in online environments, students who use SRL strategies effectively are more engaged in their learning, submit assignments more quickly, and perform better online (Bol & Garner, 2011; Cho & Shen, 2013; Haron et al., 2015; Kizilcec et al., 2016; Pérez-Sanagustín et al., 2021; Terras & Ramsay, 2015). According to the literature, SRL promotes positive motivation and self-efficacy, as well as high levels of engagement in online learning (Broadbent & Poon, 2015; Callan et al., 2022; Lawanto et al., 2014). There is a significant positive relationship between SRL and non-academic outcomes such as student satisfaction, engagement, and attitude toward learning (Anthonysamy et al., 2020; Cho et al., 2017; Haron et al., 2015; Li et al., 2018; Pérez-Sanagustín et al., 2021; Vo et al., 2017; Yang et al., 2016).

Though the online learning environment is student-centered, which can encourage SRL, not all students participate in SRL because SRL skills cannot be developed over time and some of their deeply ingrained habits in traditional classrooms conflict with SRL (Zimmerman & Schunk, 2001). According to the literature, a lack of SRL skills among online students is frequently associated with them struggling in online courses, increasingly procrastinating on assignments, failing the course, becoming frustrated and anxious, or withdrawing from university (Alemayehu & Chen, 2021; Flynn et al., 2020; Greene et al., 2018; Lee et al., 2012; Milligan et al., 2013; You & Kang, 2014). The empirical research indicated that variables, such as student personal characteristics, course design, goal orientation, previous online experience, and self-efficacy, attributed to students' SRL and their online academic performance (Cazan & Schiopca, 2014; Cho & Heron, 2015; Puzziferro, 2008; Samruayruen et al., 2013; Wang et al., 2013).

Given that effective SRL is critical for online students' success in postsecondary education, it is clear that online students must be equipped with high levels of SRL skills in order to succeed in highly autonomous learning environments. As a result,

how to assist students who lack SRL skills in developing and implementing SRL strategies to drive positive academic outcomes has become a priority. However, there is little research on SRL intervention in the online environment; thus, more empirical studies are required to investigate how SRL can be facilitated (Araka et al., 2020; Lee et al., 2019; Onah & Sinclair, 2017; Wong et al., 2019). It is challenging to get students to comply with those interventions in an online learning environment (Clarebout et al., 2010). Therefore, it is critical that the online learning environment provide tools to identify students who lack SRL and require interventions, and then reinforce each student with the appropriate interventions embedded in online courses to cultivate and promote their SRL skills (Anthonysamy et al., 2020; Lee et al., 2019).

Researchers have discovered a variety of methods to facilitate students' SRL skills in online learning environments; however, the role of human factors in understanding and implementing SRL in online learning is often overlooked (Wong et al., 2018). Previous research has shown that human factors influence not only the way people learn and the outcomes of their learning in traditional learning environments, but also the differences in how they use SRL strategies (Artino & Stephens, 2009; Kalyuga et al., 1998). Online learning faces a greater diversity of learners than traditional learning environments, such as students' age, gender, educational levels, and faculty (Wong et al., 2019). Furthermore, not all students benefit equally from the same SRL assistance or intervention. Thus, future research must consider the impact of the human factor on how SRL effectively supports online learners and integrates the human factor into the development of online courses.

Formative Assessment and SRL

Since the early 1990s, some researchers have focused on linking formative assessment research with SRL. Butler and Winne (1995) discovered a link between feedback and the cognitive and metacognitive processes that occur during SRL learning. Since the seminal work of Black and Wiliam (1998a), which explicitly stated that formative assessment could improve students' SRL skills, formative assessment research has developed as a field. Formative assessment, according to Pintrich and Zusho (2002), promotes SRL by assisting students in actively regulating their cognition, motivation, and behaviors. Based on previous research, the following literature discovered stronger links between formative assessment and SRL (Andrade, 2010; Black & Wiliam, 2009; Clark, 2012; Hattie & Timperley, 2007; Nicol & McFarlane-Dick, 2006; Shute, 2008; Wiliam, 2010).

Previous research has laid the groundwork for a theoretical framework for the relationship between formative assessment and SRL. Nicol and McFarlane-Dick (2006) provided a theoretical review of seven principles for how effective formative feedback can promote students' SRL development. They also claimed that formative assessment helped self-regulated learners become more persistent, resourceful, confident, and high achievers (Nicol & Macfarlane-Dick, 2006). Hattie and Timperley (2007) and Shute (2008) both emphasized the importance of formative feedback in the development of SRL skills. Black and Wiliam (2009) not only developed an SRL-based theoretical framework for formative assessment, but they also investigated the history of formative assessment and claimed that it enabled students to take ownership of their learning (Wiliam, 2010). Clark (2012) conducted a systematic review by presenting a theoretical and philosophical foundation of SRL in order to investigate the relationship between formative assessment and SRL. Using Zimmerman's model, Panadero and Alonso-Tapia (2013) examined the shared spaces of formative assessment and SRL. Panadero and Broadbent (2018) recently used Zimmerman's SRL model and concluded that formative assessment aided SRL. Panadero et al. (2019) argued that formative assessment promoted students' SRL by guiding students who took an active role in developing successful learning strategies. Chen and Bonner (2020) proposed a framework based on Zimmerman's SRL model, arguing that formative assessment provided opportunities for students to develop their SRL skills throughout the SRL process. According to the literature, formative assessment feedback is critical in assisting learners to act on feedback and then modify their learning strategies and learning behaviors (Lipnevich et al., 2016; Molloy et al., 2019; Orsmond & Merry, 2011). Thus, the theoretical foundation for the relationship between formative assessment and SRL has been strengthened, with a greater emphasis on how formative assessment facilitates the acquisition of SRL skills (Allal, 2016; Andrade & Brookhart, 2020; Broadbent et al., 2021; Cizek et al., 2019; Clark, 2012; Granberg et al., 2021; McKenzie et al., 2013; Panadero et al., 2018).

Although a strong theoretical foundation between formative assessment and SRL has been established and well demonstrated, empirical research on online formative assessment and SRL is limited (Broadbent et al., 2021; Gikandi et al., 2011). However, there have been several empirical studies regarding different types of online formative assessment and SRL: reflective diaries (Wallin & Adawi, 2018), game-based formative assessment (Nadeem & AlFalig, 2020; Broadbent et al., 2020; Yang

& Liang, 2017), online portfolio (Alexiou & Paraskeva, 2010; van der Gulden et al., 2020), online discussion forum (Yen et al., 2019). Given the various forms of online formative assessment linked to online tools, research is needed to demonstrate which type of online formative assessment best facilitates students' use of formative feedback and their SRL (Gikandi et al., 2011). Online quizzes, unlike other types of online formative assessment, can also be used to evaluate students' learning process and learning gaps, or as summative assessment to determine how much students have learned (Brown et al., 2015; Hope & Polwart, 2012). Online formative assessment emerged as the result of the convergence of assessment and technological advances. When compared to traditional formative assessment, online formative assessment has shown benefits in terms of increased motivation and autonomy, improved student engagement with valuable learning experiences, ongoing and timely feedback, and greater flexibility in terms of time and location of taking the assessment (Baleni, 2015; Gikandi et al., 2011). Gikandi et al. (2011) conducted a meta-analysis of 18 empirical studies on online formative assessment and concluded that effective online formative assessment can improve students' engagement with online learning as well as their understanding of learning goals and expected outcomes, which improves students' SRL skills. Previous research on online quizzes has concentrated on how online quizzes improve academic performance (Bell et al., 2015; Cohen & Sasson, 2016; Hope & Polwart, 2012; Johnston et al., 2021; Martins, 2017; Pennebaker et al., 2013). Therefore, the intersection of online formative quizzes and SRL deserved further empirical investigation. Research should concentrate on the interrelationship between online formative quizzes and SRL, specifically whether online formative quizzes support students' SRL and how students perceive online formative quizzes.

Conclusion

With a noticeable shift in learning theory to social constructivism and student-centered learning, the goal of assessment is no longer just to evaluate academic performance, but also to improve learning and guide future learning. Although summative assessment is the most visible form of assessment, formative assessment has emerged as a critical component of an effective learning environment in higher education, embedded in the learning process. Formative assessment is widely recognized for its effectiveness in supporting learning as a frequent, low-stakes

assessment of student progress and understanding, through the identification of learning gaps and the provision of timely feedback while learning. Online formative quizzes offer distinct advantages, such as flexibility, timely feedback, instant scoring, efficiency, and reduced test anxiety. These features give students more control over how they evaluate their own learning.

While online formative quizzes are becoming widely used, particularly in higher education, there are a number of issues that can limit their effectiveness. First, despite the fact that formative assessment and SRL have a strong theoretical foundation, empirical research on their relationship is limited. Second, several design challenges, such as the kind of feedback, item design, format, time limit, number of attempts, and course credit as incentive, all have an impact on the effectiveness of online formative quizzes. Third, the literature on the effects of online formative quizzes on learning outcomes lacks definitive answers. Therefore, the present research aimed to fill these research gaps in the literature.

The present study was carried out in the real world setting of an undergraduate and a graduate online course in statistics, with an emphasis on an in-depth investigation into the design, implementation, and embedding of online formative assessment within the courses, in order to assess the efficacy of online formative assessment in promoting students' SRL. The aforementioned online quiz design challenges were then incorporated into the design of the questionnaire used in the study.

Five research questions were developed to address the key research gaps mentioned above. First, it is necessary to determine whether different demographic characteristics of online students influence the relationship between online formative assessment and SRL (Panadero et al., 2018). Previous research has examined students' SRL in various learning contexts and discovered that SRL behaviors differ between learning environments (Broadbent, 2017; Broadbent & Poon, 2015; Richardson et al., 2012). However, online students may employ various SRL strategies while participating in formative assessment (Broadbent et al., 2021). Given the growing popularity of online learning, more research into the variations in online learning contexts is needed. Research question (RQ) 1 addresses the effects of students' demographic characteristics on SRL (gender, age, ethnicity, full-time or part-time status, faculty, prior experience with online courses, and educational level).

Second, research over the last two decades has focused primarily on how formative assessment facilitates SRL in traditional and online learning environments, with less emphasis on how SRL influences students' performance during formative assessment. There is a bidirectional synergy between formative assessment and SRL (Clark, 2012; Panadero et al., 2018). Thus, the mutual relationship should be investigated in greater depth, with special emphasis on determining how SRL influences the use of online formative assessment. Online students, in comparison to traditional students, must take a more active role in engaging in their formative assessment (Anthonysamy et al., 2020; Hattie & Timperley, 2007). To fully benefit from formative assessment, online students must be equipped with the SRL skills needed to set goals, monitor their learning, implement feedback, adjust their learning behaviors, manage their time and effort, seek help, and assess their own performance (Nicol & Macfarlane-Dick, 2006; Broadbent et al., 2021; Lodge et al., 2018; Panadero & Alonso-Tapia, 2013). Therefore, RQ 2 investigates how students' SRL influences their approach to the online course.

Third, given the lack of empirical research on the interaction of SRL with student characteristics in online formative assessment, RQ 3 seeks to determine whether SRL variables and any of the demographic variables have an effect on students' formative and summative quiz taking.

Fourth, while several studies have found that using online quizzes as a formative assessment tool improves learning outcomes in online learning environments (Cohen & Sasson, 2016; Cook & Babon, 2017; McKenzie et al., 2013), other studies have found contradictory evidence that online formative quizzes do not improve learning outcomes (Bell et al., 2015; Portolese et al., 2016). RQ 4 directly addresses whether students’ engagement in online formative quizzes predicts their learning outcomes, as well as their course satisfaction.

Finally, research on students' perceptions of SRL and how both their SRL and their perceptions change over the course of online learning is scarce (Wong et al., 2019). Because students' SRL is not fixed (Black & Wiliam, 2009; Pintrich & Zusho, 2002), their SRL may change as a result of engaging in formative assessment. Thus, it is important to examine students' SRL before and after engaging in online assessment to determine if there is improvement in students' SRL (Broadbent et al., 2021). Furthermore, some researchers believe SRL is domain specific, making it difficult to make broad generalizations about SRL changes (Poitras & Lajoie, 2013). In addition,

the question arises whether the more mature and the more experienced graduate students react to formative assessment differently than undergraduate students. Therefore, RQ 5 explores whether undergraduate and graduate students show different patterns in their perceptions of online formative and summative quizzes.

These five research questions investigate the relationship between students' SRL and formative assessment, by investigating: the effects of demographic variables and educational level, the effect of students' SRL on their online formative assessment, the interaction between students' SRL and demographic variables, the effect of students' engagement in formative assessment on their learning outcomes and course satisfaction, and the change of undergraduate and graduate students' perception of online formative assessment over the course of learning.

CHAPTER 3 — Methodology

This chapter described the methodology that was used to explore the effectiveness of online formative assessment in promoting students' SRL in online learning environments. The sequential mixed-methods design was used to examine two statistics online courses at a Canadian university, one for undergraduate students and one for graduate students. Quantitative and qualitative research methods were used to broaden the scope of the study and better understand the contextual factors in both courses (Creswell, 2014). This section began with the research questions that guided the study, followed by a description of context of this study. The participants were then thoroughly explained, as were the measures for each research question (RQ). The quantitative and qualitative data collection processes were thoroughly discussed. Finally, it explained a rationale for using the mixed-methods design.

Research Questions

This study used multiple data sources to investigate the research questions. Data from the online questionnaire, log files, and follow-up focus groups were drawn together to describe the findings for each of the following research questions:

This study addressed the following research questions:

1. What were the effects of demographic variables (gender, age, ethnicity, full/part time status, faculty, previous online learning experience, and educational level) on students' self-regulated learning (SRL), their effort on formative assessment, the value they placed on formative assessment, their scores on summative assessment, the value they placed on summative assessment, their academic outcome, and course satisfaction in online learning environments?
   (a) What were the effects of demographic variables on students' SRL?
   (b) What were the effects of demographic variables on formative quizzes (FQ) effort & students' reported value of FQ?
   (c) What were the effects of demographic variables on students' reported value of FQ?
   (d) What were the effects of demographic variables on summative quizzes (SQ) scores & students' reported value of SQ?

(e) What were the effects of demographic variables on students' reported value of SQ?
(f) What were the effects of demographic variables on their academic outcome?
(g) What were the effects of demographic variables on course satisfaction?
(h) Were the above seven effects different for undergraduate and graduates?

2. What was the effect of SRL on effort on formative assessment and scores on summative assessment in online learning environments?
   (a) What was the effect of SRL on FQ effort & students' reported value of FQ?
   (b) What was the effect of SRL on SQ scores & students' reported value of SQ?
   (c) Were the above two effects different for undergraduate and graduates?
3. Was there any interaction between SRL and demographic variables on students' effort on formative assessment and their scores on summative assessment in online learning environments?
   (a) Was there any interaction between SRL and demographic variables with regard to FQ effort?
   (b) Was there any interaction between SRL and demographic variables with regard to SQ scores?
   (c) Were the above two effects different for undergraduate and graduates?
4. What variables predicted successful academic outcome and course satisfaction in online learning environments?
   (a) Was there a combination of demographic variables, FQ effort, SQ scores, and SRL that predicts academic marks and course satisfaction better than any predictor variable alone?
   (b) Was there any interaction of the above on academic marks and course satisfaction?
   (c) Were the above two effects different for undergraduate and graduates?
5. How did undergraduate and graduate students perceive online formative and summative assessment differently?

Context

The research questions concerned students' SRL skill and their online learning experience while they were in the midst of doing formative and summative

assessments, which cannot be separated from the context. The criteria used to select online courses reflected the purpose of the study (Merriam, 2009), which required that (1) both formative assessment and summative assessment be integral in the online courses; (2) an undergraduate course and a graduate course be included. The study was carried out at a central Canadian public university with 39,000 students from more than 150 countries. Two online introductory statistics courses were chosen, one for undergraduates and one for graduate students. They both included formative and summative quizzes, which was useful in learning the effectiveness of online formative assessment as well as exploring the conditions under which formative online formative assessment might promote students' SRL, resulting in broader generalization and convincing findings. Formative and summative quizzes for both courses used the same format, that is, multiple-choice questions, allowing for a more direct comparison of formative and summative quizzes. Formative quizzes occurred within learning modules, highlighting key concepts and skills, and could be retaken without being graded, whereas summative quizzes could only be accessed after the student had completed the module, could only be taken once, and scores were recorded. The undergraduate statistics course was designed primarily for nursing faculty, while the graduate statistics course was designed for education faculty. In formative quizzes, feedback is given after each item, whereas in summative quizzes, feedback is given at the end of the set of items. In formative quizzes, feedback indicates whether the answer was correct or incorrect and provides additional information to clarify, whereas feedback in summative quizzes only indicates whether the answer was correct or incorrect. Using undergraduate and graduate online courses allowed us to peel back layers of unexplored undergraduate and graduate students' online learning experiences to gain insights into their different perspectives on their SRL skills and formative assessment while taking the online course[1].

Both of the online courses chosen were statistics. Statistics, as is well known, is an extremely important subject for students pursuing a higher education. Students with statistical knowledge can understand and think critically about the statistical data presented in published articles. Statistics, on the other hand, are difficult for students to learn, and statistics has become one of the most dreaded subjects for undergraduate

[1] The research was neither the instructor nor the course designer for the two courses under study. Furthermore, the researcher did not manipulate any event in this study.

and graduate students, particularly in the social sciences (Lalayants, 2012; Malik, 2015; Murtonen et al., 2008). Understanding the effects of formative assessment in online statistics courses is thus important in and of itself. Approximately 80 % of students report statistical anxiety, with many reporting a high level of anxiety when enrolled in a statistics class (Chew & Dilon, 2014; Onwuegbuzie & Wilson, 2003; Williams, 2010). When students are required to take more responsibility for their learning in an online statistics course, they face additional challenges. By exploring the effect of formative assessment on students' SRL in online statistics course is critical, as both SRL and formative assessment have both been shown to be effective in improving academic performance (Clark, 2012; Whittaker, 2015). Furthermore, exploring students' perception toward online statistics courses contributes the advancement of statistics teaching and learning in online learning environment.

Undergraduate Statistics Online Course

This undergraduate statistics course was a large course, with 304 students enrolled. This course was entirely online, so there would be no scheduled face-to-face meetings on campus. Students accessed all required course materials through My Course, the university's Learning Management System (LMS), including lectures, assessments (including the final exam), the recommended textbook, and the discussion board. During the semester, four live virtual sessions were scheduled to allow students to ask the instructor questions in real time using web conferencing technology. The formative assessment was an online quiz that students took after watching the videos in each module, which could be retaken but was not graded. Summative assessments were module quizzes that accounted for 20 % of the final grade. Students were expected to complete three written assignments, which accounted for 30 % of their overall grade. The final exam accounted for 50 % of the overall grade. Aside from that, students can earn up to 5 extra points by unlocking specific bonus badges throughout the semester.

Graduate Statistics Online Course

This graduate statistics course was also taught entirely online, with 104 students enrolled. This online course, unlike the undergraduate course, was taught using three different platforms: My Course, Mighty Network, and ZOOM. Students accessed all modules, including lectures and assessments, through the university's Learning Management System My Course. Through Mighty Network, students could ask questions and communicate with instructors and peers. Every student was required to

have a one-hour mandatory weekly check-in via Zoom. The formative assessment was an online quiz known as the end-of-chapter problems that could be retaken but was not graded. Summative assessments were end-of-chapter quizzes that accounted for 40 % of the final grade. Students were expected to complete three written assignments, which accounted for 15% of their overall grade. The final exam accounted for 35 % of the overall grade. Aside from that, students had a weekly contribution worth 10 % of their final grade, which included participating in the Might Network discussion, attending a one-hour weekly check-in, or assisting peers.

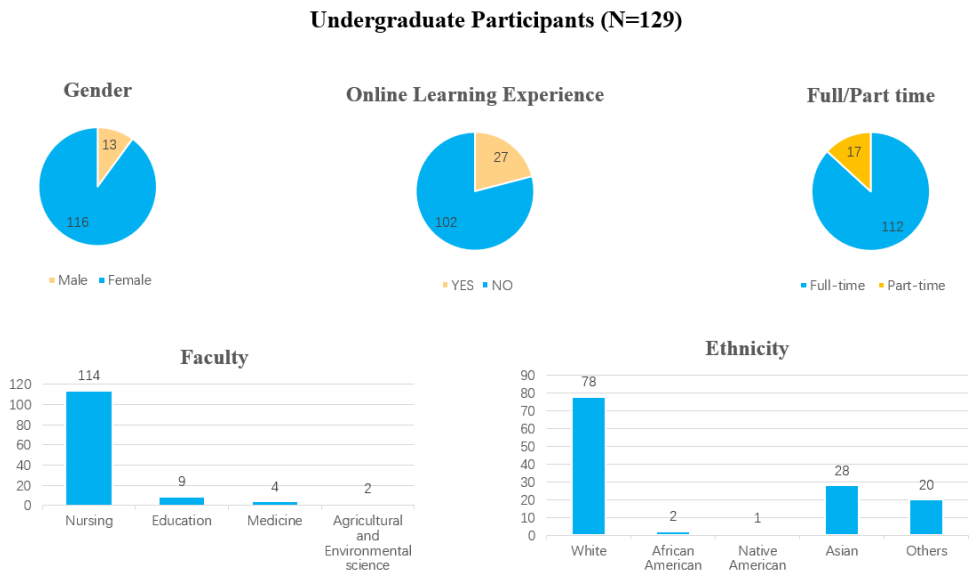
Participants

Online Statistics Course for Undergraduates

This online course was an introductory statistics course offered by the Faculty of Education aimed at undergraduate students in nursing and kinesiology. Its goal was to teach undergraduate students the fundamental tools and techniques required to conduct, analyze, and interpret statistics in order to make informed decisions.

Figure 1

Undergraduate Participants



Of the 304 students enrolled in the course, 132 volunteered to participate. However, 129 participants completed both surveys. Participants came from four faculties: nursing (n=114, 88.4% of the sample), education (n=9, 7.0% of the sample), medicine (n=4, 3.1% of the sample), and agricultural & environmental science (n=2, 1.5% of the sample). Females (n=116, accounting for 90% of the sample)

outnumbered males (n=13, accounting for 10% of the sample). Given that more females entered nursing than males, the gender distribution of students was not unexpected. Their ethnicity ranged from: Native American (n=1, 0.8% of the sample); African American (n=2, 1.5% of the sample); Asian (n=28, 21.7% of the sample); White (n=78, 60.5% of the sample), and Others (n=20, 15.5% of the sample). 87% of participants (n=112) were full-time students while only 13% were part-time (n=17). 79% of participants (n=102) had previously taken online courses, while 21% had no prior online learning experience (n=27). The majority of these students (n=96, 74.4% of the sample) were between the ages of 19 and 24, with 18 students (14.0%) between the ages of 25 and 29, and 15 students (11.6%) between the ages of 30 and above (see Figure 1).

Table 1

Demographic Information on Participants in Undergraduate Focus Group

Pseudonyms	*Tasha U*	*Ivana U*	*Kathy U*	*Ahmed U*
Gender	F	F	F	M
Age	27	32	21	29
Ethnicity	White	White	White	White
Faculty	Nursing	Nursing	Nursing	Nursing
Full/part time	Part-time	Full-time	Full-time	Full-time
Previous online experience	YES	NO	NO	YES

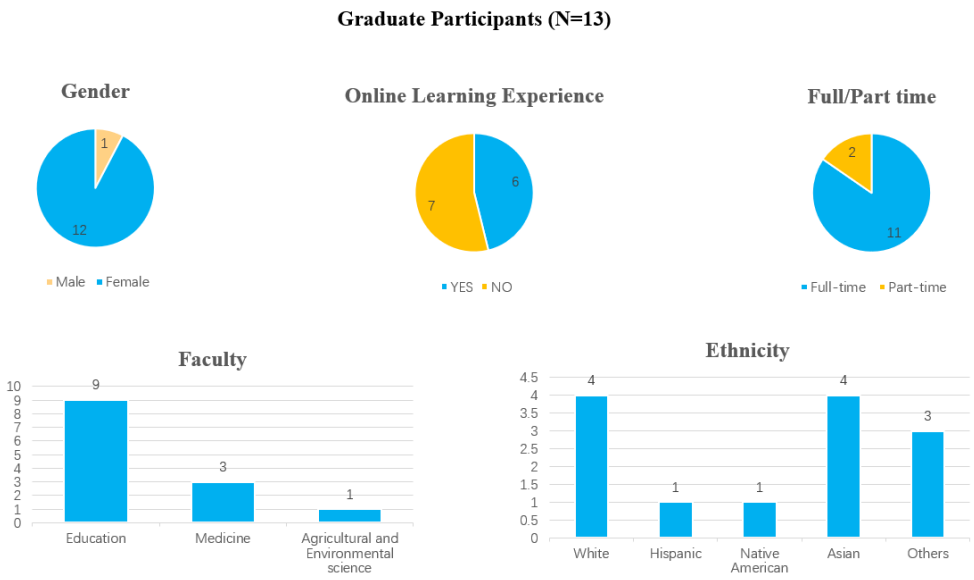
Online Statistics Course for Graduates

This online course was a statistics course offered by the Faculty of Education for graduate students. The course's goal was to assist students in understanding and interpreting basic statistical procedures used in basic and applied research. The majority of students were from the Faculty of Education. 14 students volunteered to participate out of the 104 students enrolled in the course. However, only 13 people responded to both surveys. Participants came from three faculties: education (n=9, 69.2% of the sample), medicine (n=3, 23.1% of the sample), and agricultural & environmental science (n=1, 7.7% of the sample). Females (n=12, 92.3% of the sample) outnumbered males (n=1, 7.7% of the sample). Given that more females entered education than males, the gender distribution of students was not unexpected. Their ethnicity varied: Asian (n=4, 30.8% of the sample); Hispanic (n=1, 7.7% of the sample); Native American (n=1, 7.7% of the sample); White (n=4, 30.8% of the

sample), and Others (n=3, 23.0% of the sample). The majority of participants were full-time students (n=11, 85% of the sample) while only two working part-time (n=2). 54 % of participants had previously taken online courses (n=7), while 46 % had no prior online learning experience (n=6). 7 students (53.8%) were under the age of 30, 4 students (30.8%) were between the ages of 30 and 39, and 2 students (15.4%) were 40 and older (see Figure 2).

Figure 2

Graduate Participants



Before the end of the term, all 13 graduate participants from the first phase were invited to join the focus group via email. Four participants attended the focus group (see Table 2). To be clear, all graduate participants had the letter G appended to their pseudonyms.

Table 2

Demographic Information on Participants in Graduate Focus Group

Pseudonyms	*Sita G*	*Coleen G*	*Emma G*	*Maryam G*
Gender	F	F	F	F
Age	33	59	39	34
Ethnicity	Asian	White	Native	Other
Faculty	Education	Education	Education	Education
Full/part time	Full-time	Full-time	Full-time	Full-time
Previous online experience	NO	NO	YES	YES

Measures

The research questions were answered using quantitative and qualitative methods (see Table 3). All variables, measurements, and research questions were described in detail below. Gender, age, ethnicity, faculty, educational level (undergraduate versus graduate), full/part-time status, and prior online learning experience were all demographic variables.

Table 3

Measures for Research Questions

	Variables	Measurement	RQ
Quantitative	Demographic variables	Demographic questionnaire	RQ 1, 2, 3, 4, 5
	SRL	Questionnaire (MSLQ)	RQ 1, 2, 3, 4
	FQ effort	Time spent on FQ	
	Scores on SQ	SQ scores	
	Reported value of FQ	Questionnaire	RQ 1, 2
	Reported value of SQ	Questionnaire	
	Final marks	Final mark	RQ 4
	Satisfaction on online learning	Questionnaire	
	Perception of online quizzes (FQ & SQ)	Questionnaire	RQ 5
Qualitative	SRL	Focus group	RQ 1, 2, 3, 4, 5
	FQ effort		
	Scores on SQ		
	Reported value of FQ		
	Reported value of SQ		
	Final marks		
	Satisfaction on online learning		
	Perception of online quizzes (FQ & SQ)		

The Motivated Strategies for Learning Questionnaire (MSLQ) scale was used to assess SRL variables (Pintrich et al., 1993). Effort on formative assessment was measured by time spent on FQ. Summative assessment scores were determined by the grades students received on SQ. The time spent on FQ and SQ scores was recorded by the LMS during the course and provided by the instructors with students' final grades. Students' reported value of formative and summative quizzes included four subscales to determine the value students placed on formative assessment: motivation, pressure, accurate reflection of understanding, and fair assessment. Questionnaires were used to assess those four subscales of students' reported value of FQ and SQ. The final grade in the online course was used to assess academic performance. Finally, students' self-reported course satisfaction on four subscales was used to assess course satisfaction: overall satisfaction, learning gains, recommendation level, and willingness to take another online course. Students' perception of FQ and SQ were also measured by questionnaires concerning the purpose of quiz and, the usefulness of quiz. Finally, focus groups were used to explain and contextualize the findings from the quantitative phase.

Methodology for Questionnaires

In this study, questionnaires were used to collect demographic information from participants, to assess students' SRL skills and the extent to which formative and summative assessment were accepted as a tool to support their learning, and to identify factors influencing the perceived effectiveness of formative online quizzes by students. The questionnaires for both courses were the same. There were two questionnaires, one administered at the beginning and the other at the end of the course. The first questionnaire was divided into two parts: demographic questions and SRL questions (see Appendix A). There were eight items in the demographic section that related to students' gender, age, ethnicity, faculty, educational level, full/part time status, previous online learning experience, and current online course. The MSLQ was used to assess students' self-regulated learning in the SRL section (Pintrich et al., 1993). The second questionnaire was divided into two parts: the MSLQ and the evaluation questionnaire.

The evaluation questionnaire was divided into three sections: overall evaluations of this online course, formative quiz evaluations, and summative quiz evaluations (see Appendix B). Following a thorough review of online formative assessment literature,

an initial draft of the questionnaire was developed. The supervisor then reviewed it, and revisions were made based on the feedback. The final draft included 68 items. A five-point Likert scale was used to rate the items. To investigate students' experiences and perspectives on online assessment, nominal scales and yes/no questions were included in addition to the Likert scale items. The overall evaluation questionnaire items were divided into two sections: students' overall course satisfaction and the benefits of online courses. The questionnaire items for evaluating formative and summative quizzes were classified as follows: (a) formative/summative quiz evaluations; (b) students' SRL skills; (c) feedback effectiveness; (d) perceptions of the value of the formative/summative quiz; (e) quiz characteristics; and (f) factors influencing the effectiveness of the formative/summative quiz.

Instrument-MSLQ

The MSLQ, the instrument used in this study to assess students' SRL skills, has been shown to be a valid and reliable measure of self-regulation and has been widely used in research across many disciplines in many countries, investigating the role of self-regulated learning in both the traditional (Ben-Eliyahu et al. 2015; Wäschle et al 2014; Suhandoko & Hsu, 2020) and online learning environments (Artino & Stephens, 2009; Broadbent et al., 2020; Cho & Shen 2013; Sletten, 2017; Tock & Moxley, 2017; Wang et al., 2013). The MSLQ was a self-report instrument designed to assess college students' motivational orientations and use of various learning strategies for a college course. The MSLQ contains 81 items divided into two sections: motivation and learning strategies (see Appendix C). The motivation section includes 31 items that assessed students' goals and value beliefs, as well as their expectancy to succeed and test anxiety. The learning strategy section includes 31 items pertaining to the application of various cognitive and metacognitive strategies. In addition, the section on learning strategies included 19 items on resource management. All items were scored on a seven-point Likert-type scale, with 1 being "not at all true of me" and 7 being "very true of me." Scale scores were calculated by averaging the mean scores of the items that comprised each scale.

Methodology for Focus Group

A focus group, according to Krueger and Casey (2009), is a group interview that involves directed and interactive discussions among participants to "obtain their perceptions on a defined area of interest in a permissive, non-threatening environment" (p. 2). It was frequently used in conjunction with other data collection

methods, such as questionnaires, to obtain in-depth qualitative data from homogeneous people in a group situation about participants' perceptions that were not revealed in quantitative results (Krueger & Casey, 2000; Morgan, 1997). In this study, focus groups were held following the second online questionnaires to collect data because the collective experience of the group, particularly the interaction among participants, would encourage self-disclosure among participants and yield rich and detailed results to interpret and extend the quantitative findings (Creswell, 2014). In this study, the researcher conducted two separate focus groups, one for undergraduates and one for graduates, using video recording to document the entire discussion. The goal of the two groups was to determine the range of opinions among groups and to identify patterns in perception among undergraduate and graduate students. The data from each group was then compared and contrasted.

Focus groups, when compared to other qualitative methods, were relatively easy and efficient for gathering data from multiple participants, resulting in the group's evolving interactions reflecting the views of the larger population (Krueger & Casey, 2000). Another advantage was that the focus group provided a social environment in which participants could feel safe and relaxed (Krueger & Casey, 2009). A more natural conversational environment aided in the formation of cohesion among participants, making them more engaged in the discussion and willing to speak freely and share their perceptions and points of view (Krueger & Casey, 2000). The researcher's role in this focus group setting was that of a moderator to present a set number of questions, a listener to encourage participants to express their opinions, and an observer to allow the discussion to evolve from the group itself. Thus, the group interaction was beneficial for participants to provide more spontaneous responses to question or add to the opinions of others without being judged (Krueger & Casey, 2000; Raby, 2010).

According to Krueger and Casey (2000), focus groups typically last 1 to 2 hours and have 4 to 12 participants. The rationale for the range of group size stemmed from the goal of having enough participants in focus groups to yield as much information as possible, but having too many participants may make participants feel uncomfortable sharing their opinions (Krueger & Casey, 2000). Both focus groups were held following the completion of online courses. The graduate focus group met on Saturday, May 31, 2019, from 2:00 to 3:00 pm, while the undergraduate focus group met on Friday, June 12, 2019, from 10:00 to 11:00 am. Five students agreed to

participate in each focus group, but only four did in the end. Both focus groups were supposed to be held in a seminar room, but it was difficult to find an agreed-upon time for all participants to arrive on campus. As a result, both focus groups were conducted via Skype.

Development of Interview Guide

Brainstorming, phrasing questions, sequencing questions, estimating time for questions, and receiving feedback from others were all part of the process of creating an interview guide (Krueger & Casey, 2000). During the brainstorming session, the researcher invited the supervisor, who was also familiar with the study's purpose, to develop a set of questions. The research questions and research design guided the construction of the questions in this study. The next step was to phrase the questions. According to Creswell (2014), open-ended questions were beneficial in encouraging participants to determine the direction of their response and respond based on their own experience. Therefore, the questions were edited and phrased by removing jargons and switching to open-ended questions to make them more understandable and logical to the participants.

The third step was to reorganize the list of questions from general to more specific questions that were more important to the study (Krueger & Casey, 2009). The questions were asked in the following order: introductory question, transition question, key question, and ending question. The purpose of the introductory question was to stimulate the conversation by eliciting responses from all participants. Thus, the first question was designed to be simple so that participants could share their online learning experience while remaining focused on the discussion. The second question was a transition question, which served as a link between the introductory and key questions (Krueger & Casey, 2009). Participants were asked to elaborate on their online learning experience, specifically their initial impressions of formative and summative quizzes. As a result, the transition question set the tone for the subsequent key questions. The key questions focused on the study's major areas of concern, with the majority of time devoted to discussing these questions on the change of perception on two types of quizzes, their usage of both quizzes, the value of formative quizzes, their SRL skills, and the relationships between formative quiz and academic performance. The final question was an ending question that allowed participants to reflect on how they redesigned the formative quizzes and brought the discussion to a close.

After all questions were carefully developed and arranged in logical sequence, the time required for discussing each question was estimated, which helped the research set the time for the focus group and manage the entire discussion. Finally, the interview guide received some feedback from the supervisor. The interview guide was used in this study for both undergraduate and graduate focus groups, and it included an introduction outlining the purpose, nine open-ended questions, and a conclusion to express gratitude (see Appendix D).

Procedures for Data Collection

Creswell et al. (2003) identified six types of mixed-methods designs. The mixed-methods sequential explanatory design was used in this study, with two consecutive phases: an initial quantitative phase followed by a qualitative phase. In this design, quantitative data was collected and analyzed first, followed by qualitative data analysis to contextualize the quantitative results and provide a broad understanding of research questions (Ivankova et al., 2006). The initial quantitative phase of this study consisted of a series of online questionnaires administered at the start and end of the online course. The qualitative phase, which followed the quantitative phase, consisted of two semi-structured focus groups for undergraduate and graduate students, which refined and elaborated on quantitative results by delving deeper into participants' experiences with formative and summative assessments. The research questions were addressed using questionnaires and focus groups. The Research Ethics Board (REBs) approved both the quantitative and qualitative phases to ensure that the standards of human subject research were met (see Appendix E).

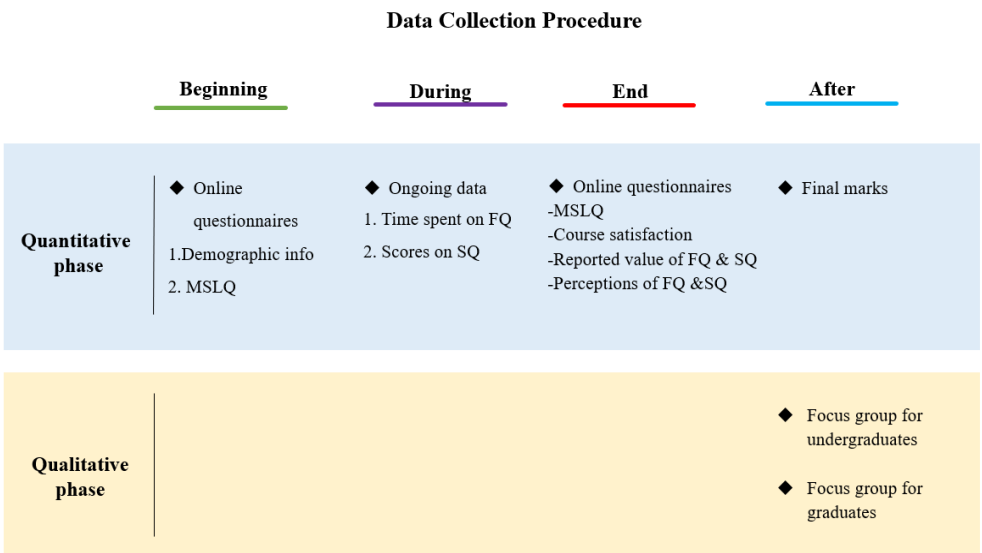
Students from both two statistics online courses were invited to participate in this study. Participants in convenience sampling were chosen based on "time, money, location, availability of sites or respondents," according to Merriam (2009). (p. 79). Both online courses used the same LMS, as well as formative and summative quizzes, but one was for undergraduates and the other for graduate students. After obtaining written permission from the instructors of two online courses, the researcher sent the recruitment notice (Appendix F) to the coordinating TA to post on My Course to recruit participants at the start of the semester. Students who were interested in volunteering emailed the researcher. The researcher then responded with an email containing the Letter of Information (Appendix G) and a Consent Form (Appendix

H). Participants were accepted by returning the signed consent form to the researcher via email. All participants were informed that they could withdraw from the study at any time.

Because the study's two online courses were time-limited, a variety of data collection methods were used to collect detailed and in-depth information within one semester (Creswell, 2014). To help answer research questions in this study, multiple sources of data were collected, including online questionnaires, ongoing data (time spent on FQ, scores on SQ), final grades, and focus groups. To ensure the credibility and validity of the findings in this study, different methods of data collection were used as data triangulation. Students completed online questionnaires at the start of the course. The LMS tracked students' use of FQ and SQ throughout the course. Finally, students completed the online questionnaires at the end of the course (course satisfaction, perceptions on online quiz, reported value of FQ and SQ). Finally, at the end of the semester, the instructors provided the students' final grades. The qualitative focus group was then held. Figure 3 illustrated the sequence of data collection from these multiple sources.

Figure 3

Data Collection Procedure



Quantitative Data Collection

The quantitative data collection process was divided into three stages. Participants completed the demographic questionnaire (including gender, age, ethnicity, faculty, online learning experience, and educational level) and the MSLQ at the start of the term. Throughout the course, the LMS database was used to collect

ongoing data containing details of each student's quiz attempts and SQ scores. Participants retook the MSLQ and two online questionnaires at the end of the term (course satisfaction, perceptions on online quiz, reported value of FQ and SQ). Finally, after the course was completed, instructors from both courses provided the final grades.

The questionnaires were distributed online via LimeSurvey. The initial survey email included a link to the LimeSurvey site and an invitation to complete the survey. A reminder email was later sent to the participant who had not completed the survey on time. A confirmation email was sent to those who completed the survey to express gratitude. After the course, two instructors gave the researcher all of the ongoing data (the number of attempts on FQ, time spent on FQ, and SQ scores) as well as the final grades.

Qualitative Data Collection

The qualitative focus groups were held just after the end of the semester. Based on the interview guide, both focus groups were semi-structured. Prior to the focus group, all eight participants' background information was gathered. Both focus groups lasted approximately one hour and were conducted and recorded via Skype. Participants in the focus group were asked to share their online learning experience, their initial perceptions of online formative and summative quizzes, and how those perceptions changed as a result of their experience. They were also asked questions on the characteristics of formative quizzes, the relationship between their academic performance and formative quizzes, and the differences between formative and summative quizzes. Finally, they were asked to assess their SRL skills throughout the course as well as make suggestions for redesigning the formative quiz. The focus group contributed to a better understanding of online assessments by exploring students' perspectives, as well as the differences in perceptions of online assessments between undergraduate and graduate students, and how they approached SRL in online courses. This provided a check on the quantitative analysis and increased the credibility of the findings, thereby strengthening the study.

Research Design

The purpose of this research was to determine the efficacy of online formative assessment in promoting students' SRL. Although formative assessments have been

used for a long time, few empirical studies have looked at the relationship between formative assessment and SRL in real-world online settings (Azevedo et al., 2013; Brown & Harris, 2013; Cho & Shen, 2013; McLaughlin &Yan, 2017; Panadero et al., 2017), as well as the differences in undergraduate and graduate student perceptions of and experiences with online formative and summative assessment in higher education. Therefore, the research design should be placed within a methodological paradigm that is congruent with both the theoretical framework and the research questions. This study used a sequential mixed-methods design, which not only filled gaps in the literature but also fit the study's goals (Creswell, 2009).

A mixed-methods design is a type of study in which both quantitative and qualitative data are collected, analyzed, and integrated at some point during the research process within a single study in order to gain a better understanding and provide in-depth results (Creswell & Plano Clarke, 2018). The rationale for incorporating both quantitative and qualitative data into this study was based on the fact that neither quantitative nor qualitative methods were sufficient to answer all of the research questions and capture the details of the findings on their own. Quantitative and qualitative research methods were developed to answer different types of research questions. The quantitative method, based on statistical analyses of the data, seeks an explanation or causation to paint a generalized picture, whereas the qualitative method focuses on painting a rich and detailed picture to capture the richness and fullness of the experience (Polkinghorne, 2005). RQ 1-4 in this study were explanatory questions, such as What questions, whereas RQ 5 was an exploratory question, such as How questions. As a result, the mixed-methods design capitalized on the strengths of both methods, allowing for a more robust analysis and a broader understanding of the research variables (Creswell et al., 2003).

CHAPTER 4 — Results

The results of questionnaires examining students' SRL and their experience with formative assessment, as well as follow-up focus groups, were combined to examine students' use of online formative assessment versus summative assessment and to investigate the relationship between online assessment and online students' self-regulated learning (SRL). This chapter began by introducing the process of data preparation and analysis for both quantitative and qualitative data. Following that, the findings of research question (RQ) 1-5 would be discussed in the following order: quantitative findings were presented first, followed by qualitative findings to determine whether they were consistent or contradictory. RQ 1 explored the impact of demographic variables on students' formative assessment effort, summative assessment scores, and the value they placed on both formative and summative assessment. RQ 2 examined the impact of SRL on online assessments. RQ 3 investigated whether any of the demographic variables and SRL variables interacted on students' online assessments. RQ 4 explored what factors predicted academic success as well as course satisfaction. RQ 5 investigated undergraduate and graduate students' perceptions of formative and summative assessment, as well as the differences between them.

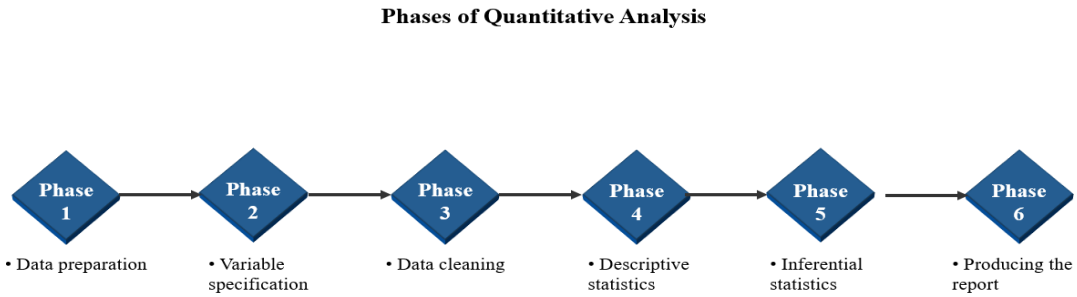
Data Analysis

Quantitative Analysis

Quantitative analysis was aimed to seek the explanation and uncover patterns by generalizing findings from a large sample population (Creswell, 2009). The quantitative analysis in this study was used to investigate the effectiveness of online formative assessment versus the use of online summative assessments, how SRL and effort on formative assessment were affected by demographic variables, the relationship between SRL and effort on formative assessment and summative assessment mark, and the difference between undergraduate and graduate students. In this study, quantitative analysis was carried out in six stages as an ongoing process (Figure 4), beginning with data preparation, variable specification, data cleaning, running descriptive and inferential statistics, and finally interpreting and reporting the results.

Figure 4

Process of Quantitative Analysis



Data preparation was the first phase of quantitative analysis, ensuring that the raw data was ready for subsequent data processing and analysis. It involved three steps: exporting the raw data, handling confidential data, and checking the data for accuracy. Following data collection, the first step in data preparation was to export the data set directly from the online survey to SPSS. Because the data was transferred to SPSS electronically, the possibility of data entry error was eliminated. The second step in data preparation was to assign a unique number to each participant in order to protect their privacy and confidentiality. The participant key file, which included the subject number and the names of the participants, was also created and encrypted. The names and emails of all participants were then removed from the data file. The final step was to double-check SPSS for errors to ensure that data preparation did not contribute to inaccuracies.

The second phase of quantitative analysis was to specify all variables. Different data types need discrete treatment to distinguish variables. To distinguish variables, different data types require discrete treatment. First, all variables were labelled in SPSS to describe what they represented. The type of variables was then specified. Finally, a table of variable specification was created, which included variable names, variable descriptions, and variable types.

The third and most important stage of quantitative analysis was data cleaning. There were some hidden problems, such as incomplete cases, outliers, incorrect values, and improperly formatted data, regardless of how well the study was designed or how carefully the questionnaire was administered. Data cleaning consisted of preparing data for quantitative analysis by detecting anomalies and removing or modifying data that jeopardized the reliability and validity of the research results. In

SPSS, the first step in data cleaning was to remove any incomplete or duplicate cases. The raw data from the online survey was directly transferred to SPSS. There were 146 volunteers who agreed to take the questionnaires, but only 142 completed both. As a result, the four incomplete cases were removed from the SPSS data set. The SPSS Identify Duplicate Cases feature was used to see if there were any possible duplicate cases in the dataset. There were no duplicate cases found. The second step was to format variables, which involved converting all numerical and ordinal variables into quantifiable data by assigning a numerical value to each response. Consider the categorical variable gender, where the values 1 and 2 were assigned to each response separately, such as 1 for male and 2 for female. For other nominal variables, such as ethnicity and faculty, each response was assigned a numerical value. The third step was to compute the MSLQ scores, which ranged from "not at all true of me" to "very true of me." The MSLQ had five subscales: interest, expectancy for success, test anxiety, cognitive and metacognitive strategies, and resource management strategies. The scores of each subscale for each participant were calculated by adding the items and taking the average. Before computing, the ratings for the items with negative wording had to be reversed. Finally, the total MSLQ was calculated by adding all of the subscales together.

Table 4

Means and Standard Deviation for Both Undergraduates and Graduates

Variables	Max scores	Undergraduate (N= 129)		Graduate (N=13)	
		M	SD	M	SD
Age	100	23.60	4.40	32.38	10.14
Pre total of MSLQ	567	22.77	2.76	22.72	3.56
Pre interest	56	4.66	.83	5.02	.91
Pre expectancy	126	5.31	.93	5.52	.82
Pre anxiety	35	3.80	1.35	3.09	1.31
Pre metacognitive strategies	217	4.32	.80	4.57	1.11
Pre resource	133	4.68	.78	4.53	.59

Post total of MSLQ	567	23.24	3.27	21.93	3.58
Post interest	56	4.59	1.03	4.92	.63
Post expectancy	126	5.13	.99	5.41	1.10
Post anxiety	35	4.46	1.41	2.34	1.00
Post metacognitive strategies	217	4.32	.87	4.55	1.21
Post resource	133	4.75	.75	4.69	.88
FQ time	In minutes	838.64	385.85	510.92	144.56
Scores on SQ	100	96.98	4.33	87.97	7.14
Final grade	100	78.92	13.92	91.22	5.88

The fourth step was to run descriptive statistics on both samples to describe their characteristics, reduce data entry error and to check for central tendency issues. SPSS was used to calculate the means and standard deviations for both samples for the continuous variables in order to compare the average of the values (see Table 4).

Table 5

Data Transformation for Skewed Data of Undergraduates

Skewed Variables	Undergraduates		
	Skew of Raw Data	Skew of Log Data	Skew of Square roots
Total time on FQ	1.67	0.38	
Scores on SQ	-2.93	0.44	
Course satisfaction 3	-1.05	0.28	
Course satisfaction 4	-1.21	0.51	
Final grade	-1.01		0.11

Undergraduates (see Table 5), graduates (see Table 6), and the combined undergraduate and graduate group (see Table 7) all had their skewness calculated. The log transform was used to convert skewed continuous data for the variables total time on FQ, scores on SQ, course satisfaction 3 and 4, pre-interest, pre-expectancy, post-expectancy, value of SQ 1, to normal distribution. Some variables, final grade, remained skewed. As a result, square root transformation was used to determine which method produced the best results. The non-skewed variables in the other two

groups were then transformed. Except for SQ scores for graduates, all non-skewed variables were within acceptable bounds after the transformation. After double-checking all of the transformations, the variable specification was updated by including the transformed variables, as well as the skewness before and after the transformation, and the transformation method.

Table 6

Data Transformation for Skewed Data of Graduates

Skewed Variables	Graduates		
	Skew of Raw Data	Skew of Log Data	Skew of Square roots
Pre-interest	-1.17	0.36	
Pre-expectancy	-1.66	0.57	
post-expectancy	-1.46	0.02	
Value of SQ 1	1.19	0.98	
Final grade	-1.22		0.23

Table 7

Data Transformation for Skewed Data of Combined Undergraduate and Graduate Groups

Skewed Variables	Combined Groups		
	Skew of Raw Data	Skew of Log Data	Skew of Square roots
Total time on FQ	1.71	0.42	
Scores on SQ	-2.34	0.38	
Course satisfaction 3	-1.06	0.25	
Course satisfaction 4	-1.16	0.45	
Final grade	-1.07		0.20

The next step was to run appropriate inferential statistics. All assumptions should be met before running inferential statistics. Given that the questionnaire was designed in response to the research questions, it was important to check the questionnaire's reliability. The internal consistency was calculated to be $\alpha = 0.84$. Thus, the questionnaire was considered reliable in the respective samples with high internal consistency. The correlation matrix was then calculated for undergraduates, graduates,

and the combined undergraduate and graduate group to check the correlation between each pair of variables in preparation for meeting the multiple regression assumption. During the inspection of the correlation matrix for the combined undergraduate and graduate group, the educational level variable was highly correlated and confounded with the age variable, r (141) = .30, p < .001; and the faculty variable, r (141) = .56, p < .001. Graduate students are older than undergraduate students. The majority of graduate students were in the faculty of education, while the majority of undergraduate students were in the faculty of nursing. Thus, only the educational level variable was used as a particular variable in the following analysis for the combined undergraduate and graduate group, and the age variable and the faculty variable were omitted from the analysis. Then, for all variables in the combined undergraduate and graduate group, an independent-samples t-test was run to see if there was a significant difference between the means of undergraduates and graduates. The age differences between undergraduate 375 and graduate 575 were compared using an independent-samples t-test, $F(1, 140) = 18.355$, $p < 0.001$. The p value of Levene's test for equal of variance is less than an alpha level of .05, indicating a significant difference between groups. Thus, the assumption was not met. Levene's test indicated unequal variances, so degrees of freedom were adjusted from 140 to 12 and the equal variance not assumed was read in SPSS. Undergraduates were younger (M = 23.60, SD = 4.404) than graduates (M = 32.38, SD = 10.137), $t(12) = -3.094$, p=.009, d = 1.53. The effect size for this analysis (d = 1.53) was found to exceed Cohen's (1988) convention for a large effect (d = .80). According to the t-test results, the undergraduate and graduate groups were significantly different in terms of age, indicating that there was little overlap. For each of the three groups, all of the age variables were positively skewed. It was still skewed after attempting both log transformation and square roots transformation. As a result, the age variable was converted from scale to categorical and renamed in the combined undergraduate and graduate group.

Inferential statistical analysis included multiple regressions and analyses of variance (ANOVA) in this study. For RQ 1, multiple regressions were used to address the effects of these demographic variables on students' self-reported SRL, their effort on formative assessment, their scores on summative assessment, and the value they placed on formative and summative assessment. For the effect of educational level (undergraduate versus graduate), analyses of variance (ANOVA) were used to

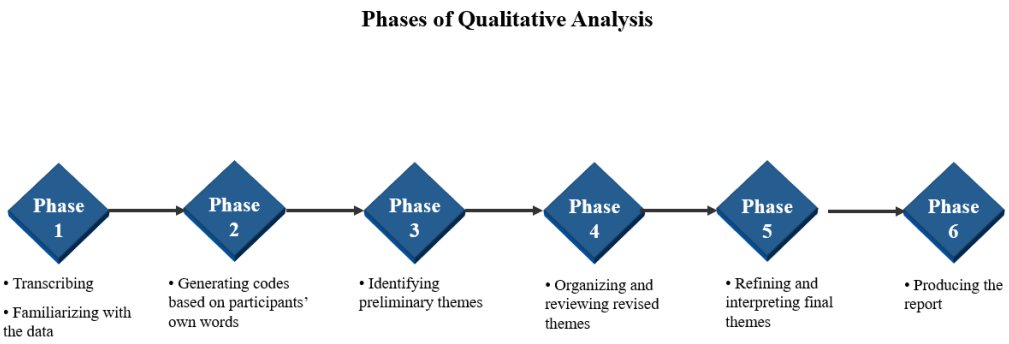
identify group differences between undergraduate and graduate students. For RQ 2, multiple regressions were used to explore how students' SRL affected how they approached the online course. For RQ 3, two-way ANOVA was used to determine whether there was an interaction between the demographic variables and SRL variables on students' online quiz taking. For RQ 4, multiple regressions were used to discover what variables predicted successful academic outcomes, as well as course satisfaction. For RQ 5, a series of one-way repeated measured ANOVAs were used to address whether undergraduate and graduate students showed different patterns in their perceptions of online formative and summative quizzes.

Qualitative Analysis

The qualitative data analysis served to explore the deeper meaning and understanding for the effectiveness of formative quizzes in promoting SRL in online learning environments by explaining and contextualizing the quantitative results. Thematic analysis (Creswell, 2009) was used to analyze the qualitative data from two semi-structured focus groups. As an ongoing and interactive process, thematic analysis was conducted in six steps in this study (Figure 5), starting with preparing the data, coding the data to identify themes, then analyzing and organizing themes, and finally, interpreting and reporting the meaning of the data (Braun & Clarke, 2006).

Figure 5

Process of Qualitative Analysis



The first phase of the analysis was to become familiar with the data, instead of rushing to start coding. Qualitative research seeks to gain a deep understanding, instead of a surface description of a large sample of a population (Creswell, 2014). It was, therefore, vital for the researcher to understand the perspective of each participant prior to conducting the thematic analysis. Data preparation involves transcribing, reading through, and removing all identifiable information. Two focus

groups of four participants each, one for undergraduates and the other for graduates, were digitally recorded and watched numerous times. To ensure that the focus group recordings were transcribed completely, the transcript included fillers, stutters, slang, incomplete sentences, grammatical errors, and repetitions, as well as nonverbal communication. Another challenge was determining where and when punctuation was required so that the original meaning of each participant's comment was not altered. Given the importance of confidentiality and anonymity, all participants in the focus groups were given pseudonyms. After the transcriptions were completed, each transcript was read several times to ensure a thorough understanding of the data (Creswell, 2009). The transcribing process also provided the advantage of intimate familiarity with the data, which was useful in developing codes in the second phase (Corbin & Strauss, 2014). During these preliminary readings, notes were taken on the topic and each participant's experience in order to capture the nuances of the collected data. All transcriptions and notes were stored on a password-protected computer that only the researcher and supervisor had access to. The transcripts from the two focus groups were then imported into the ATLAS.ti software, which was used to organize and code the data before categorizing it into themes, allowing for a more comprehensive analysis.

Following a thorough examination of the data, the second phase was to generate initial codes. The open coding process began with the development of initial codes that marked participants' thoughts about related concepts, regardless of whether they fit into any research question (Braun and Clarke, 2006). Following that, a descriptive label was assigned to each code, which served as the foundation for the preliminary codes that were identified and generated. Similar codes within ATLAS.ti were highlighted using the same color after comparing the similarities and differences among participants' responses (Figure 6). Throughout the coding process, weekly meetings with the supervisor, who had over three decades of experience coding transcripts, were held in which the supervisor went through the data and performed a think-aloud about how his thoughts evolved as he coded the data, as well as double checking that the data were not being coded beyond what the participant said. Thus, coding was an iterative process in which initial codes were refined, combined, split, or discarded while delving deeper into the data (Nowell et al., 2017). Next, code memos were generated by exporting all initial codes to an Excel spreadsheet containing information from participants and focus groups, which was critical for the third stage

of theme development. Code memos also had the added benefit of keeping track of codes and creating an audit trail for the analysis (Figure 7). Peer briefing and code memos thus increased the study's credibility and trustworthiness.

Figure 6

A Screenshot of Coding (from ATLAS.ti)

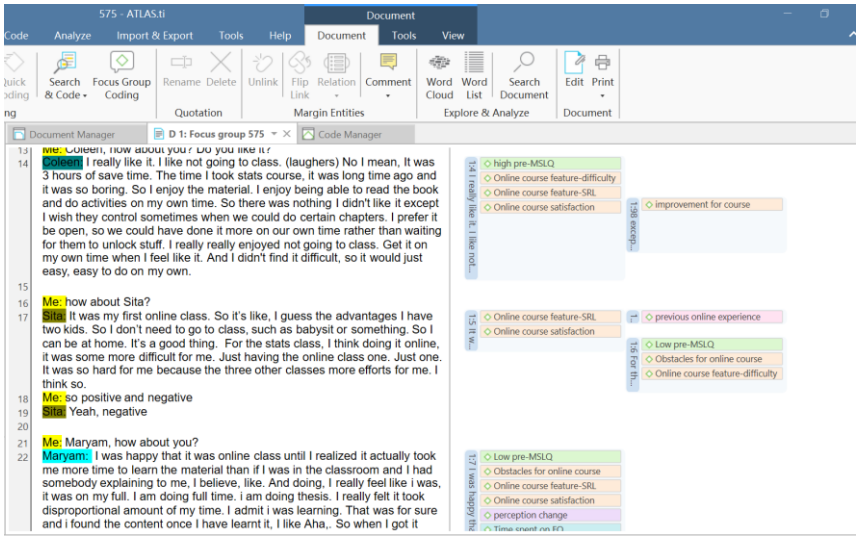
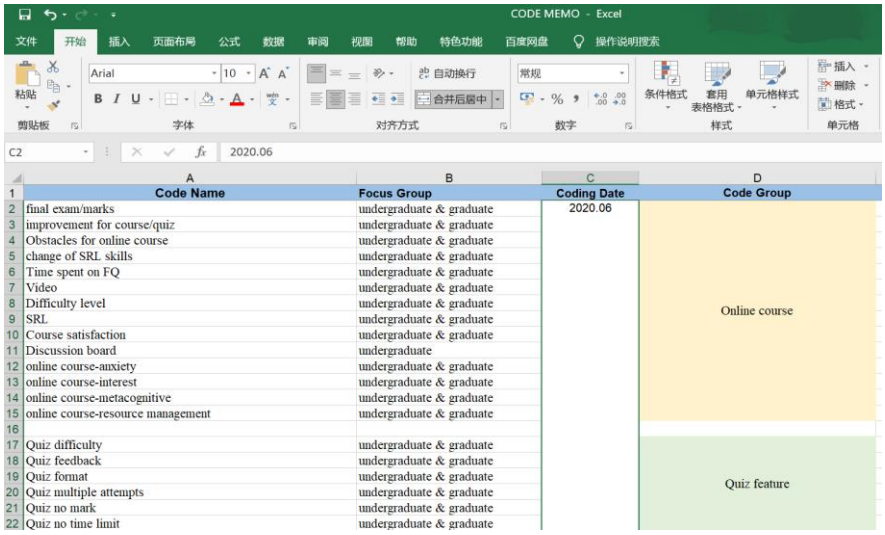


Figure 7

Except from Code Memo



	A	B	C	D
1	Code Name	Focus Group	Coding Date	Code Group
2	final exam/marks	undergraduate & graduate	2020.06	
3	improvement for course/quiz	undergraduate & graduate		
4	Obstacles for online course	undergraduate & graduate		
5	change of SRL skills	undergraduate & graduate		
6	Time spent on FQ	undergraduate & graduate		
7	Video	undergraduate & graduate		
8	Difficulty level	undergraduate & graduate		
9	SRL	undergraduate & graduate		Online course
10	Course satisfaction	undergraduate & graduate		
11	Discussion board	undergraduate		
12	online course-anxiety	undergraduate & graduate		
13	online course-interest	undergraduate & graduate		
14	online course-metacognitive	undergraduate & graduate		
15	online course-resource management	undergraduate & graduate		
16				
17	Quiz difficulty	undergraduate & graduate		
18	Quiz feedback	undergraduate & graduate		
19	Quiz format	undergraduate & graduate		Quiz feature
20	Quiz multiple attempts	undergraduate & graduate		
21	Quiz no mark	undergraduate & graduate		
22	Quiz no time limit	undergraduate & graduate		

The third phase of theme identification began after coding was completed. The most fundamental aspect of thematic analysis is the search for themes. According to Braun and Clarke (2006), a theme is a central concept that captures something important to the research questions and encompasses numerous insights, whereas a code only captures one or a few data insights. They frequently used the analogy of a brick and a house to explain the difference between a code and a theme (Braun &

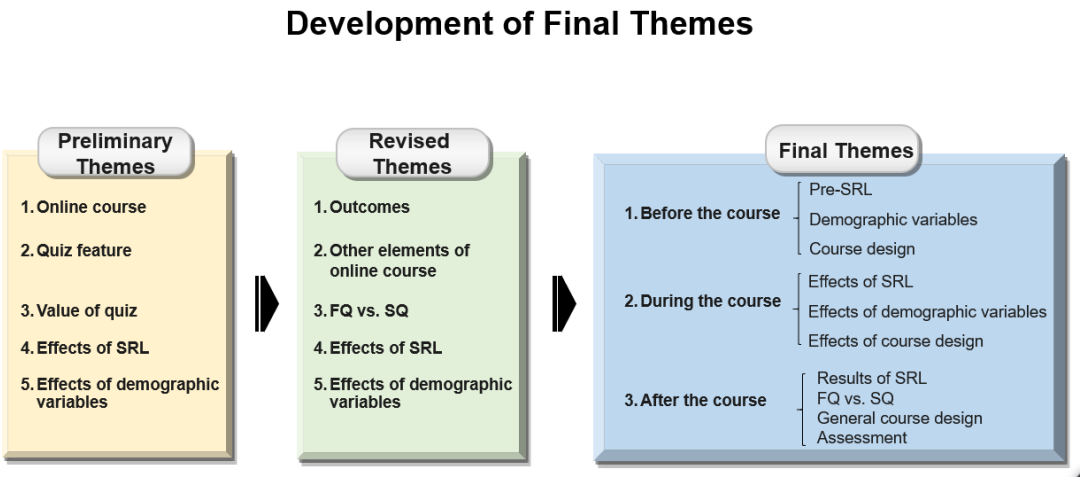
Clarke. 2006). Because there were so many codes in this study, it was critical to start by examining the relationships between these open codes and categorizing them. ATLAS.ti facilitated this process by establishing a web-like network to aid in the formation of connections between codes and the classification of codes into larger patterns. The constant comparative method (Creswell, 2014) was also used to compare each code and identify the categories with similar features. The categories were then combined to form higher level and broader themes. Five preliminary themes were identified: *Online Course, Effects of Demographic Variables, Effects of SRL, Value of Quiz, and Quiz Feature*. For example, codes such as *Quiz Difficulty, Quiz Feedback, Quiz Format, Quiz multiple attempts, Quiz no mark,* and *Quiz no time limit* were grouped under the theme of *Quiz Feature*. Using an inductive approach, the themes were grounded in the data and could be directly linked back to the data. Although the majority of the themes were highly relevant to the research questions, some codes did not fit into the preliminary themes. Participants, for example, reported their emotions and the strategies they used to cope with final exams, which did not directly address the research questions. Braun and Clarke (2006) advised against discarding such codes at this stage, even if they had little relevance to research questions. Thus, these codes were kept because they might be useful later in the data analysis to further explore the participants' experience with online learning. When necessary, subthemes were developed under each preliminary theme, such as the theme of Effect of SRL, which had two subthemes: before taking the class and while taking the class. Atlas.ti's network was useful in visualizing the connections between themes and subthemes. Detailed notes about the development of themes and subthemes were written in the code memos to serve as an audit trail.

The fourth phase involved organizing and reviewing the themes. The following criteria were used to review all of the themes, subthemes, and codes: responsiveness to research questions, sensitivity to data, exhaustive coding, mutually exclusive coding, and conceptual congruence (Merriam, 2009). Initial codes in the thematic analysis were not fixed, but evolved throughout the coding process. As a result, a reflexive approach was used to allow for a more thorough review of all the codes by adding, subtracting, combining, or splitting codes (Braun & Clarke, 2006). When the initial codes were insufficient to cover new themes, the items that had been missed earlier in the previous coding stage were recoded. For example, the demographic background of participants (age, gender, educational level, full/part time, with/without

online learning experience) was added under the theme of *Effects of Demographic Variables*. When there was overlap between codes, such as *Final Exam* and *Final Marks*, the two codes were merged. When the theme or subtheme was too broad, such as the subtheme, *Effects of Resource Management*, it was divided into three separate codes: *Effect of Peer Learning*, *Effect of Help Seeking*, and *Effect of Time & Effort*. The theme *Online Course*, which includes codes about course outcome (such as final marks and course satisfaction), the elements of course (such as discussion boards, video, technology), and the effects of course on SRL. Thus, *Online Course* was deleted and two new themes were created: *Outcome of the Course* and *Other Elements of Course*. Furthermore, SRL codes were merged with the theme *Effects of SRL*. The code *Emotions*, which did not belong to the original themes, was combined with other outcome-related codes to form the new theme *Outcome of the Course*. When the distinctions between some themes were not clear and identifiable, the boundaries of the themes were redrawn. For example, the theme *Quiz Feature* and *Value of Quiz* both included codes about FQ and SQ. These were split into two subthemes: *FQ* and *SQ*, which resulted in the creation of a new theme called *FQ vs. SQ* was created. Thus, the preliminary five themes were revised into new five revised themes: *FQ vs. SQ, Effects of Demographic Variables, Effects of SRL, Outcome of the Course*, and *Other Elements of Course*.

Figure 8

Development of Final Themes.



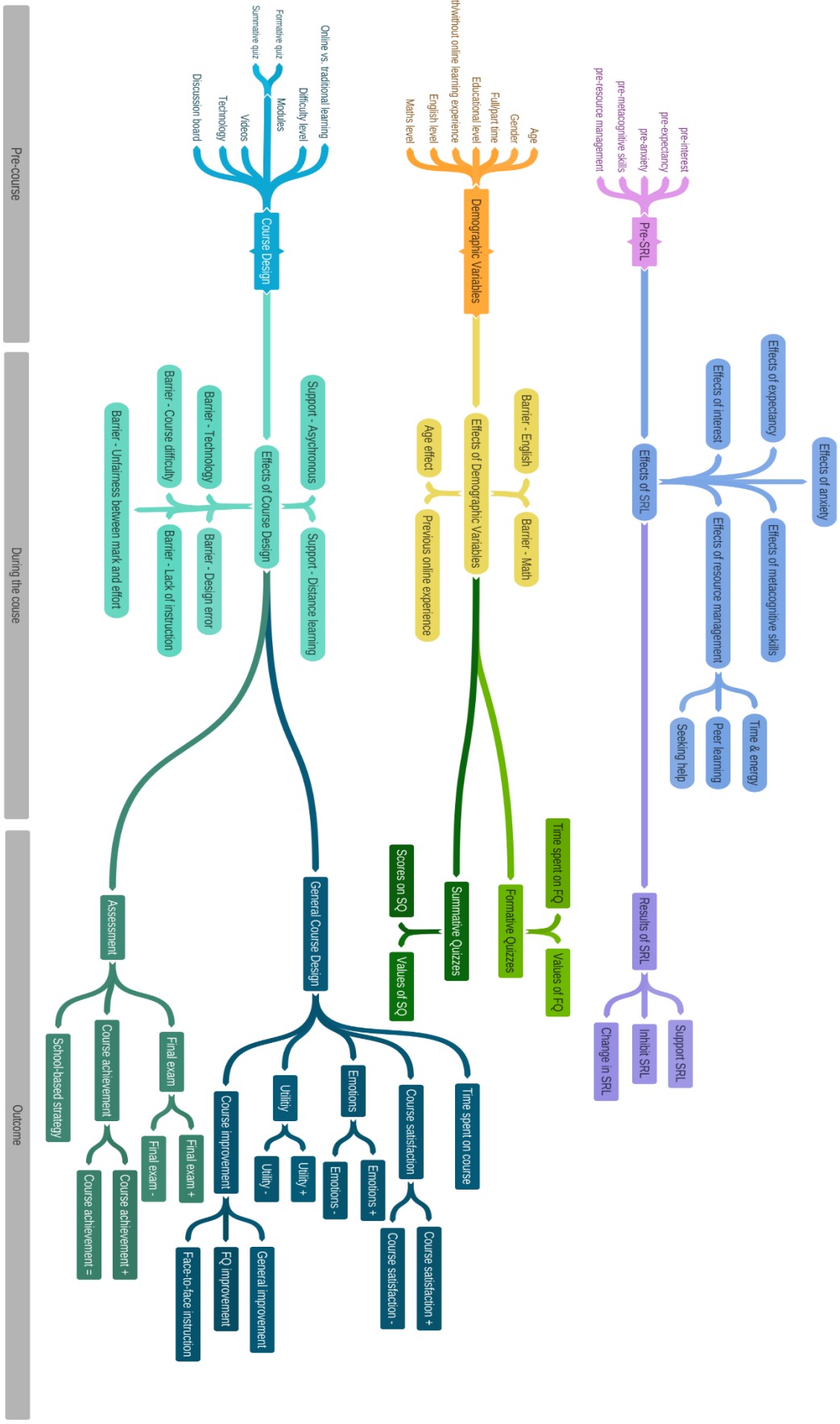
The fifth phase involved refining and interpreting the revised themes. Returning to the transcripts, we identified an important pattern in the data: the time line: whether it described elements before, during or after the online course. Thus, all the themes

and subthemes were reorganized into three final themes: *Before the Course*, *During the Course*, and *After the Course* (Figure 8), with most of the revised themes becoming final subthemes.

The existing subthemes and codes were reorganized, merged, removed, or condensed into smaller units during this phase to ensure that the data was displayed and represented coherently and meaningfully. There were three subthemes under the new theme *Before the Course*: *pre-SRL, Demographic Variables*, and *Course Design*. The subtheme *pre-SRL* was moved from the theme *Effects of SRL* to the theme *Before the Course.* The subtheme of *Demographic Variables* was moved from *Effects of Demographic Variables*. In addition, two new codes were added to the subtheme: participants' comments on their English and math levels. The new code *Online vs. Traditional Learning* was added to the new subtheme *Course Design,* merging with the codes from the previous theme *Other Elements of Course.* Under the new theme *During the Course*, there were four subthemes: *Effects of Demographic Variables, Effects of SRL, Barriers for the Course, and Support by the Course.* The previous codes about obstacles for the courses were split into more specific codes: barriers from demographic variables and from course design, and then grouped together under the new subtheme *Barriers for the Course*. Codes under the subtheme *Course Satisfaction* were examined and two news codes were created: *Asynchronous* and *Distant Learning*, and were moved under the new subtheme *Support by the Course.* Under the new theme *After the Course*, there were four subthemes: *FQ & SQ, General Course Outcome, Assessment,* and *Results of SRL.* Concerning the new subtheme *FQ & SQ*, a new code *FQ vs. SQ* was merged with other codes under the previous theme *FQ vs. SQ*. The majority of codes under the previous theme *Outcome of the Course* were put under the subtheme *General Course Outcome,* however, the code *Final Exam* and *Achievement* were merged with the code *School-based Strategy* which did not fit the initial themes, and placed under the new subtheme *Assessment*. Some codes under previous *Effects of SRL* and codes from previous *Outcome of the Course* were combined to form the new subtheme *Results of SRL*.

Figure 9

Final Theme Map (from ATLAS.ti)


Pre-course
During the couse
Outcome
Effects of anxiety
Effects of expectancy
Effects of metacognitive skills
Effects of interest
Effects of resource management
Effects of SRL
Time & energy
Peer learning
Seeking help
pre-interest
pre-expectancy
pre-anxiety
pre-metacognitive skills
pre-resource management
Pre-SRL
Support SRL
Inhibit SRL
Change in SRL
Results of SRL
Time spent on FQ
Values of FQ
Formative Quizzes
Barrier - English
Barrier - Math
Age
Gender
Full/part time
Educational level
With/without online learning experience
English level
Maths level
Demographic Variables
Effects of Demographic Variables
Age effect
Previous online experience
Scores on SQ
Values of SQ
Summative Quizzes
Online vs. traditional learning
Difficulty level
Modules
Formative quiz
Summative quiz
Videos
Technology
Discussion board
Course Design
Support - Asychronous
Support - Distance learning
Effects of Course Design
Barrier - Technology
Barrier - Design error
Barrier - Course difficulty
Barrier - Lack of instruction
Barrier - Unfairness between mark and effort
General Course Design
Time spent on course
Course satisfaction
Course satisfaction +
Course satisfaction -
Emotions
Emotions +
Emotions -
Utility
Utility +
Utility -
Course improvement
General improvement
FQ improvement
Face-to-face instruction
Assessment
Final exam
Final exam +
Final exam -
Course achievement
Course achievement +
Course achievement =
School-based strategy

The thematic map was created in ATLAS.ti to aid in this process (Figure 9). All of the names of themes, subthemes, and codes were revisited during weekly meetings with the supervisor to discuss whether each name conveyed a clear message about what the theme was about and whether the unified story of the data that emerged from the themes addressed the research questions. During this stage, all of the data were read over and over again, and the coding was scrutinized until each theme was clearly defined, and both raters agreed on the coding. Finally, the overall themes and subthemes fit together to provide a snapshot of the overall picture of the data.

After the final themes had been refined, the final stage of thematic analysis was to write up the report. The final report aimed to explain the results that contribute meaningfully to answering research questions and persuade readers of the validity and merit of the analysis through a clear, concise, logical, and interesting account of the data (Braun & Clarke, 2006). Direct quotes from participants, including both short and long block quotes, were included in the reports as the valid argument to support the research questions. Shorter quotes helped readers understand the themes, while longer quotation passages gave readers a taste of the original context (Nowell et al., 2017). In the discussion section, all of the themes were discussed in order to determine how these themes fit together to tell a coherent and compelling story about the data. All of the findings were interpreted in a credible manner, particularly those that were unexpected or did not correspond to quantitative results (Côté & Turgeon, 2005).

Results of RQ 1: Effects of Demographic Variables

The demographic characteristics of students were examined to determine their relationship to self-regulated learning (SRL). Demographic predictor variables were defined as gender, ethnicity, full/part time status, previous online learning experience, and educational level (undergraduate versus graduate). More specifically, RQ 1 addressed the effects of these demographic variables on students' self-reported SRL, their effort on formative assessment, the value they placed on formative assessment, their scores on summative assessment, the value they placed on summative assessment, their final marks, and the course satisfaction. To answer this research question, a series of multiple regressions were carried out using the demographic variables as predictor variables to predict seven criterion variables: (a) students' SRL;

(b) the total time students spent on formative quizzes; (c) students' reported value of formative quizzes; (d) students' scores on summative quizzes; (e) students' reported value of summative quizzes; (f) students' academic outcome; and (g) course satisfaction and its four subscales (overall satisfaction, learning gains, recommendation level, and willingness to take another online course) (see Table 8). The results were computed for all participants, including undergraduate and graduate students.

Table 8

Predictor and Criterion Variables of Research Question 1

	Predictor Variables	Criterion Variables
RQ 1	Demographic variables (gender, ethnicity, full/part time status, previous online learning experience, and educational level)	A. Students' SRL
		B. Time spent on FQ
		C. Reported value of FQ
		D. Scores on SQ
		E. Reported value of SQ
		F. Final mark
		G. Course satisfaction

Quantitative Results

Quantitative Results 1A: Effect of Demographic Variables on Students' SRL. Demographic variables were used as predictor variables to predict students' SRL. In order to better understand students' SRL, especially their motivational orientations and their use of different learning strategies during the online course, students' SRL were measured by the total score on the concurrent MSLQ, as well as on the five subscales of the concurrent MSLQ (interest, expectancy for success, anxiety, cognitive and metacognitive strategies, and resource management). The concurrent MSLQ, which refers to the total MSLQ score students reported during the online course, was used in the analyses to represent the entire picture of students' SRL while engaged in online class. Results of six multiple regressions, one for the concurrent MSLQ and its five subscales, indicated that the model significantly predicted the interest subscale (see Table 9), R^2 = .084, F (5, 136) =2.50, p = .034, η_p^2= .084; the expectancy subscale (see Table 10), R^2 = .093, F (5, 136) =2.79, p = .020, η_p^2= .093; and the anxiety subscales (see Table 11), R^2 = .194, F (5, 136) =6.55, p <.001, η_p^2= .194. For the interest subscale of students' SRL, there was one

predictor: gender. Male students reported significantly higher interest during the course than female students. For the expectancy subscale of students' SRL, there were two predictors for the expectancy subscale: gender and ethnicity. Female students reported significantly higher expectancy for success during the course than male students. For the anxiety subscale of students' SRL, there was one predictor: educational level. Undergraduate students reported significantly higher anxiety during the course than graduate students.

Table 9

Summary of Multiple Regression Analyses for Demographic Variables Predicting Interest Subscale of Concurrent MSLQ (N = 142)

	Variable	*B*	*SE B*	*β*	t
Demographic variables	Gender	-.65	.28	-.19	**-2.31***
	Ethnicity	-.05	.04	-.10	-.1.24
	Full/part time status	-.34	.29	.14	-1.40
	Educational level	.49	.29	.14	1.68
	Previous online experience	.32	.20	.14	1.61

**p* < .05. ***p* < .01.

Table 10

Summary of Multiple Regression Analyses for Demographic Variables Predicting Expectancy Subscale of Concurrent MSLQ (N = 142)

	Variable	*B*	*SE B*	*β*	t
Demographic variables	Gender	.13	.05	.22	**2.59***
	Ethnicity	.02	.01	.19	**2.24***
	Full/part time status	.02	.04	.04	.44
	Educational level	-.09	.05	-.14	-1.69
	Previous online experience	-.02	.04	-.05	-.60

**p* < .05. ***p* < .01.

Table 11

Summary of Multiple Regression Analyses for Demographic Variables Predicting Anxiety Subscale of Concurrent MSLQ (N = 142)

	Variable	*B*	*SE B*	*β*	t
Demographic variables	Gender	.44	.40	.09	1.11
	Ethnicity	.06	.05	.08	1.02
	Full/part time status	-.56	.34	-.13	-1.64
	Educational level	-2.19	.41	-.42	**-5.33*****
	Previous online experience	-.09	.28	-.03	-.32

*p < .05. **p < .01. ***p < .001

Quantitative Results 1B: Effect of Demographic Variables on the Total Time Spent on FQ. Demographic variables were used as predictor variables to predict the total time students spent on formative quizzes. Results of the multiple regression indicated that the model significantly predicted the time spent on formative quizzes, R^2 = .118, F (5, 136) =3.65, p = .004, η_p^2= .118, explaining 11.8% of the variance. There was only one predictor for the time spend on formative quizzes: educational level (undergraduate versus graduate), b = -.186, t (136) = -3.57, p <.001, d = .61, indicating that undergraduate students spent more time on formative quizzes than graduate students.

Quantitative Results 1C: Effect of Demographic Variables on Reported Value of FQ. It addressed the effects of demographic variables on the value students placed on formative assessment by using the demographic variables as predictor variables to predict students' reported value of formative quizzes. Results of four parallel multiple regressions, one for each of the value subscales, indicated that none of the demographic variables predicted students' reported value of formative quizzes as measured by the four subscales: motivation, F (5,136) =.96, p =.443; pressure, F (5,136) =1.44, p =.213; accurate reflection of understanding, F (5,136) =.61, p =.693; and fair assessment, F (5,136) =1.45, p =.212.

Quantitative Results 1D: Effect of Demographic Variables on Scores on SQ. It addressed the effects of demographic variables on students' scores on summative

assessment by using the demographic variables as predictor variables to predict students' scores on summative quizzes. Results of the multiple regression indicated that the model significantly predicted scores on summative quizzes, R^2 = .217, F (5, 136) =7.54, p < .001, η_p^2= .217, explaining 21.7% of the variance. There was only one predictor for scores on summative quizzes: educational level (undergraduate versus graduate), b = .617, t (136) = 5.71, p <.001, d = .98, indicating that graduate students scored higher on summative quizzes than undergraduate students.

Quantitative Results 1E: Effect of Demographic Variables on Reported Value of SQ. It addressed the effects of demographic variables on the value students placed on summative assessment by using the demographic variables as predictor variables to predict students' reported value of summative quizzes. Results of four parallel multiple regressions, one for each of the value subscales, indicated that the model significantly predicted the motivational subscale (see Table 12), R^2 = .097, F (5, 136) =2.91, p = .016, η_p^2= .097; and pressure subscales of reported value of summative quizzes (see Table 13), R^2 = .103, F (5, 136) =3.12, p = .011, η_p^2= .103.

Table 12

Summary of Multiple Regression Analyses for Demographic Variables Predicting Motivation Subscale of Reported Value of SQ (N = 142)

	Variable	*B*	*SE B*	*β*	t
Demographic variables	Gender	.13	.06	.18	**2.22***
	Ethnicity	-.01	.01	-.05	-.60
	Full/part time status	-.05	.05	-.09	-1.04
	Educational level	.17	.06	.24	**2.83****
	Previous online experience	-.02	.04	-.04	-.45

*p < .05. **p < .01.

There were two predictors for both motivation and pressure subscales: educational level and gender. Graduate students were more motivated and felt less pressure by the use of summative quizzes than undergraduate students, while female students were more motivated and felt less pressure by the use of summative quizzes than male students. Based on standardized coefficient, educational level explained

more of the variance in the motivation and pressure subscales than the gender. However, none of the demographic variables predicted the two remaining subscales of students' reported value of summative quizzes: accurate reflection of understanding, F (5,136) =.16, p =.977; and fair assessment, F (5,136) =.66, p =.655.

Table 13

Summary of Multiple Regression Analyses for Demographic Variables Predicting Pressure Subscale of Reported Value of SQ (N = 142)

	Variable	*B*	*SE B*	*β*	t
Demographic variables	Gender	-.54	.27	-.17	**-2.04***
	Ethnicity	-.03	.04	-.08	-.93
	Full/part time status	.09	.23	.03	.40
	Educational level	-.64	.28	-.19	**-2.31***
	Previous online experience	.34	.19	.15	1.78

*p < .05. **p < .01.

Table 14

Summary of Multiple Regression Analyses for Demographic Variables Predicting Final Marks (N = 142)

	Variable	*B*	*SE B*	*β*	t
Demographic variables	Gender	.83	.41	.16	**-2.01***
	Ethnicity	-.06	.06	-.08	-1.03
	Full/part time status	.27	.36	.06	.76
	Educational level	-.1.50	.43	-.29	**-3.49****
	Previous online experience	-.30	.30	-.08	-1.02

*p < .05. **p < .01.

Quantitative Results 1F: Effect of Demographic Variables on Final Mark. It addressed the effects of demographic variables on students' final mark by using the demographic variables as predictor variables to predict students' academic outcome. Results of the multiple regression indicated that the model significantly predicted scores on summative quizzes (see Table 14), R^2 = .345, F (5, 136) =3.68, p = .004,

η_p^2= .345, explaining 34.5% of the variance. There were two predictors for final mark: educational level and gender. Undergraduate students earned significantly higher final marks than graduate students, while female students earned significantly higher final marks than male students. Based on standardized coefficient, educational level explained more of the variance in the final marks than the gender.

Quantitative Results 1G: Effect of Demographic Variables on Course Satisfaction. It addressed the effects of demographic variables on course satisfaction by using the demographic variables as predictor variables to predict students' course satisfaction. Results of four parallel multiple regressions, one for each of the course satisfaction subscales, indicated that none of the demographic variables predicted students' course satisfaction as measured by the four subscales: overall satisfaction, F (5,136) =.16, p =.977; learning gains, F (5,136) =.66, p =.655, recommendation to other students, R^2 = .094, F (5, 136) =2.83, p = .180, and willingness to take another online course, F (5,136) =.66, p =.655.

Summary of Significant Effects for RQ 1. For all participants, including both undergraduate and graduate students, educational level (undergraduate versus graduate) significantly predicted students' anxiety during the course, effort on formative assessment (measured by time on task), scores on summative quizzes, the motivation and pressure subscales of reported value of summative quizzes, and final mark. Undergraduate students reported significantly higher anxiety during the course than graduate students. Undergraduate students put more effort into formative assessment and earned higher final marks than graduate students, while graduate students scored higher on summative quizzes than undergraduate students. Graduate students were more motivated and felt less pressure by the use of summative quizzes than undergraduate students.

Furthermore, gender significantly predicted the interest and expectancy subscales of student concurrent SRL, the motivation and pressure subscales of reported value of summative quizzes, and final mark. Male students reported significantly higher interest during the course than female students, while female students reported significantly higher expectancy for success during the course than male students. Female students were more motivated and felt less pressure by the use of summative quizzes than male students. Female students earned significantly higher final marks than male students.

Qualitative Results

Qualitative Results 1A: Effect of Demographic Variables on Students' SRL. Consistent with the quantitative results that undergraduates reported significantly higher anxiety during the course than graduate students, all participants in the undergraduate focus group reported anxiety whereas only one participant in the graduate focus group did. While talking about the reason of increasing anxiety, the undergraduate focus group felt that the anxiety was from the discussion board, "*I just felt overwhelmed by the amount of posts. So it gave me anxiety just looking at it*" (Tasha U), whereas graduate focus group felt that the anxiety came from the lack of support, "*I didn't have that group at the beginning, which frustrated me a lot… I felt like I was on my own. I wasn't very comfortable using the online platform"* (Maryam G). When being asked what helped them lessen their anxiety, the undergraduate focus group reported that the feature of formative quiz and summative quiz were helpful to ease the anxiety for the final exam. For example, Kathy U commented that "*once placing that grading on it (FQ), I think the stress level will really go up.*". Ahmed U commented, "*we have all the grades of those quizzes and in most cases, you got a good grade in them. And so this is gonna boost your self-confidence and you have like less anxiety before answering the final exam"*.

Although no significant result was found for the effect of previous online experience, two participants in undergraduate focus group with previous online learning experience both gave positive comments on the current online experience compared to their previous ones. Tasha U commented, "*the last one I have been taken statistics online … it was a little bit too old... who literally posted the PowerPoint, it was like here you go…That statistics class was can't be compared to this one*". Ahmed U added, "*like compared … to the course I took before, the online course. The difference is that before they just give you the slides and you go through the slides. This one like, you have the video so you have like the professor talking and explaining, so this is like a bit of thing than the other online course*". One participant in graduate focus group without previous online learning experience claimed that lack of online learning experience made this online course hard for her, "*It was my first online class. … For the stats class, I think doing it online, it was some more difficult for me*" (Sita G). Although no significant result was found for the effect of full/part-status, Maryam G in graduate focus group said that she spent more time on the course because of her full-time status, "*I am doing full time. I am doing thesis. I really felt it took disproportional amount of my time*." Although no significant result was found

for the effect of age on SRL, Maryam G commented that being an old student helped her improve her SRL skills, "*taking this course when I was younger, I would struggle a lot more than when I am like an older student. I brought a lot that to when I was recognizing for example, a chapter just by skimming it….so I am able to dedicate my time to it.*"

Beyond the above demographic variables measured, participants in both undergraduate and graduate focus groups reported that math background was important for this online statistics course. Ahmed U in undergraduate focus group found the course was easy because "*I am a little bit mathematics, so I found like easy …Like maybe it is easier course in the nursing program*" whereas Ivana U found the course was hard "*because I am not very good at math.*" Coleen G in graduate focus group reported that "*I don't think I ever worked at something mathematical that hard before*." Maryam G added that "*I was really trying because math is not my background...my brain doesn't work like that when it comes to mathematics*." In addition, all four participants in the graduate focus group emphasized the importance of English to this course. No matter as the native speaker or not, participants found difficulty of understanding," *I am English and I still had hard time understanding what was written in the textbook and sometimes even on those quizzes*" (Emma G). Sita G expressed the same concern:" *English is not my first language, so I have some difficulty learning*." All participants complained English part of final exam, even for those native speakers, for example, "*the quality of English was bad. There were errors on the exam and they had to stop the exam and correct errors*" (Coleen G). Maryam G agreed with her, "*You have to be linguistic strong in in English… They are all international students. They said that … it was very disheartening for them.*" The previous experience in maths and English subject mattered and also seemed to have an effect, which should be included as variables in the further study.

Qualitative Results 1B: Effect of Demographic Variables on the Total Time Spent on FQ. Consistent with the quantitative results that undergraduate spent significantly more time on formative quizzes than graduate students, all participants in the undergraduate focus group reported that they put more effort into formative assessment whereas only two graduates did. While talking about why they were willing to spent more time on formative quizzes, the undergraduate focus group mentioned various reasons: Ivana U spent more time because "*this specific course was hard for me. That's why I spent so much time"* while Ahmed U spent more time

because he could use formative quizzed to bridge "*knowledge gap*". Two other participants spent more time on formative quizzes because they were online. When being asked how much time they would spend if this course were traditional, two participants in the undergraduate focus group said that they would spend less time while Kathy U "*would put the same amount of time into it in the physical class."* In the graduate focus group, two participants reported that they spend more time on formative quiz to understand the feedback of the quiz by reading "*two to three times even for the feedback to make sense"* (Mayhem G). Emma G added, "*there was feedback in it that explained it but it did its way. I mean it's written in one way and you can read it 100 times. but if you don't understand it…So you left there to re-read and re-read, and re-read."* Thus, the reasons why students put more effort into formative assessment should be explored in the further study.

Qualitative Results 1C: Effect of Demographic Variables on Reported Value of FQ. Consistent with the quantitative results that there was no significant effect of demographic variables on value of FQ, no participant in either focus group mentioned the above.

Qualitative Results 1D: Effect of Demographic Variables on Scores on SQ. Consistent with the quantitative results that the graduates scored significantly higher on summative quizzes than the undergraduates, three participants in the graduate focus group reported how they tried to get higher score on summative quizzes whereas only one participant in the undergraduate focus group did. The participant in the undergraduate focus group reported that she "*did really well in the quizzes"* (Tasha U). For participants in the graduate focus group, they expressed their aim of getting higher mark on summative quiz, "*I did want to get 100, so I had to figure out to work around*" (Emma G). Coleen G agreed by saying, "*I just got better taking more time doing them to make sure I didn't lose marks there…I was about to get 100"*. While talking about their aim to get higher score on summative quiz, one of the participants in the graduate focus group described her change from intrinsic motivated to extrinsic motivated in this course, "*First, I'm going to learn stats finally. And then I'm just going how do I get the best mark possible… this class was so extrinsically motivated... I am ashamed to say so, but that is all like, like just all at the beginning it is what can I learn and at the end, it is like what do I need to know in order to get this mark"* (Maryam G). Thus, the factors which made graduate students became extrinsic motivated deserved more exploration in the further study.

Qualitative Results 1E: Effect of Demographic Variables on Reported Value of SQ. Consistent with the quantitative results that female students were more motivated and felt less pressure by the use of summative quizzes than male students, two female participants in the undergraduate focus group and two female participants in the graduate focus group expressed their motivation for summative quiz whereas no male participant did. The female participants from both focus groups were extrinsic motivated for summative quiz, as Ivana U from undergraduate focus group reported, "*get the best grade I could get*" and Maryam G from graduate focus group said, "*I was definitely more extrinsically motivated….it was just like, for mark wis. Here is the mark, but you have to learn. Make sure you learn it on your own*". Consistent with the quantitative results that female students felt less pressured by the use of summative quizzes than the males, one female participant in the undergraduate focus group and one female participant in the graduate focus group reported that they felt less pressure for summative quiz whereas no male participant did. As Ivana U in the undergraduate focus group said, *"(summative quiz) accumulated grades. If I do better online quiz, then I can have a worst mid-term grade and final exam, and still pass."* Consistent with the quantitative results that graduate students felt more motivated and less pressured by the use of summative quizzes than undergraduate students, one participant in the graduate focus group reported, "*when I was younger, I would struggle a lot more, definitely stress a little bit more than when I am like an older student.*" (Maryam G). With regard to other reported value of summative quiz, two participants in the graduate focus group felt that the summative quiz was not fair because the summative quiz was *"took so much time … to learn the information. 40% is not the amount it should be…it should be worth more"* (Maryam G), as well as it was "*not testing our ability in math. It is just: can you understand English?"* (Emma G).

Qualitative Results 1F: Effect of Demographic Variables on Final Mark. Consistent with the quantitative results that the undergraduates earned significantly higher final marks than the graduates, all participants in the undergraduate focus group expressed positively on their final marks whereas all participants in the graduate focus group had negative comments on their final exam. Two undergraduate participants mentioned they performed well in the final exam, like Ivana U said *"I really succeeded in this course",* while the other two reported that online quiz helped them getting good marks in the final exam, as Kathy U said "*It (online quiz) is a good*

predictor for the final... I think it did help getting good grades." Contrary to the undergraduate focus group, all participants in the graduate focus group mentioned why they were dissatisfied with the final exam: Coleen G complained the final exam "*did not reflect the course at all*" and *"the quality of English was bad. There were errors on the exam"*. Maryam G said that the format of the final exam was not matching the online quiz they took, which led to "*a disconnect between …what people would be doing it in general and what they put on the exam.*" Sita G and Emma G both commented that the hours they spent on preparing for the final exam became in vain because "*all the work we have done online was from [the textbook]. The exam we got was done by the professors"* (Emma G).

Qualitative Results 1G: Effect of Demographic Variables on Course Satisfaction. Although the quantitative result revealed that there was no significant effect of demographic variables on students' course satisfaction, the qualitative results showed that all participants in the undergraduate focus group were satisfied with their online learning experience whereas three participants in the graduate focus group were dissatisfied. Two of the undergraduates were happy with learning gains from this course, "o*verall I really like this experience…A valuable experience. I thought there were extremely helpful doing like the modules and keep following immediately with quizzes with what I am getting and what I am not understanding"* (Ivana U). The other two undergraduates' satisfaction came from the course being offered online, "*I much prefer doing like everything online vs. the traditional way like in class. I have been able to go back and review the material on my own pace… Like Ivana U said, if you didn't get something, it is easy just to go back vs. in class you could get interrupted by a lot of people"* (Tasha U). However, only one participant in the graduate focus group expressed her satisfaction for the online course, "*I really like it… I enjoy being able to read the book and do activities on my own time"* (Coleen G), whereas three other participants in the graduate focus group were negative on the experience of this online course, "*there is no support…Another challenge is that the fact that nobody is actually teaching it…There was no instruction. So that's a major fallback"* (Emma G).

Summary of RQ 1. For all participants, including both undergraduate and graduate students, educational level (undergraduate versus graduate) significantly predicted students' anxiety during the course, effort on formative assessment (measured by time on task), scores on summative quizzes, the motivation and pressure

subscales of reported value of summative quizzes, and final mark. First, undergraduate students reported significantly more anxiety than graduate students during the course. Consistent with the quantitative results, all undergraduate focus group participants reported anxiety, whereas only one graduate focus group participant did. However, the cause of increased anxiety differed between undergraduate and graduate students. Second, undergraduates reported spending significantly more time than graduate students on formative quizzes. Consistent with the quantitative results, all undergraduate focus group participants reported putting more effort into formative assessment, whereas only two graduates did. However, the reasons for focusing more on formative assessment varied between undergraduate and graduate students. Third, graduate students outperformed undergraduate students on summative quizzes. Consistent with the quantitative results, three graduate focus group participants explained how they attempted to improve their summative quiz scores, whereas only one undergraduate focus group participant did. Fourth, summative quizzes increased graduate students' motivation and decreased their stress levels significantly more than undergraduate students. But no one in either focus group mentioned it. Fifth, undergraduate students earned significantly higher final marks than graduate students. Consistent with the quantitative results, all undergraduate focus group participants expressed positive feelings about their final grades, whereas all graduate focus group participants expressed negative feelings about their final exam. Finally, although the quantitative result revealed that there was no significant effect of demographic variables on students' course satisfaction, the qualitative results showed that all participants in the undergraduate focus group were satisfied with their online learning experience whereas three participants in the graduate focus group were dissatisfied.

Furthermore, gender significantly predicted the interest and expectancy subscales of student concurrent SRL, the motivation and pressure subscales of reported value of summative quizzes, and final mark. First, male students reported significantly higher interest during the course than female students, while female students reported significantly higher expectancy for success during the course than male students. Second, female students felt more motivated and less stressed by the use of summative quizzes than males. Consistent with the quantitative results, female participants in both undergraduate and graduate focus groups reported feeling more extrinsically motivated and less pressured for the summative quiz whereas no male

participant did. Third, female students earned significantly higher final marks than male students. Consistent with the quantitative results, most female students expressed positive feelings about their final grades.

Although no significant result was found for the effect of previous online experience, two participants in undergraduate focus group with previous online learning experience both gave positive comments on the current online experience compared to their previous ones. Beyond the above demographic variables measured, participants in both undergraduate and graduate focus groups reported that math background was important for this online statistics course. In addition, all four participants in the graduate focus group emphasized the importance of English to this course.

Results of RQ 2: Effects of SRL on Formative and Summative Quizzes

To explore how students' SRL affected how they approached the online course, RQ 2 addressed the effect of students' self-reported SRL on the total time they spent on formative quizzes, the value they placed on formative quizzes, their scores on summative quizzes, and the value they placed on summative quizzes.

Table 15

Predictor and Criterion Variables of Research Question 2

	Predictor Variables	Criterion Variables
RQ 2	Five subscales of the MSLQ (interest, expectancy for success, anxiety, cognitive and metacognitive strategies, and resource management)	A. Time spent on FQ
		B. Reported value of FQ
		C. Scores on SQ
		D. Reported value of SQ

Because the total score on the MSLQ was a product of the MSLQ subscale scores, both the total score on the MSLQ and the subscales could not be included in the same analysis. In order to better understand the effect of students' SRL, students' SRL was measured by the five subscales in this analysis: interest, expectancy for success, anxiety, cognitive and metacognitive strategies, and resource management. Thus, a series of multiple regressions was conducted using the five-subscales of the MSLQ (both predicted and concurrent) to predict: (a) the total time students spent on formative quizzes; (b) students' reported value of formative quizzes; (c) students'

scores on summative quizzes, (d) students' reported value of summative quizzes (see Table 15). A series of multiple regressions were run using the data both groups combined.

Quantitative Results

Quantitative Results 2A: Effect of SRL on the Total Time Spent on FQ. Results of the multiple regression also indicated that the model significantly predicted the total time spent on formative quizzes, R^2 = .179, F (10, 131) =2.85, p =.003, η_p^2= .179, explaining 17.9% of the variance. There was one significant predictor for the total time spent on formative quizzes: students' predicted anxiety, b = .044, t (131) = 2.93, p =.004, d = .52. Students who predicted higher anxiety before the course spent more time on formative quizzes than those who predicted lower anxiety before the course.

Quantitative Results 2B: Effect of SRL on Reported Value of FQ. Results of four parallel multiple regressions, one for each of the subscales, indicated that there were significant predictors for the motivation subscale, R^2 = .204, F (10, 131) =3.35, p = .001, η_p^2= .204; pressure subscale, R^2 = .170, F (10, 131) =2.69, p = .005, η_p^2= .170; and fair assessment subscales of FQ reported value, R^2 = .133, F (10, 131) =2.01, p = .037, η_p^2= .133. However, none of SRL variables predicted the understanding subscale of FQ reported value, F (10, 131) = .897, p = .538.

For the motivation subscale: students' concurrent interest was the only significant predictor, b = .421, t (131) =3.02, p =.003, d = .51. Students who reported higher interest during the course felt more motivated by the use of formative quizzes than those who reported lower interest during the course. For the pressure subscale, there were two significant predictors: the concurrent interest, b = .280, t (131) =2.30, p =.023, d = .38; and concurrent anxiety. b = .121, t (131) =2.08, p =.040, d = .37. Students who reported lower interest or anxiety during the course felt less pressured by the use of formative quizzes than those who reported higher interest or anxiety during the course. Based on standardized coefficient, the concurrent interest explained more of the variance in the pressure subscales than the concurrent anxiety. For the fair assessment subscale, there were two significant predictors: the concurrent interest, b = -.139, t (131) = -3.15, p =.001, d = .52; and concurrent metacognitive strategies, b = .115, t (131) = 2.68, p =.008, d = .47. The students who reported less interest or greater use of cognitive and metacognitive strategies during the course felt that formative quizzes were a fairer assessment instrument than those who reported higher

interest or less use of cognitive and metacognitive strategies during the course. Based on standardized coefficient, the concurrent interest explained more of the variance in the fair assessment subscales than the concurrent metacognitive strategies.

Quantitative Results 2C: Effect of SRL on Scores on SQ. Results of the multiple regression indicated that the model significantly predicted scores on summative quizzes, R^2 = .163, F (10, 131) =2.55, p =.008, η_p^2= .163. There were three significant predictors for scores on summative quizzes: students' predicted resource management, b = -.188, t (131) = -3.33, p =.001, d = .58; concurrent expectancy for success, b = .734, t (131) = 2.13, p =.035, d = .37; and concurrent anxiety, b = -.061, t (131) = -2.17, p =.032, d = .38. The students who predicted less use of resource management before the course scored higher on summative quizzes than those who predicted greater use of resource management before the course. This analysis also indicated that the students who reported higher expectancy for success or lower anxiety during the course scored higher on summative quizzes than those who reported lower expectancy for success or higher anxiety during the course. Based on standardized coefficient, the predicted resource management explained more of the variance in the scores on summative quizzes than two other predictors.

Quantitative Results 2D: Effect of SRL on Reported Value of SQ. The multiple regression model failed to predict the motivation subscale, F (10, 131) =1.65, p = .100; understanding subscale, F (10, 131) =1.21, p = .293; and fair assessment subscales of SQ reported value, F (10, 131) =1.56, p = .127. However, the model significantly predicted the pressure subscale, R^2 = .225, F (10, 131) =3.80, p < .001, η_p^2= .225. There was one significant predictor for the pressure subscale: the concurrent anxiety, b =.136, t (131) = 2.12, p = .036, d =.38, indicating that students who reported lower anxiety during the course felt less pressured by the use of summative quizzes than those who reported higher anxiety during the course.

Quantitative Results 2E: Difference between Undergraduate and Graduate Students. To explore the difference on the above effects between undergraduate and graduate students, a series of multiple regressions were run using the data from undergraduate students, however, while simple correlations were run for the graduate group.

Effect of SRL on the Total Time Spent on FQ. For undergraduates, results of the multiple regression indicated that the model significantly predicted the total time spent on formative quizzes, R^2 = .162, F (10, 118) =2.28, p = .018. η_p^2= .162,

explaining 16.2% of the variance. There were two significant predictors for the total time spent on formative quizzes: students' predicted anxiety, b = .048, t (118) = 3.04, p =.003, d = .56; and concurrent interest, b = .060, t (118) = 2.12, p =.037, d = .39. Undergraduate students who predicted higher anxiety before the course spent more time on formative quizzes, while undergraduate students who reported higher interest during the course spent more time on formative quizzes. Based on standardized coefficient, the predict anxiety explained more of the variance in the total time spent on formative quizzes than the concurrent interest.

For graduates, consistent with the results from undergraduate students, simple correlation results also indicated that there was significant positive relationship between the predicted anxiety and the total time spent on formative quizzes. The graduate students who predicted higher anxiety before the course spent more time on formative quizzes than those who predicted lower anxiety before the course. However, for the graduate students, there was no significant relationship between the concurrent interest and the total time spent on formative quizzes. There were also significant positive relationships between the total time spent on formative quizzes and other subscales of the MSLQ (predicted interest, predicted metacognitive strategies, concurrent anxiety, and concurrent metacognitive strategies), indicating that graduate students who predicted higher interest or greater use of cognitive and metacognitive strategies before the course, who reported higher anxiety or greater use of cognitive and metacognitive strategies during the course spent more time on formative quizzes.

Therefore, although both undergraduate and graduate students who predicted higher anxiety before the course spent more time on formative quizzes. there were different effects of SRL on time spent on FQ between undergraduate and graduate students. Undergraduate students who reported higher interest during the course spent more time on formative quizzes, whereas graduate students who reported higher predicted interest, higher predicted metacognitive strategies, higher concurrent anxiety, or higher concurrent metacognitive strategies spent more time on formative quizzes.

Effect of SRL on Reported Value of FQ. For undergraduates, results of four parallel multiple regressions, one for each of the value subscales, indicated that the model significantly predicted the motivation subscale, R^2 = .234, F (10, 118) =3.60, p < .001, η_p^2= .234; and pressure subscale of FQ reported value, R^2 = .174, F (10, 118)

=2.49, p = .010, η_p^2= .174. For the motivation subscale, the concurrent interest was the only significant predictor, b = .544, t (118) = 3.61, p <.001, d = .66. Undergraduate students who reported higher interest during the course felt more motivated by the use of formative quizzes than those who reported lower interest during the course. For the pressure subscale, the concurrent interest was also the only significant predictor, b = 366, t (118) = 2.79, p =.006, d = .50. Undergraduate students who reported lower interest during the course felt less pressured by the use of formative quizzes than those who reported higher interest during the course. However, for the remaining two subscales of FQ reported value (understanding, fair assessment), there was no significant association. However, none of SRL variables predicted the two remaining subscales of students' reported value of summative quizzes: accurate reflection of understanding, F (10, 118) =.771, p = .656; and fair assessment, F (10, 118) =1.83, p = .063.

For graduates, consistent with the results from undergraduate students, simple correlation results indicated that there was a significant positive relationship between the concurrent interest and the motivation subscale of FQ reported value. Graduate students who reported higher interest during the course felt more motivated by the use of formative quizzes than those who reported lower interest during the course. Simple correlation results also indicated that there were significant relationships in the motivation and pressure subscales of FQ reported value. For the motivation subscale, there were significant positive relationships between the motivation subscale and two subscales of the MSLQ (concurrent expectancy for success and concurrent metacognitive strategies). Graduate students who reported higher expectancy for success or greater use of cognitive and metacognitive strategies during the course felt more motivated by the use of formative quizzes than those who reported lower expectancy for success or greater use of cognitive and metacognitive strategies during the course. For the pressure subscale, there were significant positive relationships between the pressure subscale and two subscales of the MSLQ (concurrent expectancy for success and concurrent metacognitive strategies). Graduate students who reported lower expectancy for success during the course felt less pressured by the use of formative quizzes than those who reported higher expectancy for success during the course, while graduate students who reported less use of cognitive and metacognitive strategies during the course felt less pressured by the use of formative quizzes than those who reported greater use of cognitive and metacognitive strategies

during the course. For the understanding subscale, there were significant positive relationships between the understanding subscale of FQ reported value and five subscales of the MSLQ (predicted interest, predicted expectancy for success, predicted metacognitive strategies, concurrent expectancy for success, concurrent metacognitive strategies) in the graduate students. Graduate students who predicted higher interest, higher expectancy for success, or greater use of cognitive and metacognitive strategies before the course, or who reported higher expectancy for success or greater use of cognitive and metacognitive strategies during the course felt that formative quizzes reflected their understanding more accurately. For the fairness subscale, there was positive relationship between the fair assessment subscale of FQ reported value and concurrent expectancy for success in the graduate students. Graduate students who reported higher expectancy for success during the course felt that formative quizzes were a fairer assessment instrument.

Therefore, although both undergraduate and graduate students who predicted who reported higher interest during the course were more motivated, there were different effects of SRL on reported value of FQ between undergraduate and graduate students. However, undergraduate students who reported lower interest during the course felt less pressured by the use of formative quizzes, whereas graduate students who reported lower expectancy for success and who reported less use of cognitive and metacognitive strategies during the course felt less pressured by the use of formative quizzes.

Effect of SRL on Scores on SQ. For undergraduates, results of the multiple regression indicated that the model significantly predicted scores on summative quizzes, R^2 = .221, F (10, 118) =3.36, p = .001, η_p^2= .221, explaining 22.1% of the variance. There was only one significant predictor for scores on summative quizzes: students' predicted resource management, b = -.185, t (118) = -3.58, p = .001, d = .66. Undergraduate students who predicted less use of resource management before the course scored higher on summative quizzes than those who predicted greater use of resource management before the course. For graduates, simple correlation results indicated that there was no significant relationship between any subscale of the MSLQ and scores on summative quizzes.

Effect of SRL on Reported Value of SQ. For undergraduates, results of four parallel multiple regressions, one for each of the value subscales, indicated that the model significantly predicted the motivation subscale, R^2 = .181, F (10, 118) =2.60, p

=.007, η_p^2= .181; and pressure subscale of SQ reported value, R^2 = .253, F (10, 118) =4.00, p < .001, η_p^2= .253. Although both multiple regression models were significant, no single predictor contributed to the models. Significant predictors may have been masked because of the collinearity. Thus, concurrent expectancy for success was omitted from the analysis because it was confounded with concurrent interest (r (129) = .65, p < .001). For the motivation subscale, there was one significant predictor: concurrent anxiety, b =.031, t (119) = 2.05, p = .043, d = .37, indicating that undergraduate students who reported higher anxiety during the course felt more motivated by the use of summative quizzes than those who reported lower anxiety during the course. For the pressure subscale, there was still no predictor. For the two remaining subscales, the multiple regression model failed to predict the understanding subscale, F (10, 118) =1.22, p = .288; and fair assessment subscale, F (10, 118) =1.54, p = .133.

For graduates, simple correlation results indicated that there were significant relationships between subscales of the MSLQ and each subscale of SQ reported value. For the motivation subscale, a significant negative relationship was found with the predicted resource management, indicating that graduate students who predicted less use of resource management before the course felt more motivated by the use of summative quizzes than those who predicted greater use of resource management before the course. For the pressure subscale, significant positive relationships were found with two subscales of the MSLQ (predicted expectancy for success and concurrent interest). The graduates who predicted lower expectancy for success before the course or who reported lower interest during the course felt less pressured by the use of summative quizzes. For both the understanding and fair assessment subscales, significant positive relationships were found with the five subscales of the MSLQ (predicted interest, predicted expectancy for success, predicted metacognitive strategies, concurrent expectancy for success, and concurrent metacognitive strategies). The graduate students who predicted higher interest, higher expectancy for success, or greater use of cognitive and metacognitive strategies before the course, or who reported higher expectancy for success or greater use of cognitive and metacognitive strategies during the course stated that summative quizzes not only reflected their understanding more accurately but also were a fairer assessment instrument.

Therefore, undergraduate students who reported higher anxiety during the course felt more motivated by the use of summative quizzes, whereas graduate students who predicted less use of resource management before the course felt more motivated by the use of summative quizzes.

Summary of Significant Effects for RQ 2. For all participants, including both undergraduate and graduate students, SRL variables significantly predicted students' effort on formative quizzes (measured by time on task), the value they place on formative quizzes, their scores on summative quizzes, and the value they place on formative quizzes. First, the students who predicted higher anxiety before the course spent more time on formative quizzes. Second, students who reported higher interest during the course felt more motivated and more pressured by the use of formative quizzes. The students who reported lower anxiety during the course felt less pressured for formative quizzes. The students who reported less interest or greater use of cognitive and metacognitive strategies during the course felt that formative quizzes were a fairer assessment instrument. Third, the students who reported lower interest or anxiety during the course, or who predicted less use of resource management before the course or who reported higher expectancy for success scored higher on summative quizzes.

Qualitative Results

Qualitative Results 2A: Effect of SRL on the Total Time Spent on FQ. For undergraduates, the quantitative result revealed that undergraduates who predicted higher anxiety before the course spent significantly more time on formative quizzes. However, no participant in the undergraduate focus group mentioned their anxiety before the course. Consistent with the quantitative results that undergraduates who reported higher interest during the course spent significantly more time on formative quizzes, two participants with higher interest in the undergraduate focus group reported that they spent more time on the formative quizzes, as Tasha U said, "*I did really like the (formative) quiz… And I did like having several try (tries)*". Ahmed U added, "*this (formative quiz) is going to let you have more time to think about the question and quizzes and like answer properly. That's why that is very helpful. Like you know for the learning process."*

For graduates, the quantitative results revealed that there was significant positive relationship between the predicted anxiety and the total time spent on formative quizzes. Consistent with the quantitative results, one participant in the graduate focus

group mentioned that she had anxiety before the course because she was not "*very comfortable using the online platform"* and spent more time on formative quiz "*I read it two to three times even for the feedback to make sense to me*" (Maryam G). Consistent with the quantitative results that there was significant positive relationship between the predicted interest and the total time spent on formative quizzes, one participant mentioned that "*whenever I needed a break, I just did stats because I have done it and I found it interesting"* (Coleen G). Consistent with the quantitative results that there was significant positive relationship between the concurrent metacognitive strategies and the total time spent on formative quizzes, all four participants in the graduate focus group mentioned that they used different cognitive and metacognitive strategies on formative quiz, "*the (formative) quiz you could do up to three times. But you could click on the answer and find out what you did wrong. So I just did them right away, right then and there. So I always got it wrong once and right twice. Cuz I make sure, I just make sure I figured it out before I did it the second time. And the third one, you did it once and you could redo once... And I learned by doing it cuz I did look at why it was getting them wrong"* (Coleen G). Emma G explained her cognitive and metacognitive strategies by "*I would go through … what's that in the quiz. And I would take a screenshot of everything if it's not correct. I would hit the checked answers, tell me right or wrong… I looked at all my wrong answers and I worked on them. And I worked on them."* Sita G added by, "*you have to learn the subject like the lesson which has given to you. so after understanding everything. Then you can do the problems. So for me the readings it takes more time".* Maryam G mentioned how she used cognitive and metacognitive strategies on formative quizzes, "*I brought a lot that to when I was recognizing for example, a chapter just by skimming it. It's gonna take me longer than previous chapter, those kinds of things. So I am able to dedicate my time to it."* Although quantitative results showed that there was significant positive relationship between two subscales of the MSLQ (predicted metacognitive strategies and concurrent anxiety) and the total time spent on formative quizzes, no participant in the graduate focus group mentioned that.

Qualitative Results 2B: Effect of SRL on Reported Value of Formative Quizzes. For undergraduates, the quantitative results revealed that formative quizzes increase the motivation of undergraduates who reported higher interest during the course. Consistent with the quantitative results, three participants with higher interest in the undergraduate focus group reported that formative quizzes did motivate them

more, "*these (formative) quizzes…like push you to work harder and to understand the material… It's going to motivate you… to understand more to go more and try another time"* (Ahmed U), and *"I really enjoy doing those online quizzes. I thought there were extremely helpful doing like the modules and keep following immediately with quizzes with what I am getting and what I am not understanding"* (Tasha U). Although the quantitative results revealed that the undergraduates who reported lower interest during the course feel less pressured by the use of formative quizzes, no participant in the undergraduate focus group mentioned that.

For graduates, consistent with the quantitative results that there was a significant positive relationship between the concurrent interest and the motivation subscale of FQ reported value, three participants who reported high interest in the graduate focus group reported that formative quizzes increased their motivation, "*I enjoy the material. I enjoy being able to read the book and do activities on my own time. So there was nothing I didn't like it…So formative I think I learned is to work harder independently with more focus...So whenever I needed a break, I just did stats because I have done it and I found it interesting so you know I find the whole thing engaging"* (Coleen G). Emma G added, "*the feature (feedback of FQ) was there if it explains me the reason why, how to do this problem that would help me out."*

Consistent with the quantitative results that there was a significant positive relationship between the concurrent expectancy for success and the motivation subscale of FQ reported value, two participants with higher expectancy for success in the graduate focus group reported that formative quizzes increased their motivation, "*the (formative) quiz you could do up to three times. But you could click on the answer and find out what you did wrong. So I just did them right away, right then and there. So I always got it wrong once and right twice. Cuz I make sure, I just make sure I figured it out before I did it the second time. And the third one, you did it once and you could redo once, but it was the same question so I just wrote down all the answers to make sure I got 100. I did want to get 100, so I had to figure out to work around. And I learned by doing it cuz I did look at why it was getting them wrong"* (Coleen G). Maryam G concluded that, "*first, I'm gonna learn stats …like figured it out… what can I take away from this class. And then I'm just gonna…how do I get the best mark possible… This class was so extrinsically motivated."*

Consistent with the quantitative results that there was a significant positive relationship between the concurrent metacognitive strategies and the motivation

subscale of FQ reported value, three participants in the graduate focus group reported that formative quizzes increased their motivation by making use of the special features of formative quizzes with different cognitive and metacognitive strategies, "*after receiving the feedback, so I'll be doing. I will be learning each every step while I do the formative, so I can it is it's so helpful so I can actually I do take a screenshot when I'm doing my formative. I will go through it. So it would helpful for me"* (Sita G). Coleen G agreed with Sita, "*if you got it wrong, you could redo it all. But the answer is all there. So you just click on with the right answer it was, and they just change the order. So wrote down key words with the answer, so I can redo it in less than 5 minutes"* (Coleen G). Maryam G introducted her cognitive and metacognitive strategies, "*So the ones like I got wrong, and I fixed. I would remember better than the ones I maybe would have gotten right…The advantage (of formative quiz) was actually reinforcing what you know and you don't know on the way… It's actually a learning tool tool, I mean the feedback sometimes it's pretty… I read it two to three times even for the feedback to make sense to me."*

Consistent with the quantitative results that there was a significant positive relationship between the concurrent expectancy for success and the understanding subscale of FQ reported value, two participants with high expectancy for success in the graduate focus group reported that formative quizzes helped them understand in a better way, "*it (formative quiz) was the same question so I just wrote down all the answers to make sure I got 100. I did want to get 100, so I had to figure out to work around. And I learned by doing it cuz I did look at why it was getting them wrong"* (Coleen G). Maryam G added, "*I read it two to three times even for the feedback to make sense to me…so it helps but for sure it is more on the mark-wise".*

Consistent with the quantitative results that there was a significant positive relationship between the concurrent metacognitive strategies and the understanding subscale of FQ reported value, all four participants mentioned that formative quizzes did help their understanding by using cognitive and metacognitive strategies, "*The way i do, like I would go through that, the, what's that in the (formative) quiz, And I would take a screenshot of everything if it's not correct. I would hit the checked answers, tell me right or wrong… I looked at all my wrong answers and I worked on them"* (Emma G). Sita G used the similar strategy, "*Actually I do take a screenshot when I'm doing my formative. I go through it. So it would helpful for me. you have to learn the subject like the lesson which has given to you. so after understanding*

everything. Then you can do the problems. " Maryam G explained her strategy, "*The feedback sometimes it's pretty, It was always clear …I read it two to three times even for the feedback to make sense to me…I have to write on reflection, i did."*

Although quantitative results revealed that there were significant positive relationships between two subscales of SRL variable (concurrent expectancy for success and concurrent metacognitive strategies) and the pressure subscale of FQ reported value, between three subscales of SRL (predicted interests, predicted expectancy for success, and predicted metacognitive strategies) and the understanding subscale of FQ reported value, and between the concurrent expectancy for success and the fairness subscale of FQ reported value, no participant in the graduate focus group mentioned that.

Qualitative Results 2C: Effect of SRL on Scores on Summative Quizzes. For undergraduates, the quantitative results revealed that undergraduates who predicted less use of resource management before the course scored higher on summative quizzes. However, no participant in the undergraduate focus group mentioned their expected use of resource management. Instead, participants with greater use of resource management during the course reported that they scored well on summative quizzes. Two participants in the undergraduate focus group reported that they regulated their time and controlled their effort, "*I prefer like those online courses because also sometimes three hours is is really too much you know for the concentration and focus all the time. So having your own pace is very is very helpful. It's at least you know that you are in your best brain shape to go through the module…you have enough time to go and think. So this is gonna give you more time to practice and practice is gonna lead to the good grades"* (Ahmed U). Another two participants reported that they used peer learning during the course to get high scores on summative quizzes, "*I really enjoy doing those online quizzes... I had a friend that which took the course at the same time. So we kind of just sat and grew. And we looked at the material then we compared"* (Tasha U) and "*I did have lots of study groups here that I would work with...I would be able to just check very quickly what had been responded to" (*Kathy U).

For graduates, consistent with the quantitative results that there was no significant relationship between any subscale of the MSLQ and scores on summative quizzes, no participant in the graduate focus group mentioned that.

Qualitative Results 2D: Effect of SRL on Reported Value of Summative Quizzes. Although the quantitative results revealed that students who reported lower anxiety during the course felt less pressured by the use of summative quizzes, no participant in the undergraduate and graduate focus groups mentioned that.

Summary of RQ 2. For all participants, including both undergraduate and graduate students, SRL variables significantly predicted students' effort on formative quizzes. Congruent with the results from undergraduate and graduate students, the students who predicted higher anxiety before the course did spend more time on formative quizzes. Second, SRL variables predicted the value of formative quizzes significantly. According to the findings of undergraduate and graduate students, formative quizzes motivated students who reported higher levels of interest during the course. Students who reported lower interest during the course felt less pressured for formative quizzes, which is only consistent with the findings of undergraduate students. Furthermore, quantitative results revealed that students who reported lower anxiety during the course felt less pressured for formative quizzes, and students who reported less interest or greater use of cognitive and metacognitive strategies during the course felt formative quizzes were a fairer assessment instrument. Third, SRL variables predicted students' summative quiz scores significantly. Students who predicted less use of resource management prior to the course performed better on summative quizzes. The quantitative results also showed that students who reported higher success expectations or lower anxiety during the course performed better on summative quizzes. Finally, summative quizzes relieved stress in students who reported lower anxiety during the course.

Effects of SRL variables on students' effort on FQ, scores on SQ, and values of FQ and SQ were different for undergraduate and graduate students. First, undergraduate students who predicted higher anxiety before the course or who reported higher interest during the course spent significantly more time on formative quizzes, whereas graduate students who predicted higher interest, higher anxiety, or greater use of cognitive and metacognitive strategies before the course, who reported higher anxiety or greater use of cognitive and metacognitive strategies during the course spent more time on formative quizzes. Second, undergraduate students with more interest reported that formative quizzes motivated them more, whereas graduate participants with higher interest, higher expectancy for success, or greater use of cognitive and metacognitive strategies reported that formative quizzes increased their

motivation. Third, undergraduate students who predicted less use of resource management prior to the course performed better on summative quizzes, whereas there was no significant relationship between any subscale of the MSLQ and scores on summative quizzes for graduate students. Finally, undergraduate students who reported higher anxiety during the course felt more motivated by the use of summative quizzes, whereas graduate students who predicted less use of resource management before the course felt more motivated by the use of summative quizzes.

Results of RQ 3: Interactions between Demographic Variables and SRL

To determine whether there was an interaction between any of the demographic variables and SRL variables on students' quiz taking, RQ 3 addressed whether there was an interaction between demographic variables and SRL variables on both the total time spent on formative quizzes and their scores on summative quizzes. One measure of SRL was used in the analyses to represent the whole picture of students' SRL while engaged in online class: the concurrent MSLQ.

A series of two-way ANOVAs was carried out, using each of the demographic variables and the concurrent MSLQ as independent variables to predict the dependent variables of (a) the total time students spent on formative quizzes; (b) students' scores on summative quizzes. Results were computed for the two groups combined (see Table 16). To meet the assumption of two-way ANOVA, the concurrent MSLQ was transformed from continuous to categorical variable, which was divided into three equal-sized groups: high, middle and low.

Table 16

Independent and Dependent Variables of Research Question 3

<table>
<tr><td></td><td></td><td colspan="2">Independent Variables</td><td>Dependent Variables</td></tr>
<tr><td rowspan="2">RQ 3</td><td rowspan="2">Both groups combined</td><td rowspan="2">Demographic variables (gender, ethnicity, full/part time status, previous online learning experience, and educational level)</td><td rowspan="2">SRL variable (the total score on the concurrent MSLQ)</td><td>A. Time spent on FQ</td></tr>
<tr><td>B. Scores on SQ</td></tr>
</table>

Quantitative Results

Quantitative Results 3A: Interaction on the Total Time Spent on FQ.

Table 17

Results of the two-way ANOVA on Time Spent on FQ (N= 142)

Variable	*df*	*MS*	*F*
Gender	1	.07	2.04
Concurrent MSLQ	2	.08	2.33
Gender x Concurrent MSLQ	2	.03	.81
Error	136	.03	
Total	142		
Ethnicity	5	.06	1.84
Concurrent MSLQ	2	.01	.33
Ethnicity x Concurrent MSLQ	6	.02	.66
Error	128	.03	
Total	142		
Full/part time status	1	.01	.16
Concurrent MSLQ	2	.08	2.30
Full/part time status x Concurrent MSLQ	2	.05	1.36
Error	136	.03	
Total	142		
Educational level	1	.44	**14.63*****
Concurrent MSLQ	2	.05	1.51
Educational level x Concurrent MSLQ	2	.01	.13
Error	136	.03	
Total	142		
Previous online experience	1	.11	3.23
Concurrent MSLQ	2	.03	.88
Previous online experience x Concurrent MSLQ	2	.01	.07
Error	136	.03	
Total	142		

***$p < .001$

Results of five parallel two-way ANOVAs, one for each of the demographic variables, indicated that there was no significant interaction between the total mark on the concurrent MSLQ and any demographic variables (gender, ethnicity, full/part time status, educational level, and previous online learning experience) on the total time students spent on formative quizzes (see Table 17).

Quantitative Results 3B: Interaction on Scores on SQ. Results of five parallel two-way ANOVAs (see Table 18), one for each of the demographic variables, indicated that there was one significant interaction on SQ scores: interaction between full/part time status and the total score on the concurrent MSLQ. Part-time students who reported medium MSLQ during the course scored the highest on summative quizzes, while part-time students who reported higher MSLQ during the course scored the lowest on summative quizzes (see Figure 10).

Table 18

Results of the two-way ANOVA on Scores on SQ (N= 142)

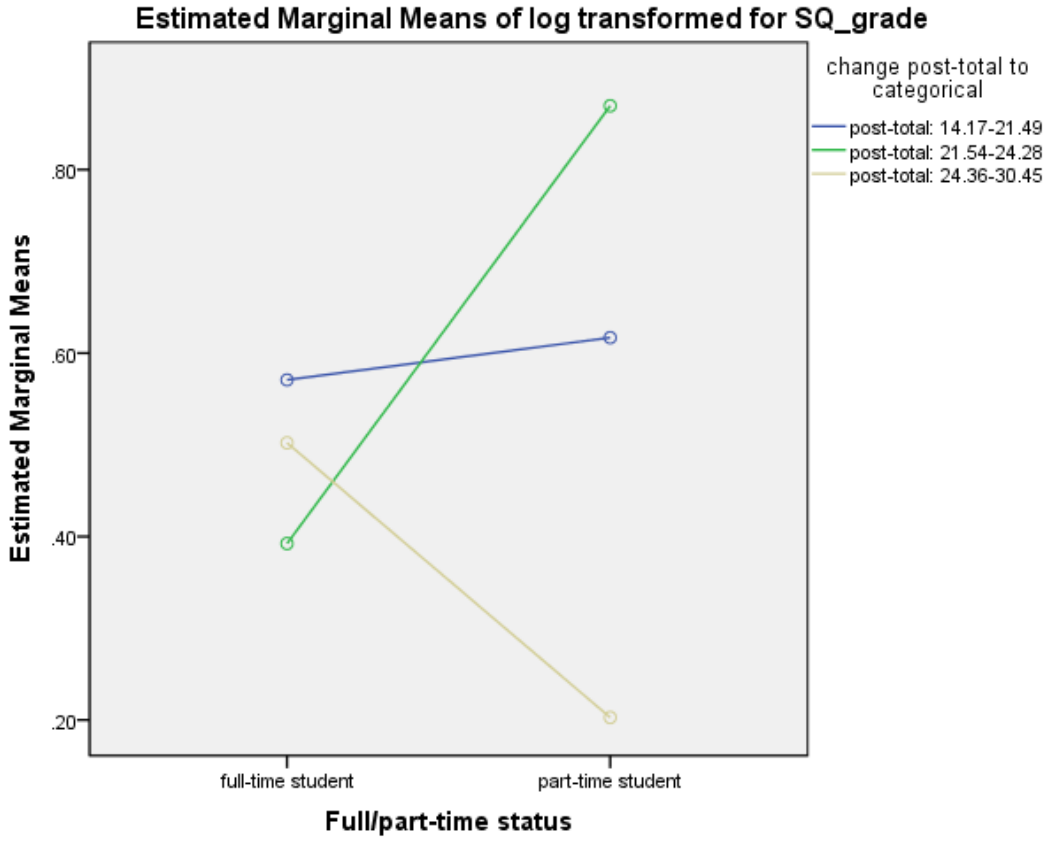
Variable	*df*	*MS*	*F*
Gender	1	.52	3.27
Concurrent MSLQ	2	.03	.21
Gender x Concurrent MSLQ	2	.02	.15
Error	136	.16	
Total	142		
Ethnicity	5	.22	1.45
Concurrent MSLQ	2	.09	.56
Ethnicity x Concurrent MSLQ	6	.27	1.80
Error	128	.15	
Total	142		
Full/part time status	1	.09	.59
Concurrent MSLQ	2	.51	**3.35***
Full/part time status x Concurrent MSLQ	2	.77	**5.08****
Error	136	.15	
Total	142		
Educational level	1	4.31	**32.88*****

Concurrent MSLQ	2	.10	.78
Educational level x Concurrent MSLQ	2	.03	.21
Error	136	.13	
Total	142		
Previous online experience	1	.01	.01
Concurrent MSLQ	2	.37	2.34
Previous online experience x Concurrent MSLQ	2	.29	1.83
Error	136	.16	
Total	142		

*p < .05. ** p < .01. ***p < .001

Figure 10

Interaction between full/part time status and the total score on MSLQ (Both Groups Combined)



Quantitative Results 3C: Difference between Undergraduate and Graduate Students. To explore the difference on the above effects between undergraduate and

graduate students, a series of parallel two-way ANOVAs were run using the data from undergraduate and graduate students.

Interaction on the Total Time Spent on FQ. For undergraduates and graduates separately, results of six parallel two-way ANOVAs, one for each of the demographic variables, indicated that there was no significant interaction between the total score on the concurrent MSLQ and any demographic variables (gender, age, ethnicity, full/part time status, faculty, previous online experience) on the total time undergraduate or graduate students spent on formative quizzes. Therefore, there was no difference in the interaction on time spent on FQ between undergraduate and graduate students.

Interaction on Scores on SQ. For undergraduates, results of six parallel two-way ANOVAs, one for each of the demographic variables, indicated that there were two significant effects of interactions on SQ scores (see Table 19): 1) Interaction between full/part time status and the total score on the concurrent MSLQ: Part-time undergraduate students who reported medium MSLQ during the course scored the highest on summative quizzes while part-time undergraduate students who reported higher MSLQ during the course scored the lowest on summative quizzes (see Figure 11). 2) Interaction between previous online experience and the total score on the concurrent MSLQ: Undergraduate students with previous online experience and who reported lower MSLQ during the course scored the highest on summative quizzes, while undergraduate students with previous online learning experience and who reported higher MSLQ during the course scored the lowest on summative quizzes (see Figure 12).

Table 19

Results of the two-way ANOVA on Undergraduates' Scores on SQ (N=129)

Variable	*df*	*MS*	*F*
Gender	1	.26	1.90
Concurrent MSLQ	2	.05	.34
Gender x Concurrent MSLQ	2	.02	.17
Error	123	.14	
Total	129		
Age	3	.42	**3.31***
Concurrent MSLQ	2	.16	1.27
Age x Concurrent MSLQ	6	.09	.69

Error	117	.13	
Total	129		
Ethnicity	4	.14	1.09
Concurrent MSLQ	2	.11	.89
Ethnicity x Concurrent MSLQ	5	.26	2.04
Error	117	.13	
Total	129		
Full/part time status	1	.12	.95
Concurrent MSLQ	2	.43	**3.35***
Full/part time status x Concurrent MSLQ	2	.49	**3.77***
Error	123	.13	
Total	129		
Faculty	3	.10	.75
Concurrent MSLQ	2	.17	1.20
Faculty x Concurrent MSLQ	3	.07	.48
Error	120	.14	
Total	129		
Previous online experience	1	.19	1.45
Concurrent MSLQ	2	.59	**4.53***
Previous online experience x Concurrent MSLQ	2	.43	**3.35***
Error	123	.13	
Total	129		

*$p < .05$.

Figure 11

Interaction between full/part time status and the total score on MSLQ (Undergraduates)

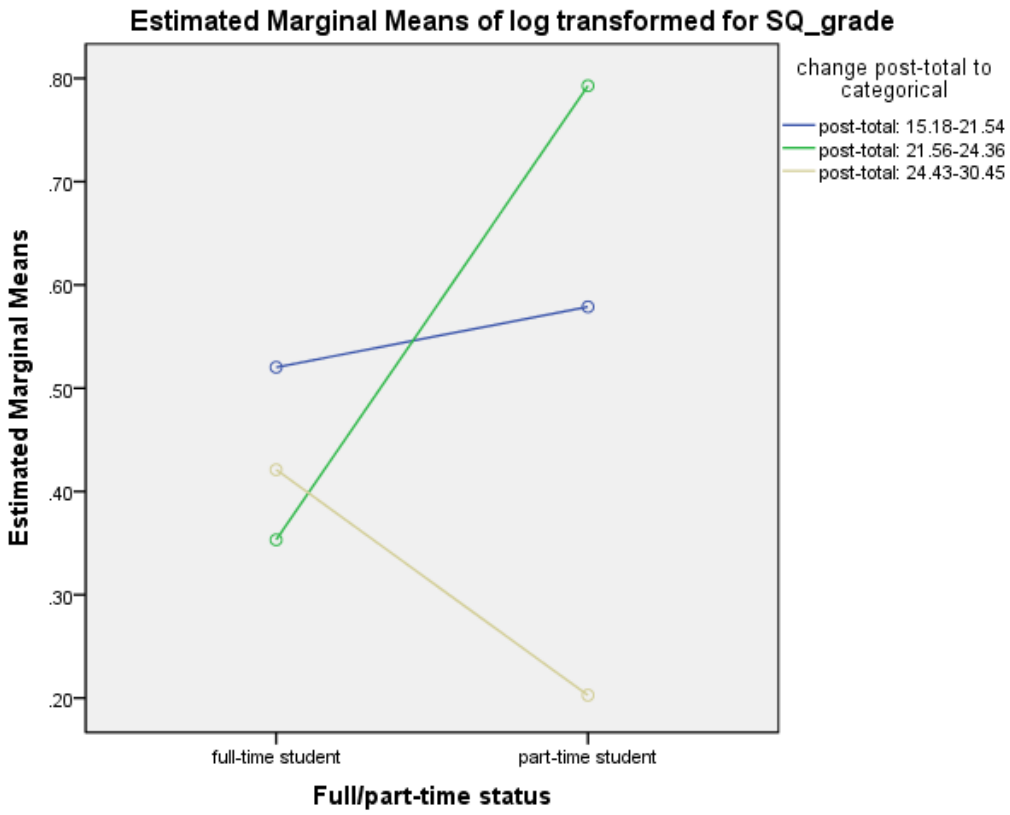
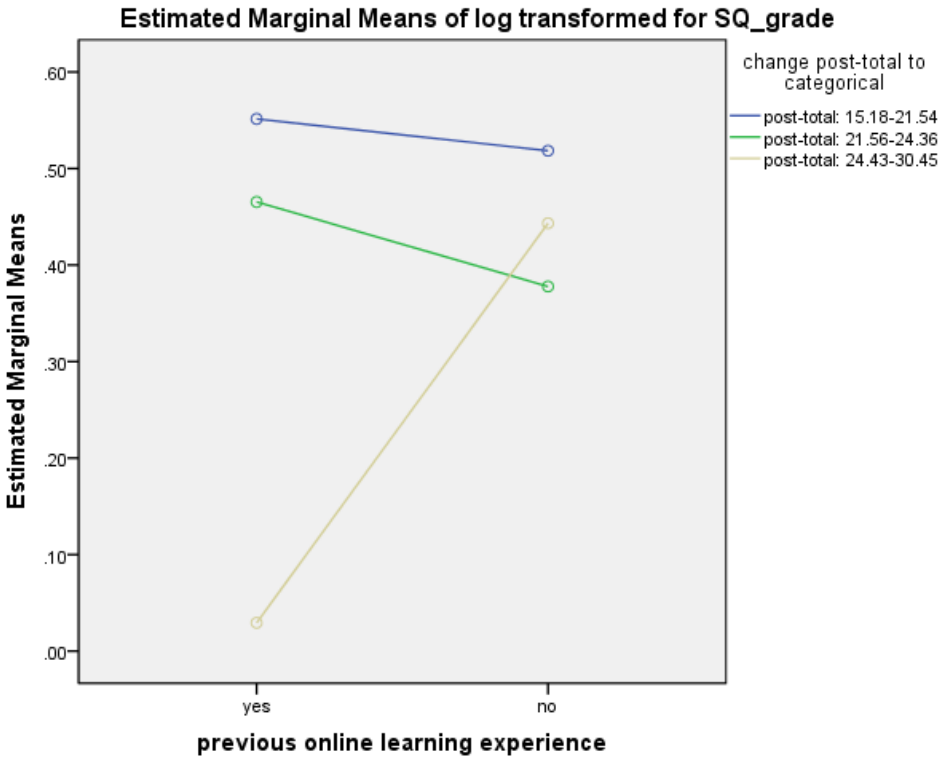


Figure 12

Interaction between previous online experience and the total score on MSLQ (Undergraduates)



However, results of six parallel two-way ANOVAs, one for each of the demographic variables of graduate students, indicated there was no significant interaction between the total score on the concurrent MSLQ and any variable from demographic variables on SQ scores.

Summary of Significant Effects of RQ 3. There was no significant interaction between the total score on the MSLQ during the course and any demographic variables on students' effort on formative assessment (measured by time on task) in undergraduate students, graduate students or in the two groups combined.

As to the interaction on scores on summative quizzes, the significant interaction between full/part time status and the total score on the MSLQ during the course was found in both undergraduate students and the two groups combined: Part-time students who reported medium MSLQ during the course scored the highest on summative quizzes while part-time students who reported higher MSLQ during the course scored the lowest on summative quizzes. In addition, there was one more significant interaction on scores on summative quizzes in the results from undergraduate students: interaction between previous online experience and the total score on the MSLQ during the course. Undergraduate students with previous online experience and who reported lower MSLQ during the course scored the highest on summative quizzes, while undergraduate students with previous online learning experience and who reported higher MSLQ during the course scored the lowest on summative quizzes.

Qualitative Results

Qualitative Results 3A: Interaction on the Total Time Spent on FQ. Consistent with the quantitative results that there was no significant interaction between the total scores on the MSLQ and any demographic variables, no participant in either undergraduate or graduate focus group mentioned.

Qualitative Results 3B: Interaction on Scores on SQ. The quantitative results revealed that there was significant interaction between full/part time status and the total score on the MSLQ on summative scores. Among four participants in the undergraduate focus group, three of them were full-time students while only one was part-time. Consistent with the quantitative results, the only part-time participant in the undergraduate focus group who reported medium MSLQ did score the highest on summative quizzes, "*I did really well in the quizzes"* (Tasha U). Among three full-time participants in the undergraduate focus group, the participant who reported the

lowest MSLQ got higher scores on summative quizzes than the one who reported the medium MSLQ. The quantitative results also revealed that there was significant interaction between previous online experience and the total score on the MSLQ on summative scores. Among four participants in the undergraduate focus group, two of them had previous online learning experience while the other two did not. Consistent with the quantitative results, the participant without previous online experience and who reported the lower MSLQ did score the highest on summative quizzes, "*I really I succeeded in this course"* (Ivana U). Surprisingly, the participants with previous online learning experience and who reported higher MSLQ scored high on summative quizzes, which showed the opposite pattern as the quantitative results.

Summary of RQ 3. The quantitative results revealed that there was no significant interaction between the total score on the MSLQ during the course and any demographic variables on students' effort on formative assessment in undergraduate students, graduate students or in the two groups combined. Consistent with the quantitative results, no participant in either focus group mentioned the interaction between their SRL and demographic variables. The quantitative results also revealed that there were two significant effects of interaction on summative scores: the interaction between full/part time status and the total score on the MSLQ and the interaction between previous online experience and the total score on the MSLQ. Consistent with the quantitative results, the part-time participant in the undergraduate focus group who reported medium MSLQ did score the highest on summative quizzes while the full-time participant who reported the lowest MSLQ got higher scores on summative quizzes than the one who reported the medium MSLQ. Next, the participant with no prior online experience and the lowest MSLQ scored the highest on summative quizzes. The focus group, on the other hand, revealed the opposite pattern: undergraduate participants with prior online learning experience and higher MSLQ performed well on summative quizzes.

Results of RQ 4: Prediction of Course Outcome

To predict students' course outcome, RQ 4 addressed what variables predicted successful academic outcome, as well as course satisfaction (see Table 20). The first step of addressing this research question was to compute simple correlations for both two criterion variables, students' final mark and self-reported course satisfaction and

the following predictor variables: the demographic variables (gender, age group, ethnicity, full/part time status, faculty, previous online learning experience), the total time students spent on formative quizzes, their scores on summative quizzes, and both predicted and concurrent SRL variables (total scores on the MSLQ and its five subscales). Results were computed separately for undergraduate and graduate students, as well as for the two groups combined.

Table 20

Predictor and Criterion Variables of Research Question 4

	Predictor Variables	Criterion Variables
RQ 4	Demographic variables Time spent on FQ Scores on SQ Total score on the MSLQ (both predicted and concurrent)	A. Final mark
	Demographic variables Time spent on FQ Scores on SQ Five subscales of the MSLQ (both predicted and concurrent)	
	Demographic variables Time spent on FQ Scores on SQ Total score on the MSLQ (both predicted and concurrent)	B. Course satisfaction
	Demographic variables Time spent on FQ Scores on SQ Five subscales of the MSLQ (both predicted and concurrent)	

Then, the next step of addressing this research question was to run a series of multiple regressions to determine whether the dependent variables of (a) final mark and (b) course satisfaction could be predicted by a set of above-mentioned predictor

variables. Because the total score on the MSLQ was a product of the MSLQ subscale scores, both the total MSLQ and the subscales could not be included in the same analysis. Therefore, two parallel multiple regression analyses were run: the first using the total score on the MSLQ (both predicted and concurrent) as predictors, the second using the five subscales of the MSLQ (both predicted and concurrent) as predictors. These multiple regressions were run using the data from both groups combined.

Quantitative Results

Table 21

Correlational Analysis on Final Marks (N = 142)

Variable		Final Marks
Demographic variables	Gender	-.15
	Ethnicity	.12
	Full/part time status	-.07
	Educational level	**.28****
	Previous online experience	.01
Time spent on FQ		**-.40*****
Scores on SQ		**.32*****
Predicted SRL variables	Predicted MSLQ	-.05
	Predicted interest	.07
	Predicted expectancy for success	-.02
	Predicted anxiety	-.16
	Predicted metacognitive strategies	-.01
	Predicted resource management	.03
Concurrent SRL variables	Concurrent MSLQ	-.01
	Concurrent interest	.12
	Concurrent expectancy	**.18***
	Concurrent anxiety	**-.27****
	Concurrent metacognitive strategies	-.02
	Concurrent resource management	.09

*$p < .05$. **$p < .01$. ***$p < .001$.

Quantitative Results 4A: Predictors of Final Marks. Results of simple correlations indicated that there was a significant negative relationship between the total time spent on formative quizzes and the final mark, as well as a significant positive relationship between scores on summative quizzes and the final mark (see Table 21). Students who spent less time on formative quizzes, or who scored higher on summative quizzes, achieved higher final marks. However, there was a significant negative relationship between the concurrent anxiety and the final mark, indicating that students who reported lower anxiety during the course achieved higher final marks than those who reported higher anxiety during the course. In addition, there were significant positive relationships between being the undergraduate student and final mark, and between the concurrent expectancy for success and the final mark. Undergraduate students achieved higher final marks than graduate students. Students who reported higher expectancy for success during the course achieved higher final marks than those who reported lower expectancy for success during the course.

Table 22

Summary of Multiple Regression Analyses Predicting Final Marks 1 (N = 142)

Variable		*B*	*SE B*	*β*	t
Demographic variables	Gender	.36	.34	.07	1.05
	Ethnicity	-.05	.05	-.07	-1.04
	Full/part time status	.16	.29	.04	.53
	Educational level	-2.27	.41	-.43	**-5.53*****
	Previous online experience	-.49	.24	-.14	**-2.01***
SRL variables	Predicted MSLQ	.06	.04	.12	1.41
	Concurrent MSLQ	-.03	.04	-.06	-.73
Time spent on FQ		2.55	.60	.31	**4.28*****
Scores on SQ		1.95	.28	.52	**6.90*****

*$p < .05$. **$p < .01$. ***$p < .001$

The first multiple regression used the set of demographic variables (gender, ethnicity, full/part time status, educational level, previous online learning experience), the total time students spent on formative quizzes, their scores on summative quizzes,

and the total scores on the predicted and concurrent MSLQ to predict students' final mark (see Table 22), R^2 = .435, F (9, 132) =11.31, p < .001, η_p^2= .435.

Table 23

Summary of Multiple Regression Analyses Predicting Final Marks 2 (N = 142)

	Variable	*B*	*SE B*	*β*	t
Demographic variables	Gender	.16	.36	.03	.45
	Ethnicity	-.04	.05	-.06	-.87
	Full/part time status	.17	.30	.04	.57
	Educational level	-1.80	.47	-.35	**-3.84*****
	Previous online experience	-.41	.25	-.12	-1.64
SRL variables	Predicted interest	.10	.14	.09	.72
	Predicted expectancy for success	-.21	.15	-.17	-1.41
	Predicted anxiety	-.02	.02	-.09	-.87
	Predicted metacognitive strategies	.01	.01	.02	.15
	Predicted resource management	.01	.01	.11	1.19
	Concurrent interest	-.01	.01	-.06	-.47
	Concurrent expectancy for success	.12	.15	.11	.86
	Concurrent anxiety	.03	.02	.16	1.67
	Concurrent metacognitive strategies	.01	.01	.07	.68
	Concurrent resource management	-.01	.01	-.08	-.91
Time spent on FQ		2.82	.63	.34	**4.45*****
Scores on SQ		1.94	.31	.52	**6.35*****

**p* < .05. ***p* < .01. ****p* < .001

The coefficient of determination indicated that 43.5% of the variance in the final mark can be accounted for by the set of predictors. There were four significant predictors for the final mark: educational level, the previous online experience, the total time students spent on formative quizzes, and their scores on summative quizzes. Compared to the results for undergraduate students, the only difference was that the educational level also significantly predicted the final mark, with undergraduate students having higher final marks than graduate students. Based on standardized coefficient, the scores on summative quizzes explained more of the variance in the final mark than other predictors.

The second multiple regression used the same set of predictors as the first, except that it used the five subscales of the MSLQ (interest, expectancy for success, anxiety, cognitive and metacognitive strategies, and resource management) rather than the total score on the MSLQ, to predict students' final mark (see Table 23), $R^2 = .481$, $F(17, 124) = 6.76$, $p < .001$, $\eta_p^2 = .481$. The coefficient of determination indicated that 48.1% of the variance in the final mark can be accounted for by the set of predictors, which was higher than the previous analysis. There were three significant predictors: the education level, the total time students spent on formative quizzes, and their scores on summative quizzes. Based on standardized coefficient, the scores on summative quizzes explained more of the variance in the final mark than other predictors.

Quantitative Results 4B: Predictors of Course Satisfaction. Simple correlation results for all participants indicated that there was a significant positive relationship between the concurrent expectancy for success and course satisfaction (see Table 24). The students who reported higher expectancy for success during the course reported higher course satisfaction.

Two parallel multiple regression were then conducted. The first multiple regression used the set of demographic variables, the total time students spent on formative quizzes, their scores on summative quizzes, and the total scores on the predicted and concurrent MSLQ to predict students' course satisfaction. As before, the regression model failed to predict students' course satisfaction, $F(9, 132) = 1.04$, $p = .412$.

The second multiple regression used the same set of predictors as the first, except that it used the five subscales of the MSLQ (interest, expectancy for success, anxiety, cognitive and metacognitive strategies, and resource management) rather than the

total score on the MSLQ, to predict students' course satisfaction. The regression model also failed to predict course satisfaction, F (17, 124) = 1.05, p = .410.

Table 24

Correlational Analysis on Course Satisfaction (N = 142)

Variable		Course Satisfaction
Demographic variables	Gender	-.02
	Ethnicity	.01
	Full/part time status	.07
	Educational level	-.06
	Previous online experience	-.03
Time spent on FQ		-.14
Scores on SQ		.07
Predicted SRL variables	Predicted MSLQ	.05
	Predicted interest	.05
	Predicted expectancy for success	.08
	Predicted anxiety	.02
	Predicted metacognitive strategies	.05
	Predicted resource management	-.05
Concurrent SRL variables	Concurrent MSLQ	.12
	Concurrent interest	.07
	Concurrent expectancy	**.17***
	Concurrent anxiety	-.01
	Concurrent metacognitive strategies	.15
	Concurrent resource management	.07

*p < .05. **p < .01

Quantitative Results 4C: Difference between Undergraduate and Graduate Students.

Predictors of Final Marks. For undergraduates, results of simple correlations indicated there were significant negative relationships between the concurrent anxiety and the final mark, and the total time spent on formative quizzes and the final mark. The undergraduate students who reported lower anxiety during the course achieved higher final marks than those who reported higher anxiety (see Table 25). The undergraduate students who spent more time on formative quizzes achieved lower

final marks than those who spent less time on formative quizzes. However, there was a positive relationship between scores on summative quizzes and the final mark. The undergraduate students with higher scores on summative quizzes achieved higher final marks than those with lower scores on summative quizzes.

Table 25

Correlational Analysis on Final Marks (N = 129)

Variable		Final Marks
Demographic variables	Gender	-.14
	Age	-.11
	Ethnicity	.09
	Full/part time status	-.10
	Faculty	-.08
	Previous online experience	.07
Time spent on FQ		**-.35*****
Scores on SQ		**.49*****
Predicted SRL variables	Predicted MSLQ	-.08
	Predicted interest	.03
	Predicted expectancy for success	-.06
	Predicted anxiety	-.15
	Predicted metacognitive strategies	-.07
	Predicted resource management	.06
Concurrent SRL variables	Concurrent MSLQ	.01
	Concurrent interest	.09
	Concurrent expectancy	.14
	Concurrent anxiety	**-.19***
	Concurrent metacognitive strategies	-.07
	Concurrent resource management	.12

*p < .05. **p < .01. ***p < .001

Two parallel multiple regression were then conducted. The first multiple regression used the set of demographic variables, the total time students spent on formative quizzes, their scores on summative quizzes, and the total scores on the predicted and concurrent MSLQ to predict students' final mark (see Table 26), R^2 = .385, F (10, 118) =7.38, p < .001, η_p^2= .385. The coefficient of determination

indicated that 38.5% of the variance in the final mark can be accounted for by the set of three predictors: previous online experience, the total time students spent on formative quizzes, and their scores on summative quizzes. Higher final marks were predicted by more previous online experience, more time spent on formative quizzes, and higher scores on summative quizzes. Based on standardized coefficient, the scores on summative quizzes explained more of the variance in the final mark than other predictors.

Table 26

Summary of Multiple Regression Analyses Predicting Final Marks for Undergraduates 1 (N = 129)

Variable		*B*	*SE B*	*β*	t
Demographic variables	Gender	.26	.38	.05	.70
	Age	-.09	.12	-.07	-.80
	Ethnicity	-.05	.05	-.07	-.93
	Full/part time status	.25	.34	.06	.73
	Faculty	.15	.20	.06	.78
	Previous online experience	-.60	.28	-.16	**-2.11***
SRL variables	Predicted MSLQ	.08	.05	.15	1.64
	Concurrent MSLQ	-.03	.04	-.06	-.68
Time spent on FQ		2.58	.63	.31	**4.08*****
Scores on SQ		1.96	.31	.48	**6.26*****

*$p < .05$. **$p < .01$. ***$p < .001$

The second multiple regression used the same set of predictors as the first, except that it used the five subscales of the MSLQ (interest, expectancy for success, anxiety, cognitive and metacognitive strategies, and resource management) rather than the total score on the MSLQ, to predict students' final mark (see Table 27), $R^2 = .437$, $F(18, 110) = 4.72$, $p < .001$, $\eta_p^2 = .437$. The coefficient of determination indicated that 43.7% of the variance in the final mark can be accounted for by the set of predictors,

which was higher than the previous analysis. However, there were only two significant predictors: the total time students spent on formative quizzes and the scores on summative quizzes. The results were consistent with the previous analysis. Based on standardized coefficient, the scores on summative quizzes explained more of the variance in the final mark than the total time spent on formative quizzes.

Table 27

Summary of Multiple Regression Analyses Predicting Final Marks for Undergraduates 2 (N = 129)

Variable		*B*	*SE B*	*β*	t
Demographic variables	Gender	.07	.39	.02	.19
	Age	-.06	.12	-.04	-.47
	Ethnicity	-.04	.05	-.05	-.70
	Full/part time status	.28	.36	.06	.77
	Faculty	.16	.20	.06	.79
	Previous online experience	-.47	.29	-.13	-1.64
SRL variables	Predicted interest	.98	1.39	.09	.71
	Predicted expectancy for success	-1.61	1.35	-.17	-.1.19
	Predicted anxiety	-.09	.12	-.08	-.73
	Predicted metacognitive strategies	.14	.22	.07	.63
	Predicted resource management	.16	.21	.08	.77
	Concurrent interest	-.18	.21	-.12	-.87
	Concurrent expectancy for success	.34	1.30	.04	.26

	Concurrent anxiety	.19	.10	.18	1.79
	Concurrent metacognitive strategies	.16	.19	.09	.84
	Concurrent resource management	-.21	.20	-.11	-1.07
Time spent on FQ		2.89	.68	.35	**4.27*****
Scores on SQ		1.84	.34	.45	**5.36*****

*p < .05. **p < .01. ***p < .001

Different from undergraduate students, simple correlation results for graduate students only found a significant positive relationship between scores on summative quizzes and final mark (see Table 28). The graduate students with higher scores on summative quizzes achieved higher final marks than those with lower scores on summative quizzes.

Table 28

Correlational Analysis on Final Marks (N = 13)

Variable		Final Marks
Demographic variables	Gender	-.56
	Age	-.42
	Ethnicity	-.03
	Full/part time status	.15
	Faculty	-.18
	Previous online experience	-.05
Time spent on FQ		.01
Scores on SQ		**.98*****
Predicted SRL variables	Predicted MSLQ	.32
	Predicted interest	.21
	Predicted expectancy for success	.50
	Predicted anxiety	.15
	Predicted metacognitive strategies	.38
	Predicted resource management	-.29

Concurrent SRL variables	Concurrent MSLQ	.29
	Concurrent interest	.26
	Concurrent expectancy for success	.52
	Concurrent anxiety	.11
	Concurrent metacognitive strategies	.32
	Concurrent resource management	-.29

*p < .05. **p < .01. ***p < .001.

Predictors of Course Satisfaction. For undergraduates, results of simple correlations indicated there were significant positive relationships between the predicted interest and course satisfaction, between the predicted expectancy for success and course satisfaction, between the total score on the concurrent MSLQ and course satisfaction, between the concurrent interest and course satisfaction, between the concurrent expectancy for success and course satisfaction, between the concurrent metacognitive strategies and course satisfaction, between the concurrent resource management and course satisfaction (see Table 29). The undergraduate students who predicted higher interest, or higher expectancy for success before the course, and who reported higher MSLQ, higher interest, or higher expectancy for success, or greater use of cognitive and metacognitive strategies during the course reported higher course satisfaction. However, there was a significant negative relationship between the predicted anxiety and course satisfaction, indicating that undergraduate students who reported lower anxiety before the course reported higher course satisfaction than those who reported higher anxiety before the course.

Table 29

Correlational Analysis on Course Satisfaction (N = 129)

Variable		Course Satisfaction
Demographic variables	Gender	-.18
	Age	-.01
	Ethnicity	-.16
	Full/part time status	.01
	Faculty	-.12
	Previous online experience	.02
Time spent on FQ		-.01
Scores on SQ		.15

Predicted SRL variables	Predicted MSLQ	.16
	Predicted interest	**.33*****
	Predicted expectancy for success	**.28****
	Predicted anxiety	**-.25****
	Predicted metacognitive strategies	.15
	Predicted resource management	.11
Concurrent SRL variables	Concurrent MSLQ	**.35*****
	Concurrent interest	**.48*****
	Concurrent expectancy	**.49*****
	Concurrent anxiety	-.15
	Concurrent metacognitive strategies	**.17***
	Concurrent resource management	**.29****

**p* < .05. ***p* < .01. ****p* < .001.

Table 30

Summary of Multiple Regression Analyses Predicting Course Satisfaction for Undergraduates1 (N = 129)

	Variable	*B*	*SE B*	*β*	t
Demographic variables	Gender	-1.02	.93	-.10	-1.09
	Age	.05	.29	.02	.16
	Ethnicity	-.19	.13	-.13	-1.48
	Full/part time status	-.11	.18	-.05	-.60
	Faculty	-.70	.49	-.12	-1.43
	Previous online experience	.33	.70	.04	.47
SRL variables	Predicted MSLQ	-.11	.12	-.10	-.94
	Concurrent MSLQ	.36	.10	.37	**3.58****
Time spent on FQ		-.74	1.56	-.04	-.47
Scores on SQ		-.90	.78	-.10	-1.15

**p* < .05. ***p* < .01.

Two parallel multiple regression were then conducted. The first multiple regression used the set of demographic variables, the total time students spent on formative quizzes, their scores on summative quizzes, and the total scores on the predicted and concurrent MSLQ to predict students' course satisfaction (see Table 30), R^2 = .185, F (10, 118) = 2.68, p = .006, η_p^2= .185. The coefficient of determination indicated that 18.5% of the variance in course satisfaction can be accounted for by the set of predictors. There was one significant predictor for course satisfaction: the total score on the concurrent MSLQ, indicating that undergraduate students who reported higher MSLQ during the course reported higher course satisfaction than those who reported lower MSLQ during the course.

Table 31

Summary of Multiple Regression Analyses Predicting Course Satisfaction for Undergraduates 2 (N = 129)

	Variable	*B*	*SE B*	*β*	t
Demographic variables	Gender	-.09	.88	-.01	-.10
	Age	-.04	.27	-.01	-.15
	Ethnicity	-.11	.12	-.07	-.94
	Full/part time status	.81	.82	.09	.98
	Faculty	-.57	.46	-.10	-1.24
	Previous online experience	.05	.65	.01	.08
SRL variables	Predicted interest	-4.78	3.16	-.21	-1.52
	Predicted expectancy for success	1.41	3.05	.07	.46
	Predicted anxiety	-.24	.28	-.10	-.86
	Predicted metacognitive strategies	-.18	.49	-.05	-.37
	Predicted resource management	-.15	.47	-.04	-.32
	Concurrent interest	1.26	.47	.40	**2.67****
	Concurrent expectancy for success	-2.30	2.95	-.12	-.78
	Concurrent anxiety	-.40	.24	-.18	-1.71

	Concurrent metacognitive strategies	-.80	.44	-.22	-1.84
	Concurrent resource management	.75	.45	.18	1.68
Time spent on FQ		-.29	1.53	-.02	-.19
Scores on SQ		.29	.78	.03	.37

*$p < .05$. **$p < .01$.

The second multiple regression used the same set of predictors as the first, except that it used the five subscales of the MSLQ (interest, expectancy for success, anxiety, cognitive and metacognitive strategies, and resource management) instead of the total score on the MSLQ, to predict students' course satisfaction (see Table 31), $R^2 = .374$, F (18, 110) = 3.66, $p < .001$, $\eta_p^2 = .374$. The coefficient of determination indicated that 37.4% of the variance in course satisfaction can be accounted for by the set of predictors, which was higher than the previous analysis. There was only one significant predictor: concurrent interest. The undergraduate students who reported higher interest during the course reported higher course satisfaction than those who reported lower interest during the course.

Different from undergraduates, simple correlation results for graduate students indicated that there were significant positive relationships between the concurrent interest and course satisfaction, between the concurrent expectancy for success and course satisfaction, and between the concurrent metacognitive strategies and course satisfaction (see Table 32). The graduate students who reported higher interest, higher expectancy for success, greater use of cognitive and metacognitive strategies during the course reported higher course satisfaction than those with lower scores on the above variables.

Table 32

Correlational Analysis on Course Satisfaction (N = 13)

Variable		Course Satisfaction
Demographic variables	Gender	-.01
	Age	-.22
	Ethnicity	-.18
	Full/part time status	-.09
	Faculty	.34

	Previous online experience	.29
Time spent on FQ		.06
Scores on SQ		.03
Predicted SRL variables	Predicted MSLQ	.52
	Predicted interest	.45
	Predicted expectancy for success	.38
	Predicted anxiety	.50
	Predicted metacognitive strategies	.38
	Predicted resource management	-.06
Concurrent SRL variables	Concurrent MSLQ	.51
	Concurrent interest	**.57***
	Concurrent expectancy for success	**.72****
	Concurrent anxiety	.06
	Concurrent metacognitive strategies	**.60***
	Concurrent resource management	-.09

*$p < .05$. **$p < .01$

Summary of Significant Effects of RQ 4. For all participants, results of the multiple regression indicated that there were four significant predictors for the academic outcome. Three of those predictors were consistent with the results for undergraduate students: previous online experience, students' effort on formative assessment (measured by time on task), and their scores on summative quizzes. One more significant predictor was found in the two groups combined, which was that undergraduate students had higher final marks than graduate students. For graduate students, however, there was only one significant predictor of academic outcome: summative quiz scores.

Although there was no significant predictor for the combined undergraduate and graduate group, there was one for undergraduates' course satisfaction: total MSLQ score during the course, indicating that undergraduate students who reported higher MSLQ during the course reported higher level of course satisfaction. Multiple regression results also revealed that undergraduate students who expressed more interest in the course reported higher levels of satisfaction with the course. Different from undergraduate students, graduate students who reported higher interest, higher

expectancy for success, and greater use of cognitive and metacognitive strategies during the course reported higher course satisfaction.

Qualitative Results

Qualitative Results 4A: Predictors of Final Marks. For undergraduates, consistent with the quantitative results that there was significant negative relationship between the concurrent anxiety and the final mark. Three participants in the undergraduate focus group reported that the less the anxiety they have, the higher the final mark was. For example, Ahmed U said, "*you have like less anxiety before answering the final exam…is gonna lead to the good grades in the final for sure"*. Consistent with the quantitative results that undergraduates who scored higher on summative quizzes achieved higher final marks, three participants in the undergraduate focus group commented that, "*I think it (summative quiz) is a good predictor for the final. I think if I did them, perhaps I would realize what exactly I should focus for the final so by doing so. I think It did help getting good grades"* (Kathy U). Ahmed U added, "*the (summative) quizzes and the final exam have the same style. So this is like the first thing which is good."* Tasha concluded, "*I did really well in the (summative) quizzes. And I felt like it did give a good relation and toward my final grades from the final exam... the quizzes were done one specific way and the final exam was done another way, so that wasn't any difference…the question stays the same so as long as you think you need the material like everything did correlate well."* Consistent with the quantitative results that undergraduates who had previous online experience achieved higher final marks, two participants in the undergraduate focus group had previous online learning experience and both commented that this online learning experience was better than the previous one and achieve good marks on final exam. The quantitative results revealed that undergraduates who spent more time on formative quizzes achieved higher final marks, two partcipants in the undergraduate focus group reported that, "*those quizzes you have enough time to go and think. So this is gonna give you more time to practice and practice is gonna lead to the good grades in the final for sure…If you spend more time, you will get a little bit grade. It is like that it makes sense"* (Ahmed U). Tasha U also added, "*I still put in the extra time through all the materials and I made extra notes on the side. I read all the (formative) quizzes several times. So that I think that helps reflect the time, extra time I did put in... I felt I already put lots of time into the class, extra time put into it. But yeah, that's it. There's enough (final) grade."* However, there was a significant

negative relationship between the total time spent on formative quizzes and the final mark. Among four participants in the undergraduate focus group, Ivana U was the one who spent the most time on formative quizzes and her final exam was the lowest. She commented that she struggled with the online course because she did not have previous online experience, "*I think it also depends on the course. I have never done statistics course like this. If it wasn't online course, maybe I would have spent less time and still get a grade, a better mark, a better grade."*

For graduates, consistent with the quantitative results that there was a significant positive relationship between the score on summative quizzes and the final mark, all four participants in the graduate focus group with higher scores on summative quizzes achieved higher final marks.

Qualitative Results 4B: Predictors of Course Satisfaction.

Undergraduates. The quantitative results revealed that students' total score on MSLQ was the significant predictor for the course satisfaction. Consistent with the quantiative result, the participant who had the lowest score on the MSLQ reported the lowest course satisfaction while the one who had the highest score on the MSLQ reported the highest course satisfaction. Among all four partcipants in the undergraduate focus group, the higher the total score on the concurrent MSLQ they reported, the higher the course satisfaction they had. Consistent with the quantitative results that students' concurrent interest was the significant predictor for the course satisfaction, three participants with more interest reported higher course satisfaction, "*I really enjoy doing those online quizzes. I thought there were extremely helpful doing like the modules and keep following immediately with quizzes with what I am getting and what I am not understanding…But in general, I really did enjoy doing the class online"* (Tasha U).

Consistent with the quantitative results that there was the significant positive relationship between the concurrent expectancy for success and course satisfaction, two participants in the undergraduate focus group mentioned that concurrent expectancy for success. As Ahmed U commented, he had higher expectancy for success and also reported higher course satisfaction, "*so we have all the grades of those quizzes and in most cases you got a good grade in them."* However Ivana U who reported lower expectancy for success reported lower course satisfaction, "*If it wasn't online course, maybe I would have spent less time and still get a grade, a better mark, a better grade."*

Consistent with the quantitative results that there was the significant positive relationship between the concurrent metacognitive strategies and course satisfaction, all four participants in the undergraduate focus group commented that the greater use of cognitive and metacognitive strategies they had, the higher the course satisfaction they had, "*I think that the online (formative) quizzes in the way were both helpful, and you know keeping you on pace but also really helping to see what concepts you were missing… it (foramtive quiz) is a check-in in the moment"* (Kathy U). Tasha U added, "*I really enjoy doing those online (formative) quizzes. I thought there were extremely helpful doing like the modules and keep following immediately with quizzes with what I am getting and what I am not understanding…I really did enjoy doing the class online."* Ahmed U concluded by "*it (formative quiz) is a good tool. In the fact that you can use them to know any knowledge gap that you have. And you can work more on that…. when you are like going through maybe like some titles, it this is gonna consolidate your knowledge before you go to another title. That was like very helpful…every time you pass like another quiz, another item of the quiz, equation is slightly different, which is gonna permit you to go throw all the stuff that you just yourself...Always the feedback is helpful and useful in any learning process…The feedback is gonna help you to understand and consolidate your learning in that, in that question, that specific question…you are gonna access your knowledge before you go to the next part because in most cases the next part is gonna be like based on the first part. So at least you make sure that your knowledge is about that part is perfect before you go to the next."*

Consistent with the quantitative results that there was the significant positive relationship between the concurrent resource management skills and course satisfaction, all four participants in the undergraduate focus group commented that the greater use of resource management skills they had, the higher the course satisfaction they had. Three participants were satisfied with the online course by using help seeking, "*I like the support on the discussion board … we could ask any question and we always have support from the team, from the professor and it was really helpful, especially for the modules and for the final exam too. I think thanks to that too, I really I succeeded in this course….. It was really the first source of information for me in the discussion. That's why why I I posted my questions and people answered. Really helps me understand the material that I didn't understand"* (Ivana U). Kathy U added, "*I think the discussion board was very helpful. And i think the open forum and*

those you know judgment you could place whatever kind of level questions you wanted. I think their response rate was very helpful. And your guys always got back so quickly or peers got back so quickly. So anyway it's great." Ahmed U concluded, "*there was also the discussion forum which which is very helpful. Especially to help each other and stand more and answer more questions for the quizzes. This you know, it's a good tool. In the fact that you can use them to know any knowledge gap that you have. And you can work more on that."* One participant was satisfied with this online course by using peer learning, "*I have the study group with my friends… it was really very helpful"* (Ivana U). Three participants regulated their time and made more effort, "*I like that I was able to set up my own pace. I think that the online quizzes in the way were both helpful, and you know keeping you on pace but also really helping to see what concepts you were missing"* (Kathy U). Tasha U added, "*I did like I could go on my own pace and material with very well review. I think the video recording as well. I only looked to one ever and I didn't find it helpful so I never looked back at that… in general, I really did enjoy doing the class online."* Ahmed U also commented, " *It was very useful that you can take the course whenever you want. So you can like, you see no one forces you to come at 8 in the morning just for class, which is a good thing. Especially if you, if you live far, and you can take the course when let's say, you like prepare for it. And you are like ready to take it which is a good thing… I performed very well in such online courses than traditional courses…that reason I prefer like those online courses because also sometimes three hours is is really too much you know for the concentration and focus all the time. So having your own pace is very is very helpful. It's at least you know that you are in your best brain shape to go through the module."*

The quantitative results revealed that there was a significant negative relationship between the predicted anxiety and course satisfaction and there were significant positive relationships between the predicted interest and course satisfaction, between the predicted expectancy for success and course satisfaction. However, no participant in the undergraduate focus group mentioned that.

Graduates. Consistent with the quantitative results that there was the significant positive relationship between the concurrent interest and course satisfaction, one participant in the graduate focus group had higher interest and reported higher course satisfaction, "*I enjoy the material. I enjoy being able to read the book and do activities on my own time. So there was nothing I didn't like it…I enjoyed it. Like*

whenever I didn't feel like writing on, working on my study or I also work full time. So whenever I needed a break, I just did stats cuz I have done it and I found it interesting so you know I find the whole thing engaging" (Coleen G). However another participant in the graduate focus group had lwoer interest and reported lower course satisfaction, "*I still didn't feel like being rewarded for the amount of time that I spent in actually learning it as supposed to…I feel like the amount I spent on those comparing my actual coursework, it is the frustrating part. So it's like definitely at the end your motivation is down. And you are just doing the question with the sick of getting them done"* (Maryam G).

Consistent with the quantitative results that there was the significant positive relationship between the concurrent expectancy for success and course satisfaction, one participant in the graduate focus group had higher expectancy for success and reported higher course satisfaction, "*we use the formative and summative evaluation. I was out to get an A and make sure I just worked towards it"* (Coleen G).

Consistent with the quantitative results that there was the significant positive relationship between the concurrent metacognitive strategies and course satisfaction, two participants in the graduate focus group commented that they used different cognitive and metacognitive strategies, "*I really like it (the online course)…formative I think I learned is to work harder independently with more focus*" (Coleen G). Sita G added, "*there is benefits. So I can after receiving the feedback, so I'll be doing. I will be learning each every step. while I do the formative so I can it is it's so helpful so I can actually I do take a screenshot when I'm doing my formative. I will go through it. So it would helpful for me. "*

Summary of RQ 4. For all participants, combining both undergraduate and graduate students, the results of the multiple regression indicated that there were four significant predictors for the academic outcome. One of those predictors was consistent with the results for both undergraduate and graduate students: students' scores on summative quizzes. Consistent with the quantitative results, three participants in the undergraduate focus group stated that they achieved higher final marks by scoring higher on summative quizzes, and all four participants in the graduate focus group with higher scores on summative quizzes achieved higher final marks. Two of those predictors were consistent with the results for undergraduate students: previous online experience and time spent on formative assessment. Two participants in the undergraduate focus group who had previous online learning

experience both commented that this online learning experience was better than the previous one and they achieved good marks on final exam, and two partcipants in the undergraduate focus group reported that they spent more time on formative quizzes and achieved higher final marks. One more significant predictor was only found in the two groups combined, which was that undergraduate students had higher final marks than graduate students.

In terms of the predictors of course satisfaction, there were no significant results for the combined undergraduate and graduate group. However, results of the multiple regression indicated that there was one significant predictor for undergraduate students: the total score on the concurrent MSLQ. Consistent with the quantiative result, the participant in the undergraduate focus group who had the lowest score on the MSLQ reported the lowest course satisfaction while the one who had the highest score on the MSLQ reported the highest course satisfaction. Among the subscales of concurrent MSLQ, students' concurrent interest was the significant predictor for the course satisfaction. Consistent with the quantitative results, three participants in the undergraduate focus group with more interest reported higher course satisfaction.

As to the predictors of course satisfaction for graduate students, results of simple correlation indicated that there were significant positive relationships between the concurrent interest and course satisfaction, between the concurrent expectancy for success and course satisfaction, and between the concurrent metacognitive strategies and course satisfaction. Consistent with the quantitative results, one participant in the graduate focus group who had higher interest reported higher course satisfaction. Consistent with the quantitative results, one participant in the graduate focus group who had higher expectancy for success reported higher course satisfaction. Consistent with the quantitative results, two participants in the graduate focus group commented that they reported higher course satisfaction by using different cognitive and metacognitive strategies.

Results of RQ 5: Perception of Online Quizzes

To determine whether undergraduate and graduate students showed different patterns in their perceptions of online formative and summative quizzes, RQ 5 addressed whether there were significant differences between undergraduate and graduate students on the following variables: the usefulness, the purpose, the

effectiveness of feedback, the item-design, the effect on SRL, and the completion of formative and summative quiz.

A series of one-way repeated measured ANOVAs, using the SPSS General Linear Model command (to account for differences in sample size), was carried out such that the educational level (undergraduate versus graduate) was used as the independent variable to predict: (a) the usefulness; (b) the purpose; (c) the effectiveness of feedback; (d) the item-design; (e) the effect on SRL; and (f) the % completion of two kinds of quizzes (see Table 33).

Table 33

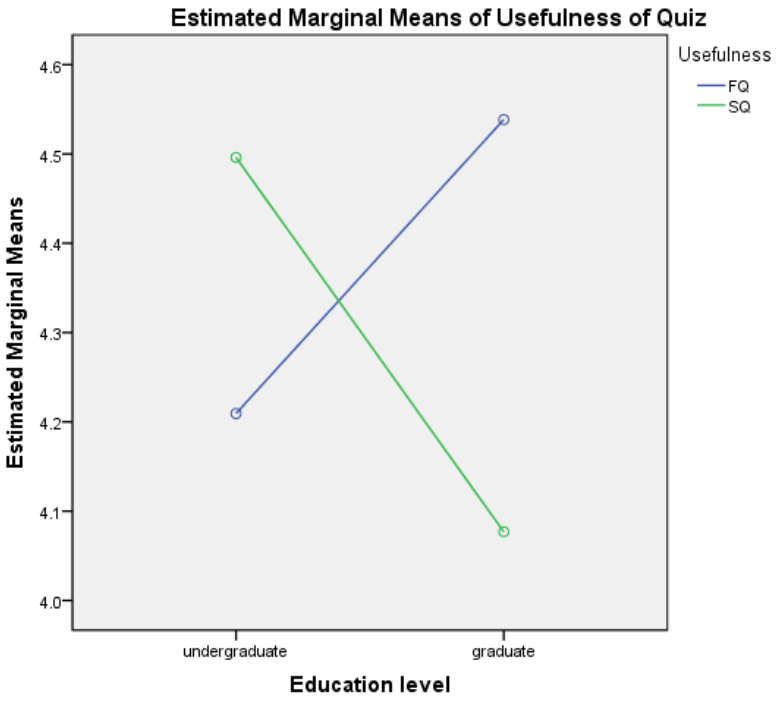
Independent and Dependent Variables of Research Question 5

	Between-subject Variables	Within-subjects: 2 kinds of Quizzes
RQ 5	Educational level (Undergraduate versus graduate)	A. Usefulness of Quiz
		B. Purpose of Quiz
		C. Effectiveness of Feedback
		D. Item-design of Quiz
		E. Effect of Quiz on SRL
		F. Completion of Quiz

Quantitative Results

Figure 13

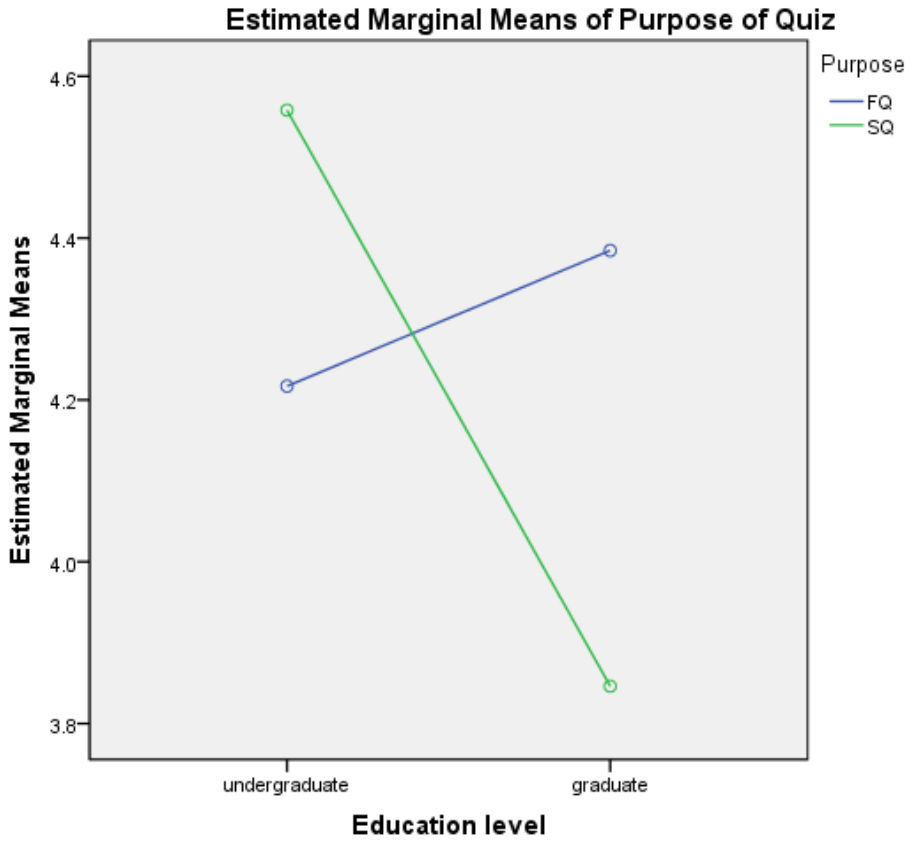
Difference on Usefulness of Quiz



Quantitative Results 5A: Difference on Usefulness of Quiz. Results of the one-way repeated measured ANOVA indicated that there was a significant interaction (F (1, 140) =7.41, p = .006, η_p^2= .05). Undergraduate and graduate students showed completely different patterns (see Figure 13). Paired sample t-tests were run separately for undergraduate and graduate students which showed that there were significant differences between their perceptions on the usefulness of FQ and SQ. For the graduate, a paired sample t-test found the difference to be significant (t (12) = 2.52, p = .027, Cohen's d =.79). Results showed that graduate students found formative quizzes more useful than summative quizzes (M = 4.54, SD = .52 vs. M = 4.08, SD = .64, respectively). For the undergraduate, the reverse was true: a paired sample t-test found the difference to be significant (t (128) = -3.45, p = .001, Cohen's d =.38), indicating that undergraduate students found summative quizzes more useful than formative quizzes (M = 4.50, SD = .66 vs. M = 4.21, SD = .87, respectively).

Figure 14

Difference on Purpose of Quiz

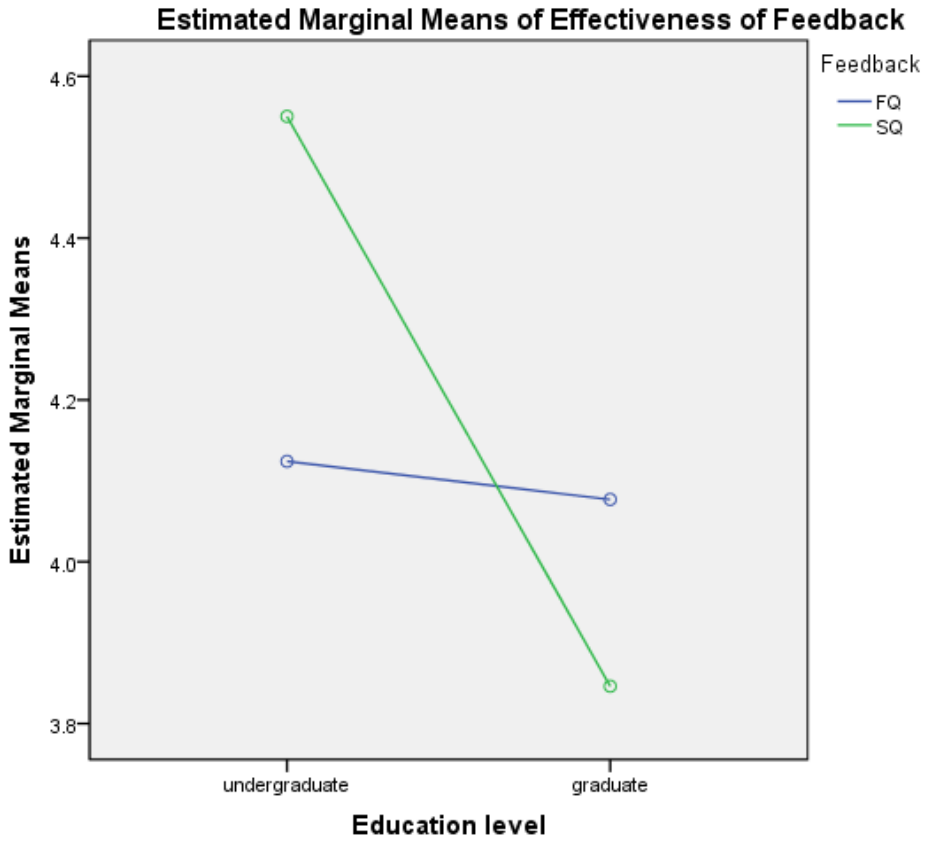


Quantitative Results 5B: Difference on Purpose of Quiz. Results of the one-way repeated measured ANOVA indicated that there was a significant interaction (F (1, 140) =11.20, p = .001, η_p^2= .07). Undergraduate and graduate students showed

completely different patterns (see Figure 14). Paired sample *t*-tests were run separately for undergraduate and graduate students which showed that there were significant differences between their perceptions on the purposes of FQ and SQ. For the graduate, a paired sample *t*-test found the difference to be significant (*t* (12) = 2.50, p = .028, Cohen's *d* =.87). Results showed that graduate students found formative quizzes was better at directing their learning than summative quizzes (M = 4.38, SD = .51 vs. M = 3.85, SD = .69, respectively). For the undergraduate, the reverse was true: a paired sample *t*-test found the difference to be significant (*t* (128) = -4.24, p < .001, Cohen's *d* =.44), indicating that undergraduate students found summative quizzes were better than directing their learning than formative quizzes (M = 4.56, SD = .62 vs. M = 4.22, SD = .89, respectively).

Figure 15

Difference on Effectiveness of Feedback

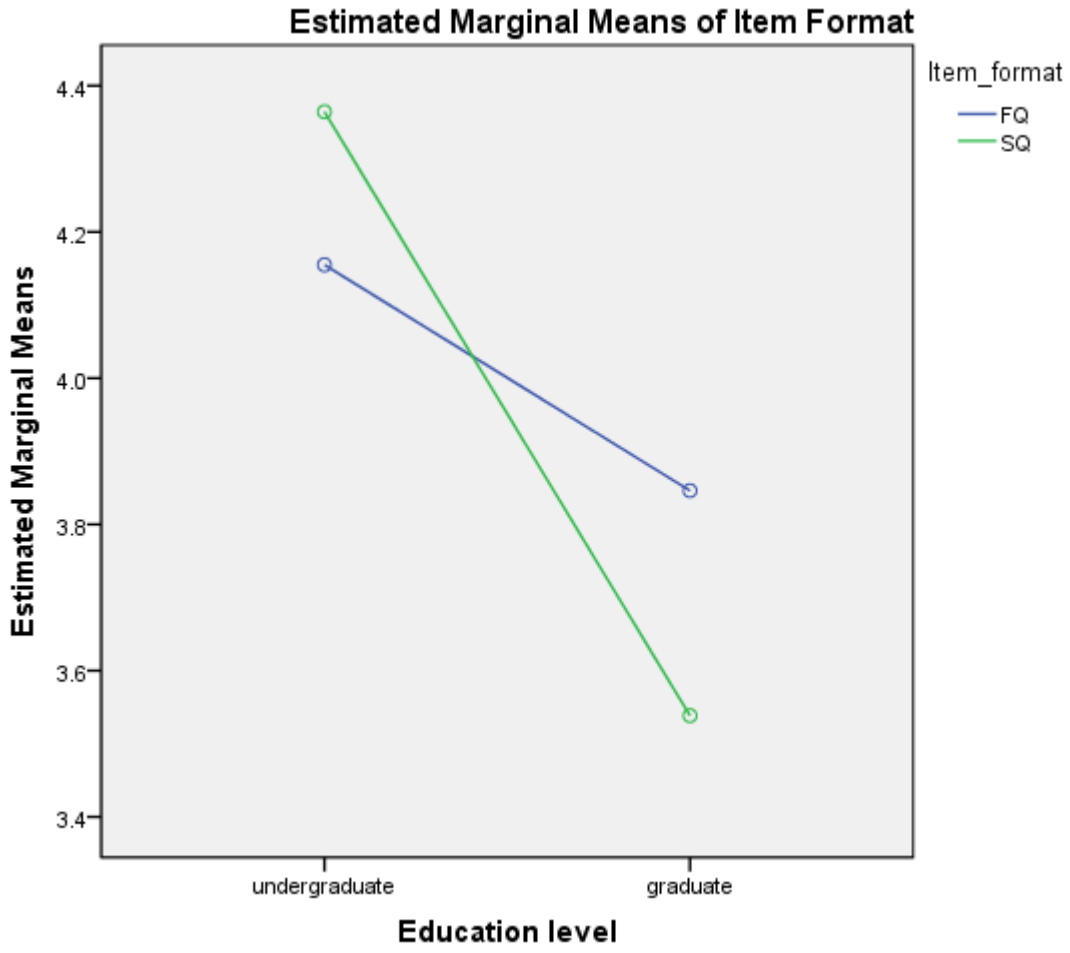


Quantitative Results 5C: Difference on Effectiveness of Feedback. Results of the one-way repeated measured ANOVA indicated that there was a significant interaction (*F* (1, 140) =8.72, *p* = .004, η_p^2= .06). Undergraduate and graduate students showed completely different patterns (see Figure 15). Paired sample *t*-tests

were run separately for undergraduate and graduate students which showed that there were significant differences between their perceptions on the purposes of FQ and SQ. For the graduate, a paired sample *t*-test found the difference to be not significant (*t* (12) = 1.15, p = .273). For the undergraduate, the reverse was true: a paired sample *t*-test found the difference to be significant (*t* (128) = -6.30, p < .001, Cohen's *d* =.58), indicating that undergraduate students found the feedback of summative quizzes was more useful than formative quizzes (M = 4.55, SD = .68 vs. M = 4.12, SD = .80, respectively).

Figure 16

Difference on Items of Quiz

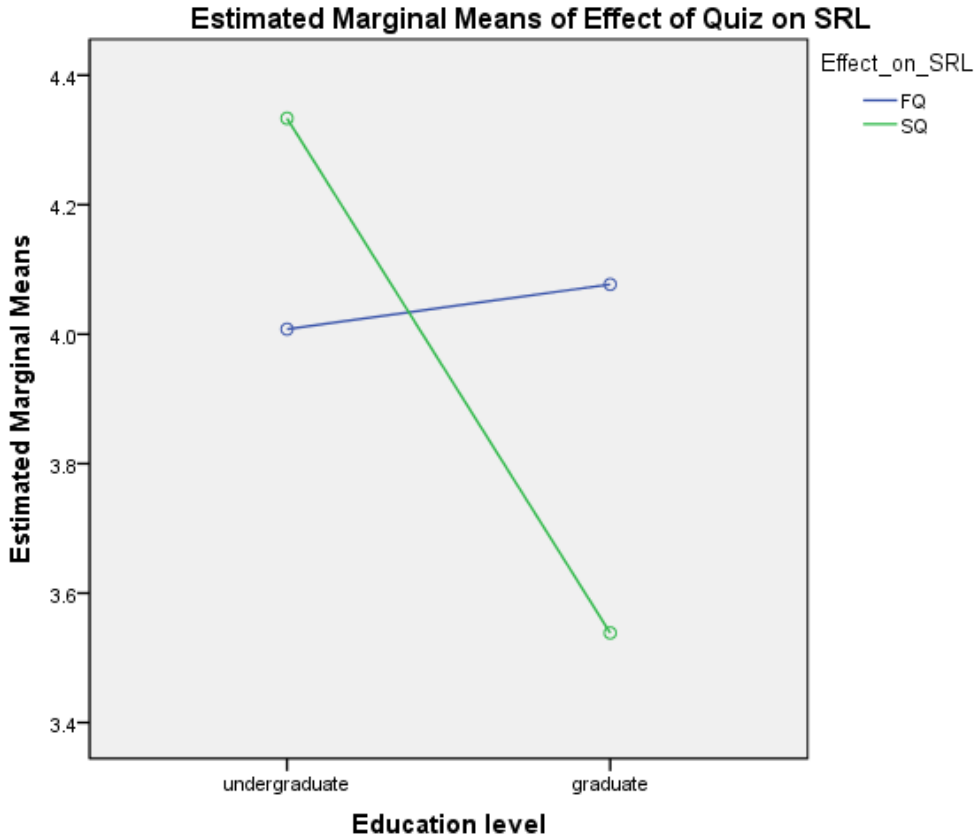


Quantitative Results 5D: Difference on Items of Quiz. Results of four one-way repeated measured ANOVAs for item number, item difficulty level, item appropriateness, and item format, indicated that there was no significant difference between undergraduate and graduate students on the item number (*F* (1, 140) =.38, *p* = .538), item difficulty (*F* (1, 140) =2.53, *p* = .114), or item appropriateness (*F* (1, 140) = 2.58, *p* = .110). However, there was a significant interaction between

undergraduate and graduates on item format (F (1, 140) = 5.66, p = .019, η_p^2= .04). Undergraduate and graduate students showed completely different patterns (see Figure 16). Paired sample *t*-tests were run separately for undergraduate and graduate students which showed that there were significant differences between their perceptions on the purposes of FQ and SQ. For the graduate, a paired sample *t*-test found the difference to be not significant (t (12) = 1.48, p = .165). For the undergraduate, a paired sample *t*-test found the difference to be significant (t (128) = -3.18, p = .002, Cohen's d =.26), indicating that undergraduate students found the format of multiple-choice question was more useful for summative quizzes than formative quizzes (M = 4.36, SD = .70 vs. M = 4.16, SD = .81, respectively).

Figure 17

Difference on Effect of Quiz on SRL



Quantitative Results 5E: Difference on Effect of Quiz on SRL. Results of the one-way repeated measured ANOVA indicated that there was a significant interaction (F (1, 140) =14.77, p < .001, η_p^2= .095). Undergraduate and graduate students showed completely different patterns (see Figure 17). Paired sample *t*-tests were run separately for undergraduate and graduate students which showed that there was

significant difference between their perceptions on the purposes of FQ and SQ. For the graduate, a paired sample *t*-test found the difference to be not significant (t (12) = 2.01, p = .068). For the undergraduate, a paired sample *t*-test found the difference to be significant (t (128) = -4.92, p < .001, Cohen's d =.41), indicating that undergraduate students found that summative quizzes had more positive effect on SRL than formative quizzes (M = 4.33, SD = .78 vs. M = 4.01, SD = .79, respectively).

Quantitative Results 5F: Difference on Completion of Quiz. Almost all students completed all the FQ and SQ. Chi-square tests of independence were conducted because both the completion of FQ and completion of SQ were categorical. However, the results indicated that there was no significant difference on the completion of formative quizzes between undergraduate and graduate students, with 79.06% of undergraduate students completed FQ, compared to 92.31% of graduate students (p = .46, by Fisher's Exact Test). There was no significant difference on the completion of summative quizzes between undergraduate and graduate students, with 96.12% of undergraduate students completed SQ, compared to 100% of graduate students completing SQ (p = 1.00, by Fisher's Exact Test).

Summary of Significant Effects of RQ 5. Undergraduate and graduate students were significantly different on their perceptions on the usefulness of quiz, the purpose of quiz, the effectiveness of feedback of quiz, the item format of quiz, and the effect of quiz on SRL. Graduate students found that formative quizzes were more useful and better at directing their learning than summative quizzes. However, undergraduate students found that summative quizzes were more useful and better at directing their learning than formative quizzes. Next, undergraduate students found that both the feedback and the format of multiple-choice question were more useful for summative quizzes than formative quizzes and summative quizzes had more positive effect on SRL than formative quizzes.

Qualitative Results

Qualitative Results 5A: Difference on Usefulness of Quiz. All participants in the undergraduate focus group thought positively of both quizzes, "*the online quizzes in the way were both helpful, and you know keeping you on pace but also really helping to see what concepts you were missing*" (Kathy U). Consistent with the quantitative results that undergraduate students found that summative quizzes were more useful than formative quizzes, two participants in the undergraduate focus group

commented that the fact that the mark of summative quiz count to the final was the reason, "*they (summative quizzes) prepare you for the mark quizzes because in most cases there are like similar questions. So it was like really helpful"* (Ahmed U). Kathy U agreed, "*I found the first time going through (formative) quiz within the module, if I understood the mistakes I made, then I just left it. I didn't go back through…because it wouldn't count."* Tasha U gave different reason why formative quiz was not that useful,"*I was more often rushed to get through some of these (formative quizzes)…now I am stuck in this silly quiz, so then I just want to get through it. So I found it, for me it was waste of my time.*" However, Ivana U disagreed with them, "*I found the course hard for me personally. And so it (formative quiz) was really helpful for me. A valuable experience. And although they didn't count, but they really did help me to understand the material."*

The quantitative results also revealed that graduate students found that formative quizzes were more useful than summative quizzes. Consistent with the quantitative results, three participants in the graduate focus group commented the reason that formative quiz was more useful, "*I learned by doing it (formative quiz) cuz I did look at why it was getting them wrong*" (Coleen G). Sita G added, "*I like the one to do the exercises. It was good to have long gap."* Maryam G concluded, "*The advantage was actually reinforcing what you know and you don't know on the way.*" However, one participant thought neither of quiz was useful, "*if you got it wrong, you don't know what you did and how you get that answer. There is no support, none."*

Qualitative Results 5B: Difference on Purpose of Quiz. The quantitative results revealed that undergraduate students found that summative quizzes were better at directing their learning than formative quizzes. However, most participants in the undergraduate focus group thought positively of formative quizzes on directing their online learning, "*the good thing about these (formative) quizzes is like you have the quiz after… every every part of the module. And the good thing is that you are gonna access your knowledge before you go to the next part because in most cases the next part is gonna be like based on the first part. So at least you make sure that your knowledge is about that part is perfect before you go to the next. And it's helpful*" (Ahmed U). Two other students added, "*I really enjoy doing those online (formative) quizzes. I thought there were extremely helpful doing like the modules and keep following immediately with quizzes with what I am getting and what I am not understanding*" (Tasha U). Kathy U agreed with, "*you realize no I don't understand*

the cap of something. you are almost in the way forced to go back or like you hope to follow up and go back. So it's it's a nice moment check-in".

The quantitative results revealed that graduate students found that formative quizzes were better at directing their learning than summative quizzes. Consistent with the quantitative results, three participants in the graduate focus group mentioned how formative quizzes helped direct their online learning, "*Formative I think I learned is to work harder independently with more focus…when I got something wrong… I also did spend time to learn what I did wrong*" (Coleen G).

Qualitative Results 5C: Difference on Effectiveness of Feedback. The quantitative results revealed that undergraduate students found that the feedback of summative quizzes was more useful than formative quizzes. However, most participants found feedback from formative quizzes were more helpful, "*I also found feedback that was helpful if I got one wrong. It would tell me like did you remember to do that? or did you remember there is the sample or population, oh yeah, okay cool. I could try it again. But it was nice to have feedback when you went through the attempts"* (Tasha U). Ivana U agreed, "*they were helpful for me. If I didn't understand something, they provided the explanation, yes it helps me to understand the material"*. Ahmed U added, "*Always the feedback is helpful and useful in any learning process…The feedback is gonna help you to understand and consolidate your learning in that, in that question, that specific question. And I found that very helpful."* As to the feedback of summative quizzes, one participant mentioned that it was "*over simplified*" (Kathy U).

Consistent with the quantitative results that no significant difference between students' perception on feedback of formative and their perception on summative quiz was found, three participants in the graduate focus group agreed that the feedback from both formative and summative quizzes were helpful, *"you just click on your wrong answer, it would explain everything….I find I really like the feedback right away. I didn't like waiting 2 or 3, or 4 weeks for the feedback on your assignments"* (Coleen G). Maryam G appreciated the feedback from summative quizzes, "*when it comes to just focusing on the part of your question about having the feedback. I think any time you can get the feedback is in the timely manner. It is definitely a help…I hate not knowing what happened to my exam…I know my mark is…like I said, you don't appreciate having that feedback until you don't have it for something right"* . Sita G thought the feedback from formative quizzes has some benefits for her

learning, "A*fter receiving the feedback, so I'll be doing. I will be learning each every step. While I do the formative so I can it is it's so helpful so I can actually I do take a screenshot when I'm doing my formative. I will go through it. So it would helpful for me. "* Different from other participants, Emma G said she did not know the feedback at the beginning and thought none of the feedback was useful, " *I didn't get any feedback…I eventually found out that there was feedback in it that explained it but it did its way. I mean it's written in one way and you can read it 100 times. but if you don't understand it, there is nobody like Maryam said, there was no one there stopping it and explained no no no you are misunderstanding."*

Qualitative Results 5D: Difference on Items of Quiz. The quantitative results revealed that undergraduate students found that the format of multiple-choice question was more useful for summative quizzes than formative quizzes. Consistent with the quantitative results, three participants in the undergraduate focus group thought the format of summative quiz was more useful, "*I found the (SQ) quizzes and the final exam have the same style. So this is like the first thing which is good…they prepare you for the mark quizzes because in most cases there are like similar questions. So it was like really helpful. In the fact they prepare you for those quizzes"* (Ahmed U). Tasha agreed, "*I found the questions (in final) were even sometimes the same as in the quizzes.*" Consistent with the quantitative results that there was no significant difference on graduate students' perception of the item format, no participant in the gradaute focus group mentioned the difference.

Consistent with the quantitative results that there was no significant difference on students' perception on item difficulty in undergraduate and graduate students, all participants in the undergraduate focus group and one participant in the graduate focus group had different opinions on this subject. Three in the undergraduate focus group felt the items of formative quizzes were difficult, "*I found the quizzes after the video were a little bit harder for me"* (Ivana U). Kathy U and Tasha U both agreed, "*I agree. That the ones within the module was a little harder but still good practice"* (Kathy U). However,one participant in the undergraduate focus group argued that items in both formative and summative quizzes were easy, "*I am a little bit mathematics, so I found like easy*" (Ahmed U). One participant in the graduate focus group thought the item of formative quiz was easier than that in summative quizzes, "*I found the (formative) quizzes in general always, like the easier than the, than the end of chapter"* (Maryam G).

Qualitative Results 5E: Difference on Effect on SRL. The quantitative results revealed that undergraduate students found that summative quizzes had more positive effect on SRL than formative quizzes. Three participants in the undergraduate focus group mentioned that both online quizzes had very positive effect on their self-regulated learning skills. Ahmed U compared the different effect of formative and summative quiz on SRL: the summative quiz was more helpful on increasing the motivation and lowering down the anxiety whereas formative quiz was more helpful on learning strategies, "*we have all the grades of those (summative) quizzes and in most cases you got a good grade in them. And so this is gonna boost your self-confidence and you have like less anxiety before answering the final exam…compared to those (formative) quizzes, you have enough time to go and think. So this is gonna give you more time to practice…this is gonna like push you to work harder and to understand the material, not just like go through the quizzes and without thinking… this is gonna let you have more time to think about the question and quizzes and like answer properly. That's why that is very helpful. Like you know for the learning process."* Two other participants agreed that formative quiz was better at improving their cognitive and metacognitive strategies, "*some people might agree with the material and believe that they understand all. But when you kind of held the accountable and have that check-in, you realize no I don't understand the cap of something. You are almost in the way forced to go back*" (Kathy U). Ivana U added, "*I think I have improved (SRL) …you read material. You think you understand everything but then you take the (formative) quiz. Then Oh I think I didn't understand, that's right. And this happens to me many times... I really found it helpful and some. Maybe I have to pay more attention to this thing or to that thing, maybe I have to read twice the material I didn't understand. Maybe I have to do my calculations twice because I don't know for some reason it didn't work for the first time.*" However, Tasha argued that formative quiz had negative effect on SRL because "*I am stuck in this silly quiz, so then I just want to get through it. So I found it, for me it was waste of my time. But that was me cuz in a rush mode to understand most of the material going through it…So you couldn't continue leaving the module unless you keep the quiz. So it is very frustrating"* (Tasha U).

Consistent with the quantitative results that there was no significant difference between the effect of formative and summative quiz on SRL for the graduate students, three participants in the graduate focus group thought online quizzes were helpful for

their SRL, "*You do you do end up remembering the ones you got wrong, a lot more. Like you know the one you got wrong then you fixed a lot more than the ones you necessarily got right. like I said, they cut it and ended up repeating sometimes, right. So the ones like I got wrong, and I fixed. I would remember better than the ones I maybe would have gotten right. But maybe got wrong a little bit down the lines. .. It's actually a learning tool tool"* (Maryam G). Coleen added, "*I learned by doing it cuz I did look at why it was getting them wrong. "*

Qualitative Results 5F: Difference on Completion of Quiz. There was no significant difference on the completion of summative quizzes between undergraduate and graduate students. Participants from either undergraduate or graduate group did not mention their difference on completing two online quizzes.

Summary of RQ 5. According to quantitative findings, undergraduate and graduate students' perceptions of online formative and summative quizzes differed. Summative quizzes were found to be more useful than formative quizzes in terms of usefulness, directing learning, feedback effectiveness, item format, and positive effect on SRL by undergraduate students. Consistent with the quantitative results of the perception of usefulness, two undergraduate focus group participants commented that summative quizzes were more useful because the marks from summative quizzes contributed to the final grade. However, one undergraduate focus group participant thought formative quizzes were more useful even if they did not count toward the final grade. In line with the quantitative results of the quiz's purpose, one undergraduate focus group participant stated that summative quizzes directed his online learning. However, one participant claimed that both quizzes were effective at directing learning, while the other believed formative quizzes were superior. Consistent with the quantitative results of the perception on feedback, one participant in the undergraduate focus group agreed, while two participants found feedback from both formative and summative quizzes to be useful. Three undergraduate focus group participants thought the multiple-choice format of the summative quiz was more useful, which was consistent with the quantitative results of the perception on item format. One participant in the undergraduate focus group agreed, which was consistent with the quantitative results of effect on SRL; however, three other participants thought both quizzes had a positive effect on SRL, albeit on different aspects of SRL.

Unlike undergraduate students, quantitative results showed that graduate students found formative quizzes to be more useful and effective at directing their learning than summative quizzes. Consistent with the quantitative findings, three graduate focus group participants commented on why formative quizzes were more useful and effective at directing their online learning. Consistent with the quantitative findings that there was no significant difference between students' perceptions of formative and summative quiz feedback, three participants in the graduate focus group agreed that feedback from both formative and summative quizzes was helpful. Consistent with the quantitative results that there was no significant difference on graduate students' perception of the item format, no participant in the gradaute focus group mentioned the difference. Although the quantitative results indicated that there was no significant difference on graduates' perception of item difficulty, only one participant in the graduate focus group thought the item of formative quiz was easier than that in summative quizzes. Consistent with the quantitative results that there was no significant difference between the effect of formative and summative quiz on SRL for the graduate students, three participants in the graduate focus group thought both online quizzes were helpful for their SRL.

CHAPTER 5 — Discussion

Although a number of studies have been conducted regarding the effectiveness of online formative assessment, there is limited research substantiating the connections between online formative assessment and students' SRL (Bose & Rengel, 2009; Gikandi et al., 2011; McLaughlin &Yan, 2017). In addition, there is the lack of empirical research exploring the difference between online formative and summative assessment, as well as the difference between undergraduate and graduate students' perception and experience with online formative and summative assessment. Such a critical gap in the online formative assessment literature could limit success of effort to implement this practice in high education.

The purpose of this study was to explore the effectiveness of online formative and summative assessment in promoting students' SRL. This research falls at the intersection of Vygotsky's (1978) social constructivism and Zimmerman's (2001) self-regulated learning model. Social constructivism provides the link between student-centered online learning and formative assessment in that the social environment promotes exchange of ideas and collaborative development of knowledge (Marín et al., 2000). Framing online formative assessment within Zimmerman's (2001) model of SRL permits the design of online environments that prompt students to regulate their own learning (Asghar, 2012; Black & Wiliam, 2009; Nicol & Macfarlane-Dick, 2006). Thus, social constructivism and SRL converge on promoting active learner engagement, as SRL is actualized and reinforced through well-designed online formative assessment (Black & Wiliam, 2009; Clark, 2012).

The sequential mixed-methods design was employed in this study. The context of this study was two online courses, one for the undergraduate and the other for the graduate. The sample of convenience was students from both online courses. Both undergraduate and graduate students took online introductory statistics course, in which both online formative and summative assessment were integral and used the exactly same format of multiple-choices questions. Throughout both courses, multiple-choice formative quizzes occurred within learning modules, highlighting key concepts and skills, could be retaken, and were not marked, while summative quizzes could only be accessed after the student had completed the module, could only be taken once, and marks were recorded.

This chapter consists of 5 major sections. First, the quantitative and qualitative findings for each of the five research questions are integrated and discussed in terms of possible explanations. Second, the original contribution of this study is presented. Third, it addresses limitations of this study. Fourth, the results are discussed in terms of implications both for course design and for instructor practice. Last, it suggests possible directions for future research and recommendations for practitioners.

Discussion of Findings

This section provides a constructive and critical analysis of the findings in relation to the research questions. The quantitative and qualitative results were drawn together to address each of the five research questions posed in this study. In addition, there were some interesting findings and patterns that shed lights on other issues, which might have serious implications for further research.

RQ 1: Effects of Demographic Variables

Effects of Demographic Variables. The first research question addressed the effects of demographic variables, such as gender, age, ethnicity, full/part time status, faculty, previous online learning experience, and educational level on formative and summative assessment, as well as students' SRL. Both quantitative and qualitative results indicated that there was no significant effect of demographic variables on students' SRL. Among all the demographic variables, educational level was the only demographic variable that significantly predicted both formative and summative quizzes, which would be discussed in the next section. In addition, gender was another significant predictor for motivational and pressure subscales of summative quizzes in the combined undergraduate and graduate group including both undergraduate and graduate students: the females felt more motivated and less pressured by the use of summative quizzes than the males. It is very interesting that gender was only significant for two subscales of summative assessment, not formative assessment. However, gender was not the significant predictor in the analysis for undergraduate and graduate separately. The possible explanation might be the sample: the convenience sample mainly consisted of undergraduates from nursing and graduates from education programs. For both programs, the female students are the majority. Thus, the sample size of the male students might be too small to accurately test any gender difference.

Although there was no significant association between demographic variables (except educational level) and students' SRL, online formative and summative assessment, this result did not disconfirm the impact of demographic variables on students' online learning. Participants in this study mentioned that some demographic variables did have positive or negative effects on their online learning experience. Therefore, future research could explore other demographic variables, such as how math and English effect on students' online learning of statistics content.

Differences between Undergraduate and Graduate Students. Both quantitative and qualitative results indicated that both undergraduate and graduate students, treated online formative and summative assessment differently. Educational level significantly predicted students' effort on formative assessment (measured by time on task) and scores on summative quizzes, indicating different patterns between graduates and undergraduates concerning motivation, final marks, course satisfaction, effort, and anxiety. Therefore, a review on how undergraduate and graduate students approached formative and summative online quizzes differently might highlight additional insights on the difference between online formative and summative assessment.

Intrinsic vs. Extrinsic Motivation. One of the most intriguing aspects of the results was the significant differences between undergraduates and graduates, on how they perceived and treated online formative and summative assessment with the same format. Graduate students found that online formative assessment was more useful, whereas undergraduate students found that online summative assessment was more useful. For graduate students, online formative assessment was better at directing their online learning by supporting them to take more control of their learning, to identify their strength and weakness, and to evaluate the learning at their own pace. However, for undergraduate students, online summative assessment was better at directing their online learning by counting toward their final marks in the course, identifying their strengthen and weakness, and taking more control of their online learning.

As Zimmerman (2011) stated, intrinsic motivation refers to doing some tasks or activities just because of the inherent interests, pleasure and satisfaction, whereas extrinsic motivation only focuses on doing something to gain an external reward in return. Thus, graduate students were intrinsically motivated in this online course because understanding how to use the statistics in their research was internally rewarding for them even if it did not influence the grades. On the other hand,

undergraduate students were extrinsically motivated in this online course because their primary purpose of taking online summative assessment was to improve their grades. Graduate students in the focus group reported having intrinsic motivation since they are in their chosen program and applying what they learn since they realize that understanding the content of this statistic course was important for their own professional development. Undergraduates took this statistics course as a required course for their major and were extrinsically motivated to get good grade, which was revealed in the qualitative results.

It is not surprising that there were significant differences between undergraduates and graduates who used the same kind of formative and summative quizzes in both introductory statistics courses. However, it should be noted that these are two different populations: the graduates were mainly education students with the average age of 32, whereas the undergraduates were largely nursing students with the average age of 23. Graduate students were all undergraduates once and then chose to go to graduate school, thus, graduate students are more focused in their career goals than undergraduate students. All of these might lead to an alternative explanation for graduates' being more intrinsically motivated and undergraduates' being more extrinsically motivated. Thus, age and program of study are hopelessly confounded in this study. Further research is therefore needed into exploring whether the intrinsic and extrinsic motivation differences between graduates and undergraduates is the function of educational level, maturity, or program of study.

Final Marks. The quantitative results of this study also indicated that undergraduate students earned significantly higher final marks than graduate students. Consistent with the quantitative result, the qualitative results also indicated that all undergraduate participants expressed positively on their final marks. This emphasized that undergraduates are more extrinsic motivation because grade is the most obvious extrinsic motivator for students. The majority of undergraduate students were from nursing program, which is a certification program. Thus, the important thing for them was to get high grades for the course and less concern about the content because they might not use the statistics for their following courses. However, for graduate students, the course content is important because they will definitely need to use the statistics for their further study.

Course Satisfaction. Another interesting aspect of the quantitative results was that graduate students reported having significantly more course satisfaction than

undergraduate students though undergraduates got higher final marks than graduates. The results indicated that graduates put more focus on the content and undergraduates on grades. Gradates' course satisfaction could refer to the course increasing their interest in statistics, whether they become more knowledgeable in statistics after completing this course, and whether they have achieved the desired learning outcome. However, undergraduates thought of course satisfaction in terms of whether they get better grades, and whether the online course provided greater flexibility with regard to the time and place than the traditional course. These findings confirm that graduate students are more intrinsically motivated and undergraduates are more extrinsically motivated in this context. In addition, when being asked how to improve the course in the future, graduates had lots of suggestions on different aspects of the course while undergraduates had very few suggestions. It is possible that graduates pay more attention to the learning itself and undergraduates are concerned more with the outcome of learning. Most graduates were from the Faculty of Education, thus, they have more knowledge about the course design which helps them determine improvements, whereas the majority of undergraduates were from the Faculty of Nursing who had less knowledge about the course design.

Effort on Formative Assessment. It is often assumed that time on task is a measure of student engagement. However, results of this study seem to indicate the inverse: undergraduates who found formative quizzes less useful spent significantly more time on it than graduates. Based on the qualitative results, there were three reasons explaining why undergraduates spent more time on online formative assessment: the difficulty level of the course; it being an online course; and the intention of bridging the knowledge gap. Although most undergraduate students in the social science are required to take a statistics course, there is a general consensus in the literature that learning about statistics is a huge challenge for undergraduate students in social sciences, especially for those whose mathematics backgrounds is not strong and had limited previous exposure to statistics (Abd Hamid & Sulaiman, 2014; Onwuegbuzie & Wilson, 2003). As a result, some students avoid the course and delay enrollment in the course as long as possible (Bourne, 2018; Keeley et al., 2008; Macher et al., 2012; Onwuegbuzie, 2004). Thus, those students would put more time on formative quizzes because the lack of mathematic knowledge made the course more difficult for them. Another reason for spending more time on online formative assessment was it being an online course. Some students without any previous online

learning experience did express their concerns that the unfamiliarity with online technology and an online course led them to spend more time, compared to a traditional course. Surprisingly, undergraduates who have more experience on online technology than older graduates stated that technology was one of the reasons that they spent more time on online formative assessment. Though most undergraduates claimed that summative quizzes were more useful, there were some undergraduates who are intrinsically motivated to use the formative quiz to bridge the knowledge gap of the content.

Anxiety. The quantitative results indicate that undergraduate students reported significantly higher anxiety than graduate students while taking the online statistics courses. Analysis of the qualitative focus group indicated that all participants in the undergraduate focus group reported anxiety whereas only one participant in the graduate focus group did so. Statistics is well-known to be a difficult and problematic course for post-secondary students, especially those whose majors are not related to mathematics or statistics (Lalayants, 2012; Malik, 2015). Statistics anxiety is a pervasive phenomenon that occurs when students enrolled in a statistics course, especially those in the social sciences (Abd Hamid & Sulaiman, 2014; Huang, 2018; McGarth et al., 2015; Macher et al., 2012; Malik, 2015; Onwuegbuzie et al., 2010; Pan & Tang, 2005). Previous studies indicated that statistics anxiety induced high levels of anxiety before an exam, which had negative effect on students' academic performance and induced procrastination, even a failure to complete degree programs (Bourne, 2018; Chew & Dilon, 2014; Macher et al., 2013; Najmi et al., 2018; Onwuegbuzie, 2004; Tutkun, 2019; Williams, 2010).

Although there was anxiety among both undergraduate and graduate students, there were unexpected and interesting findings in the patterns on the change of anxiety among undergraduate and graduate students. Despite the abundance of research on statistics anxiety, there were mixed results on the fluctuations of anxiety over a semester (Huang, 2018; Ramirez & Bond, 2014). Graduates became less anxious from the beginning to the end of the course, whereas undergraduates became more anxious from the beginning to the end of the course. As mentioned earlier, both undergraduate and graduate students had the minimum background of statistics and took online introductory statistics courses which used the same module for formative versus summative quizzes and the same format of multiple-choices questions. However, results indicated that graduates put more value on formative assessment and

undergraduates on online summative assessment. As the semester went on, the graduates did more and more online formative assessment and their anxiety went down. Thus, it appears that when students favor more online formative assessment, their anxiety goes down, as happened to the graduate students in this study. When students favor more online summative assessment, their anxiety goes up as the semester progresses, as happened to the undergraduate students in this study. In addition, analysis of the qualitative focus group indicated that for both graduates and undergraduates, the online formative assessment lessens anxiety. It appears that online formative assessment is less anxiety provoking while online summative assessment is more anxiety provoking. However, statistics anxiety is not only related to negative effects, but also related to positive effects of increasing effort as long as the anxiety level was not too high (Kesici et al., 2011; Macher et al., 2015). It might explain the previous results that undergraduates with high anxiety level spent more time and effort on online formative assessment. Thus, future research needs to explore both positive and negative effects of statistics anxiety.

RQ 2: Effects of SRL on FQ and SQ

In the past two decades, the literature regarding formative assessment and SRL has focused primarily on how formative assessment has played a critical role of promoting students' SRL, with less regard for how SRL has an effect on formative assessment (Clark, 2012; Hattie & Timperley, 2007; Panadero et al., 2019). Additionally, most of the studies regarding formative assessment and SRL has been in the traditional classroom, with less attention to online learning setting (Broadbent et al., 2021).

This study, on the other hand, evaluated whether SRL has the effect on students' effort on online formative assessment, subsequent summative scores, and value of both kinds of assessment in online learning context. The quantitative results of this study found that students' SRL significantly predicted the time spent on online formative assessment, scores on online summative assessment, and value of formative and summative assessment. In this study, the MSLQ was used to measure students' self-reported SRL before and during the course, consisting of subscales (interest, expectancy for success, anxiety, cognitive and metacognitive strategies, and resource management strategies) (Pintrich et al., 1993). The results indicated that all five subscales significantly predicted formative and summative assessment.

Anxiety. Among five subscales, anxiety is the only subscale of SRL that predicted both online formative and summative assessment: students with higher anxiety level before the course put more time on online formative assessment whereas students with higher anxiety level during the course not only got lower scores on online summative assessment but also felt more pressure while doing online summative assessment. In the qualitative analysis, students mentioned that the anxiety before the course mainly came from the concerns for online platform and mathematics while the anxiety during the course was too many posts on discussion board, lack of instruction from the instructors, and mathematics. The key factor in this finding is that the anxiety, no matter before or during the course, has played a critical role in influencing students' effort on online formative assessment and scores on online summative assessment. In return, the findings indicated that there is a mutual relationship between students' anxiety and online formative assessment. Students from both groups strongly favored online formative assessment embedded within each module that helped decrease their anxiety level during the online course because of features of formative quizzes, such as it can be retaken, and provides the feedback, and has no time limit or no mark.

Interest. Students' interest on the content of this online course predicted the value of formative assessment. The quantitative results indicated that students with higher interest during the course felt more motivated for formative quizzes. Then the question was whether students with high interest were intrinsically motivated or extrinsically motivated. The qualitative results further discovered that students were motivated to understand the content and fill the knowledge gap. Thus, students were intrinsically motivated to complete online formative assessment. In addition, both groups came to the same conclusion, noting that online formative assessment increased their intrinsic motivation to engage in the course. It is very interesting to discover that there were positive associations between students' intrinsic motivation and online formative assessment. In addition, we found that students who were motivated for statistics saw the usefulness of statistics. The study of statistics might help enhance their critical thinking and analytic skills. Statistics knowledge could help students read and evaluate journals findings and later effectively conduct their own research in the future. The features of online formative quizzes help students better identify their knowledge gap during the learning process, bridge the gap with multiple attempts, and consolidate the knowledge before the new module.

Expectancy. The quantitative results indicated that students who reported higher expectancy for success during the course scored higher on summative quizzes. Expectancy for success concerns a future-oriented conviction that students believe that their effort to learn would result in positive outcome for this course. Thus, students with higher expectancy for success were more likely to study more strategically and effectively to make a difference in their learning, even while facing the challenging task. However, students with low expectancy for success might avoid challenging tasks and exhibit a weak commitment to their goals. Thus, students with higher expectation for success were more likely to have more engagement and made more effort when they expected to achieve a better learning outcome. Thus, expectancy for success is linked to the performance, consistent with the qualitative analysis in which those students with higher expectancy focused on summative quizzes instead of formative quizzes because the scores on summative quizzes contributed to their final marks.

Resource Management Strategies. The quantitative results indicated that students who predicted less use of resource management before the course scored higher on summative quizzes whereas the qualitative results discovered the students with greater use of resource management during the course scored higher on summative quizzes. Under the MSLQ, resource management strategies include time and study environment, effort regulation, peer learning and help seeking (Pintrich et al., 1993). Those students who expected to use less resource management strategies did not worry about the statistics before the course because they might find mathematics easy or they might have taken a statistics course prior to the current course. Actually, their prediction was right and they did achieve higher marks on summative quizzes. For other students who utilized different strategies of resource management during the course, they set aside the time to study and effectively use of that study time by setting goals, planning and controlling their effort and attention while facing the distractions. Moreover, they collaborated with peers to solve the problems together or sought help from the peers or the discussion board. All the above strategies helped them achieve a higher score on summative quizzes.

Cognitive and Metacognitive Strategies. The students who reported greater use of cognitive and metacognitive strategies during the course felt that formative quizzes were a fairer assessment instrument. Under the MSLQ, cognitive and metacognitive strategies include five strategies: rehearsal, elaboration, organization, critical thinking,

and metacognitive self-regulation (Pintrich et al., 1993). Students reported that feature of formative quizzes helped them utilize different kinds of learning strategies for this online course and felt that formative quizzes were a fairer assessment instrument than summative ones. Since formative quizzes allow multiple attempts, students redid the formative quizzes to memorize some key concepts. Since there was no time limit to take the formative quizzes, students made notes or screenshot the answers to help them in the future. Formative quizzes were built into the module, which allowed students to find out the important points they missed and fill the knowledge gap. The timely feedback of formative quizzes helped students access their prior knowledge and build internal connections among what they have learned. In addition, formative quizzes reminded them which concepts they did not understand well so that they could go back to figure it out. Some students prioritized the material and skimmed the textbook before watching the video and doing the quizzes. Other students mentioned that they changed their way of learning adapting to online learning when they found out the traditional way did not work out. It is surprising that students mentioned lots of metacognitive self-regulatory activities while doing formative quizzes: planning, monitoring and regulating.

To sum up, there appears to be a positive relationship between students' SRL and online formative assessment. On one hand, some students' readiness for SRL help them use formative quizzes more effectively while taking online courses. Such students demonstrated a certain amount of SRL skills and learning strategies while engaging in independent learning or seeking help while facing difficulties. On the other hand, the finding also indicated the potential for online formative assessment to nurture students SRL skills. Online formative quizzes can be used as an instrument to promote self-regulated learning environments. More importantly, the relationship between students' SRL and online formative assessment might be the positive feedback loop, which implies that students' readiness for SRL might boost the online formative assessment's potential which, in turn, facilitates students' SRL to higher levels.

RQ 3: Interactions between Demographic Variables and SRL

Although the results of RQ 1 indicated that none of the demographic variables, except educational level, predicted students' usage of the online formative or summative assessment, the results of RQ 3 suggested that there were two significant effects of interaction on scores of online summative quizzes between students' SRL

and two of the demographic variables: that is, full/part-time status and previous online experience.

An intriguing difference was found between full-time and part-time students with regards to their scores on summative quizzes in terms of their SRL: there was a significant interaction between full/part time status and students' SRL on their scores on summative quizzes. Part-time students who reported medium SRL scored the highest on summative quizzes while full-time students who reported lower SRL got the highest scores. Because only one part-time student in the focus group, qualitative results can shed no light on this question. Thus, it is recommended that future studies explore if full/part-time status is a real factor in the interaction with students' SRL with regards to summative marks.

The quantitative results also revealed significant interaction between previous online experience and undergraduate students' SRL on summative scores: undergraduate students who reported lower SRL, with or without previous online experience, scored the highest on summative quizzes. Surprisingly, the qualitative results showed the opposite pattern: the undergraduate participants who reported higher SRL, with or without previous online learning experience, scored high on summative quizzes. Although the lack of previous online experience made the first online course more difficult and harder for them to adapt to, undergraduate participants with previous online experience mentioned that the previous experience did not help them a lot and it still took them time to get used to the new online course because each instructor chose a different online platform to deliver the course, to give students access to all required course materials, and to communicate with the instructor and peers. For students who lack online learning experience, they may experience more difficulties since they have never so much flexibility in their learning. Thus, students with higher SRL would be more effective in utilizing a series of cognitive and metacognitive strategies to organize and apply the new information, to plan, monitor and regulate their time and effort towards their learning goal, to make greater effort maintaining their concentration and motivation and avoiding external distractions, and to seek help from instructors and peers when facing difficulties.

RQ 4: Prediction of Course Outcome

The fourth research question looked into which variables predicted students' academic outcome and course satisfaction. According to the findings, there were three significant predictors of academic performance: previous online experience, students'

effort on formative assessment, and their scores on online summative assessment. In terms of course satisfaction determinants, the finding suggested that students' concurrent SRL scores was the only significant predictor for undergraduate students.

Predictors of Final Marks. Results indicated that students with prior online experience, who spent more time on formative quizzes, or who scored higher on summative quizzes received higher final marks. Previous research has found a link between students' online learning self-efficacy and the number of online courses they have taken (Shen et al., 2013; Wang et al., 2013). Students with previous online learning experience demonstrated a higher level of online learning self-efficacy due to their familiarity with the learning management system, whereas students without previous online learning experience may be unfamiliar and inexperienced with using the learning management platform and may be overwhelmed by online instructional and other technologies, such as discussion boards. Furthermore, students who had previously taken online courses had a clear expectation for the online course and used various SRL strategies to perform well in the online course, such as navigating within the course to find critical information or seeking help from the instructor or peers when faced with difficulties.

According to the data, students who spent more time on formative quizzes achieved higher final marks, which supports the popular idea that more study time leads to better learning outcome. However, quantitative results revealed a negative association between time spent on formative quizzes and final marks. The seemingly contradicting results of effort on formative quizzes and learning outcome were not unexpected. Students were more engaged in grasping the content and filling in the learning gasp when they spent more time on formative quizzes, which help them attain better final marks. Learning requires time, as we all know, yet spending extra time spent on a task does not guarantee a better learning outcome. Previous studies on the relationship between time and learning outcome yielded contradictory results (Godwin et al., 2021; Kupiainen et al., 2014). Students reported more anxiety and decreased interest in these online courses as a result of the surprisingly excessive time spent on online formative assessment, indicating that they were struggling in the online learning setting. The qualitative findings revealed that the struggling students were not familiar with the online learning platform, and they had a difficult time acclimating to it. Online learning, as opposed to traditional learning, requires students to be more independent and accountable for their own learning. Thus, struggling

students' inability to keep up with their online learning was hampered by a lack of the structure and support. Furthermore, online courses differed significantly from traditional learning in terms of interaction with instructors and peers. The discussion board has seen a lot of activity, which added to the strain for those struggling students who were feeling overwhelmed by the volume of posts. Moreover, most struggling students are inept at regulating their learning or seeking help while dealing with problems, exacerbating their predicament. Thus, instructors should utilize the LMS data on time spent on online formative assessment (but not online summative assessment) to identify struggling students and provide timely support so that they do not fail or drop out of the online course.

Final grades were higher for students who scored higher on summative quizzes. Scores on summative quizzes explained more of the variance in the final mark than two other predictors, indicating a stronger strength of association with final marks. Summative quizzes accounted for 20-40% of final grades in both online courses. As a result, higher summative scores would certainly result in greater learning outcomes. Furthermore, students stated that the format of summative quizzes matched the format of the final exam, which helped them prepare better for the final exam.

Predictors of Course Satisfaction. Course satisfaction is the most important factor in reflecting how students perceive their online learning experience and evaluating the quality of online learning. Student overall satisfaction, along with learning gains, recommendations to other students, and willingness to take another online course, were components used to assess course satisfaction in this study. Quantitative results indicated that students who reported higher MSLQ during the course reported higher course satisfaction. The higher the total score on the concurrent MSLQ reported by all focus group participants, the more satisfied they were with their online course. The literature has suggested that students who are more satisfied with their online learning are more persistent and successful (Alqurashi, 2019; Kuo et al., 2014; Littlejohn et al., 2016). That is, high satisfaction resulted in higher grades, more learning gains, and higher course completion in the online course. Satisfied online students are also more committed to taking another online course and are more likely to recommend the course to others than their dissatisfied counterparts.

This finding supports previous research indicating that the ability of learners to self-regulate their learning influences students' post-course evaluation (Kizilcec et al., 2017; Rabin et al., 2019; Zalli et al., 2019). Online learning environments differ

significantly from traditional learning environments in that teachers are not physically present with students. In fact, students in the focus group complained about a lack of instruction. The interaction between student and instruction, particularly the quality of student-instructor communication in the context of online learning, has a significant impact on student satisfaction. Thus, in the absence of face-to-face support and guidance from the instructor, SRL skill becomes even more important in assisting students in determining when, where, and how to engage in course content and learning activities, as well as achieving personal learning goals in the context of online learning.

The findings also revealed significant positive relationships between course satisfaction and four SRL subscales, namely, interest, expectancy for success, cognitive and metacognitive strategies, and resource management strategies. Students who expressed a strong interest in this online course demonstrated greater motivation and commitment to the course. In this study, motivation is viewed as a continuum between intrinsic and extrinsic motivation. Thus, lack of motivation hinders students' persistence for a satisfied learning experience. Second, a higher expectation of success indicates greater confidence in performing well in this course, increasing the likelihood of their satisfaction with their online learning process. Next, students who employ a variety of cognitive and metacognitive strategies are adept at planning their learning process and making decisions on how to complete a task, particularly when confronted with academic challenges or technical issues, lowering barriers to satisfaction in the context of online learning. In the absence of face-to-face guidance, self-regulated students are better at managing their time and exerting effort for knowledge acquisition, seeking help from peers, instructors, or a discussion forum when they encounter problems, which increases their satisfaction with the course.

RQ 5: Perception of Online Quizzes

The fifth research question investigated whether undergraduate and graduate students perceived online formative and summative quizzes differently. Students' perceptions of online quizzes were examined in the following areas: perceived usefulness of quiz, perceived purpose of quiz, value of quiz, feedback effectiveness, quiz characteristics, effect on SRL and quiz completion.

Before delving into why undergraduate and graduate students had such disparities in their perceptions of online formative and summative quizzes, the distinctions between the two types of quizzes were examined. Although both quizzes used the

same multiple-choice question format, they differ in four ways: the marks, the time limit, number of attempts, the feedback time, and the type of feedback. Formative quizzes are not graded, whereas summative quizzes are graded and count toward the final grade. Formative quizzes allow students to attempt multiple times, whereas summative quizzes only allow one attempt. Formative quizzes have no time limit, whereas summative quizzes must be completed within the time limit. In formative quizzes, feedback is given after each item, whereas in summative quizzes, feedback is given at the end of the set of items. In formative quizzes, feedback indicates whether the answer was correct or incorrect and provides additional information to clarify, whereas feedback in summative quizzes only indicates whether the answer was correct or incorrect.

The results revealed that undergraduate and graduate students did show different patterns in their perceptions of online formative and summative quizzes. Graduate students found formative quizzes to be more useful and better at directing their learning than summative quizzes, whereas undergraduate students found summative quizzes to be more useful and better at directing their learning than formative quizzes. The discussion surrounding this finding is presented below and includes a possible explanation for the differences between undergraduate and graduates.

Perceived Usefulness. According to quantitative results, summative quizzes were more useful to undergraduates than formative quizzes, while formative quizzes were more useful to graduate students. In this study, the perceived usefulness of quizzes is divided into two aspects: 1) *Quizzes influence my understanding of how much I learned about statistics in each video*; 2) *Quizzes allow me to assess my progress at my own pace*. As to the first aspect of perceived usefulness, formative quizzes were thought to be more useful than summative quizzes in helping undergraduate and graduate students confirm their understanding or realize they knew less than they thought. When compared to formative quizzes, more students thought summative quizzes failed to demonstrate what they had learned. Thus, formative quizzes were thought to be beneficial by all participants in both focus groups because they help students identify and bridge knowledge gaps, as well as stay on track. In terms of another aspect of perceived usefulness, graduate students preferred using formative quizzes to assess their online learning at their own pace, whereas undergraduate students preferred summative quizzes. The following qualitative results showed that summative quizzes are more beneficial to undergraduate students because the results

count toward the final exam. Therefore, the usefulness of quizzes for graduate students is determined by whether or not they aid in their understanding, however, undergraduate students are more concerned with grades.

Perceived Purpose. The purpose of online formative assessment was to provide ongoing feedback to support learning, whereas the goal of online summative assessment was to evaluate student learning. In this study, the perceived purpose of quizzes includes the following aspects: to help take more control of learning; to provide the marks in this course; to give the instructor information; to help identify the strengths and weakness; and to evaluate the learning at the own pace. According to quantitative results, summative quizzes served the purpose of directing undergraduate students' learning better than formative quizzes. Graduate students, on the other hand, held opposing views. For undergraduate students, summative quizzes were more effective at directing their online learning because they counted toward the final grades and helped identify their strengths and weakness. In comparison, graduate students were positive about using their formative quizzes to direct their learning in terms of using the instrument to identify strengths and weaknesses, take more control of their learning, self-assess their progress at their own pace. This suggests that graduates were more intrinsically motivated toward the material while undergraduates were extrinsically motivated to get a good mark. During the focus group, both undergraduate and graduate students thought positively of formative quizzes on directing their online learning by creating self-regulated learning environment. Formative quizzes are not merely unmarked summative quizzes. Instead, formative quizzes are embedded in each module to discover what students know or misunderstand while they are still in the learning process, which take place continuously at key points during the learning and support students' SRL by breaking the material into smaller tasks which scaffold students to develop SRL skills.

Based on the questionnaire results, it was evident that some undergraduate students held some misunderstanding about the purpose of the formative quizzes, believing that online formative assessment had summative properties. Despite the syllabus making clear the purpose of online formative assessment, 24.8% of undergraduate students believed it was used to provide a grade in the course, compared to 15% of graduate students. One participant mentioned during the focus group that she rushed through formative quizzes, which wasted her time. There could be a number of reasons why some undergraduates mistook online formative

assessment for measuring rather than supporting learning. It is possible that students were overwhelmed by the online course and did not carefully read the outline. It is possible that some undergraduate students who had not previously been exposed to online formative assessment found it difficult to grasp the purpose of the online formative assessment. This online course's brief exposure to online formative assessment may not have been sufficient to cause a paradigm shift in their thinking about the benefits of online formative assessment.

Quiz Characteristics. Quiz characteristics refer to whether the number of quiz questions, their difficulty level, content, and format were appropriate in assessing students' understanding in formative and summative quizzes. Both formative and summative quizzes used the same multiple-choice format. According to quantitative results, there was no significant difference in item number, quiz difficulty level, or content appropriateness between undergraduate and graduate students.

Undergraduate students, on the other hand, found that the multiple-choice question format was more useful for summative quizzes than formative quizzes. They stated that the format of summative quizzes matched the final exam, helping them prepare for the final exam. They, as previously stated, place a greater emphasis on their marks than graduate students, despite the fact that the format of formative and summative quizzes was the same. Neither undergraduate nor graduate students expressed any concerns about the difficulty of accepting or using the multiple-choice format in online learning. This finding could be attributed to the students' experience with multiple-choice questions in traditional formats or other online courses.

The lack of a significant difference in undergraduate and graduate students' perceptions of quiz difficulty was due to the fact that all participants had different perspectives on quiz difficulty. Some reported that formative quiz was more difficult than summative quiz, while others disagreed. Online formative assessment preceded online summative assessment in both online courses. Thus, it was critical that the difficulty level of online formative assessment corresponded to online summative assessment and final exam. Such an alignment increases the value of formative quizzes and provides more incentive for students to complete all online formative assessments.

Although the number of items and their content varied for two online courses, neither appeared to be a major factor influencing students' experiences with formative or summative quizzes. As a result, no significant difference in the number of items or

content was discovered. Given that formative quizzes are unmarked, some students propose increasing the number of items on formative quizzes to provide a more accurate reflection of their understanding and to assist them in identifying knowledge gaps. Similarly, there was a need for more comprehensive coverage of content in formative quizzes, which aids students in preparing for summative and final exams.

Feedback Effectiveness. Feedback is an essential component of any learning process, allowing students to narrow the gap between their actual and desired knowledge (Black & Wiliam, 1998a). This study measured the effectiveness of feedback from two perspectives: 1) *Immediate and prompt feedback from quizzes help me get a better view of my learning progress and fill in the learning gap*; 2) *I thoroughly reviewed the feedback after I finish the quizzes*. Quantitative results indicated that undergraduate students found that summative quizzes provided more useful feedback, whereas graduate students thought formative quizzes provided more useful feedback. However, qualitative findings revealed that feedback from formative quizzes was more useful to both undergraduate and graduate students. Corresponding to previous findings, undergraduates are more extrinsically motivated, so they prefer summative quiz feedback because summative quizzes count toward their final grades and sometimes ignored the feedback from formative quizzes. Graduates were more intrinsically motivated, so they preferred formative quiz feedback to aid in their understanding of the content.

There were several distinctions between the formative and summative quiz feedback. The first significant difference between the feedback of two assessments was the timing of feedback delivery. In online formative assessment, students received immediate and prompt feedback after each item, whereas in online summative assessment, students waited until they had completed all items before receiving feedback. Thus, feedback delivered after each item in formative quizzes forced students to focus cognitively on the concept by reinforcing a correct response or clarifying a misunderstanding. Given that the students had completed the entire quiz and the time for processing the information had passed, feedback delivered at the end of the quiz was too late to support learning. The second distinction between the two assessments' feedback was the different types of feedback. Formative quizzes provided detailed feedback with further explanation and clarification than summative quizzes, which only provided correct/incorrect answers. Summative quizzes with correct/incorrect feedback may be considered sufficient for those extrinsically

motivated students who only need to memorize the correct answer to perform well on the final exam. Formative quizzes, on the other hand, provided feedback explaining why a response was correct or incorrect, which intrinsically-motivated students found useful in confirming their thinking or filling knowledge gaps.

Although the findings suggest that undergraduate and graduate students differed in their preference for online formative and summative assessment feedback, the two types of feedback did not improve learning equally. Although it was important for students to know whether their response was correct or incorrect, feedback with only correct answers was ineffective in supporting student learning and fostering self-regulation because students had no incentive to figure out why it was correct or incorrect. Feedback with an explanation of why the response was correct/incorrect may encourage students to gain a deeper understanding of the content rather than simply remembering the correct answer. In addition, feedback with an explanation may also facilitate the application of the knowledge in new contexts.

Value of Quizzes. The value students held for online formative and summative assessment was examined along four dimensions: engagement (*I become more motivated and engaged after taking the quiz*); pressure (*The quizzes make me feel safer and under less pressure*); understanding (*The results of the quizzes are accurate reflection of my understanding*); and fairness (*The quiz is a fair assessment instrument*). Quantitative results showed that both undergraduate and graduate students responded more positively to the formative quizzes' two dimensions of quiz value: engagement and understanding. In accordance with the quantitative findings, students in both focus groups stated that they felt more engaged and knowledgeable about the subject matter by the use of formative quizzes. The formative quizzes were given during each module whereas the summative quiz was given at the end of each module. That is, the formative quizzes took place during the learning whereas the summative quiz took place afterwards. Thus, formative quizzes provided more opportunities for students to grasp new information and deepen their understanding of the material while learning. They broke down the learning into smaller tasks, allowing students to learn step by step throughout the module. Learning new information was accomplished through each module, with students' progress being tracked. As a result, student motivation and engagement increased. Another benefit of this online formative assessment was the additional information provided by timely feedback after each item, which allowed students to clear up any misunderstanding and

highlight the gap in their understanding. In comparison to summative feedback, online formative assessment closed the gap between current knowledge and learning goal and more accurately reflected their understanding.

The quantitative findings indicated that no significant difference was found between undergraduate and graduate students on the other two dimensions of quiz value (pressure and fairness). In the focus group, both undergraduate and graduate students reported that the formative quizzes were more helpful for reducing their perceived test anxiety than summative quizzes. Test anxiety is a common phenomenon among post-secondary students, especially for those taking statistics courses. Features of formative quizzes, such as no marking, multiple attempts and no time limit, reduced the test anxiety and made students feel comfortable while taking formative quizzes, thereby boosting their confidence and reducing the pressure they faced leading up to higher stake summative quizzes. In terms of the fairness of both formative and summative quizzes, the majority of students reported that both were fair.

Effects on SRL. The quantitative results indicated that undergraduate students found that summative quizzes had a greater positive effect on SRL than formative quizzes. The focus group revealed that both formative and summative quizzes had positive effect on their self-regulated learning skills, however, their effects on SRL varied. The summative quiz was more beneficial to undergraduate students on the motivational dimension: increasing their motivation and expectancy for success, and decreasing test anxiety; however, the formative quiz was more beneficial to undergraduate students on the dimension of learning strategies: improving their cognitive and metacognitive skills, and resource management strategies. This interesting finding was linked to the feature of formative and summative quizzes. Since summative quiz counted toward the final mark, students felt more extrinsically motivated for the course while taking them, as well as increased confidence in their ability to get a good grade for the final exam. Furthermore, undergraduate students felt less anxious before the final exam both because the format of the summative quiz matched the format of the final exam, and because marks on the summative quizzes reduced the stakes of the final exam. In contrast to summative quizzes, the features of formative quizzes provided undergraduate students with sufficient time to think and practice. They were allowed multiple attempts and were required to review the feedback with additional information. As a result, they used a variety of cognitive and

metacognitive strategies, as well as resource management strategies, to close their learning gap.

On the other hand, quantitative results indicated no significant difference between the effects of formative and summative quizzes on graduate students' SRL. However, the qualitative results revealed that formative quizzes were more beneficial for improving students' SRL skills. Graduate students, like the undergraduates, reported that formative quizzes helped them figure out what they did not understand so they could put in more effort and adopt different cognitive and metacognitive skills. They also modified their resource management strategies by allocating blocks of time to be used more effectively, regulating their effort in the face of distractions, seeking help from instructors or peers, or collaborating with peers to achieve their goals.

Quiz Completion. No significant differences were found on the completion rate of either formative or summative quizzes between undergraduate and graduate students, with the vast majority of students completing all formative and summative quizzes. However, when asked why they did not complete quizzes, responses differed. In terms of summative quizzes, two undergraduate students who did not complete them all gave reasons including family issues or that the summative quiz was not a priority given other expectations, whereas all graduate students completed all of the summative quizzes. As to formative quizzes, those undergraduate students reported that they did not complete formative quizzes for a variety of reasons. The primary reason was that formative quizzes did not count toward their final grade and therefore that they were not a priority. The only graduate student who did not complete all formative quizzes reported that she was too busy. In line with the findings on the fifth research question, undergraduate students prioritized summative quizzes, whereas graduate students prioritized formative quizzes. This suggests that undergraduates were more sensitive to extrinsic motivation while graduates were more sensitive to intrinsic motivation, as was found in research question two.

Summary

There was a significant difference in undergraduate and graduate students' perceptions of online formative versus summative assessment. In terms of perceived usefulness, purpose, format, feedback effectiveness, value, and effects on SRL, undergraduate students were more satisfied with the summative quizzes while graduate students were more satisfied with formative quizzes. Undergraduate students appear to have been more extrinsically motivated, resulting in a more positive

perception of online summative assessment. Graduate students appear to have been more intrinsically motivated and better prepared for self-regulated learning, resulting in a more positive perception of online formative assessment. Nonetheless, further research is needed to explore this and other factors that may be contributing to the perceptual differences between undergraduate and graduate students on online formative versus summative assessment, and whether the difference in intrinsic and extrinsic motivation between graduates and undergraduates is the reason they treat formative and summative quizzes differently. A better understanding of the purpose of online formative assessment would have a direct impact on helping undergraduate students view the formative quizzes as an instrument to support rather than evaluate their learning. If undergraduate students fully comprehended the formative quizzes' purpose, they might place a higher value on formative quizzes.

Original Contribution to the Field

This research represents an original contribution to our understanding of online formative assessment. First, despite the commonly held belief that more time on task leads to greater academic success, the students who earned lower final grades in the class spent the greatest amount of time on formative quizzes. This could provide instructors with an important source of information for identifying those struggling students and offering timely support and focused guidance. This finding adds to the existing research literature on the relationship between time-on-task and learning outcome. Although prior research has found a positive relationship between time spent on-task and learning outcome, the findings of this study highlight the need for researchers and educators to re-examine this multifaceted relationship between time-on-task and learning outcome in online learning.

Second, the study revealed that there was a significant positive correlation between students' effort on online formative quizzes (measured by time on task) and their concurrent SRL (as reported during the course), but not with their pre-course SRL (as reported before the course). This suggests that greater use of online formative assessment leads to increasing levels of students' SRL. This finding expands our understanding of the reciprocal relationship between online formative quizzes and SRL, providing evidence for instructional design by linking online formative assessment in online learning in promoting students' SRL skills. The results also

found that students' concurrent SRL significantly predicted their scores on summative quizzes, reported value of both kinds of assessment, as well as online course satisfaction. Therefore, students' readiness for SRL is critical for increasing the effectiveness of online formative assessment, and instructors must support them in improving SRL skills to facilitate learning.

Third, the study found that these undergraduate and graduate students treated online formative and summative assessment differently: undergraduate students reported higher anxiety, spent significantly more time on formative quizzes, and earned higher final marks whereas graduate students scored higher on summative quizzes and had higher course satisfaction, even though both were given the same type of multiple-choice questions for both formative and summative quizzes. Furthermore, the study also found that these undergraduate and graduate students had significantly different perspectives on online formative and summative quizzes: graduate students valued online formative assessment more than online summative assessment, whereas undergraduate students valued online summative assessment more. This is congruent with qualitative results that undergraduates reported more extrinsic motivation whereas graduates reported more intrinsic motivation. This finding reveals the complex nature of online learning in higher education, particularly the significant difference between undergraduate and graduate students when dealing with assessments. The comparison of undergraduate and graduate students' use of online formative and summative quizzes provides new guidance for developing and implementing online formative and summative quizzes for different levels of students in higher education.

These results address the critical gap in our understanding of the online formative assessment. This study found the negative relationship between the amount of time spent on formative quizzes and learning outcome. It also found the positive relationship between time spent on formative quizzes and students' SRL. Also, it revealed the difference in how undergraduate and graduate students approached online formative and summative assessment differently. This study paves the way for future research to highlight the role of online formative assessment in facilitating learning.

Limitations

There were several limitations to this study that were either a result of the study method and design chosen, or were unforeseen before data collection. First, we deliberately chose two online courses, one for undergraduates and one for graduate students, that were designed to have both online formative and summative assessments. Although this allowed for direct comparisons between undergraduate and graduate students taking quizzes with the same format, this does limit the generalizability of the results. Second, both online courses studied were required statistics courses. Statistics courses are known to be especially problematic for both undergraduates and graduates. Therefore, caution should be exercised when generalizing these findings to other online courses. Third, this study suffers from sample bias because it employed only students who volunteered to participate in the study, rather than being chosen at random. Thus, the validity of the study might be limited to the kinds of students who voluntarily agreed to participate. Fourth, while both undergraduate and graduate students in this study were taking an introductory statistics course online, they did not take the same statistics course. As a result, they might not be directly comparable because their courses were at different levels. Fifth, because of the deliberate choices of two online courses, undergraduates were overwhelmingly from the nursing faculty and graduate students overwhelmingly from the education faculty. Thus, the differences found between undergraduate and graduate students in this study could be due to differences in the kind of students who chose to study in different programs, as well as education students being more sensitive to the value of online formative assessment. Sixth, another limitation was the small number of graduate students in the sample.

The methodology employed in this study relied on self-report for both quantitative and qualitative data. Although self-reported data has its own limitations about the subjectivity, recent studies indicated that the subjective forms of measures are not inherently less valid simply because learners report their own SRL processes (Cleary et al., 2012). With regard to quantitative self-report data in this study, this subjectivity was mitigated through data triangulation using participants' activity logs and final grades. As to the qualitative data, there is always some bias no matter how carefully the study is planned. The main limitation from the qualitative portion of this study was the use of focus groups, which may not have accurately reflected the views

of the entire sample. The second limitation applies to any focus group: bias may have been introduced when phrasing questions and steering the focus group discussions. The last limitation worth noting is that the study was carried out in an authentic setting with no control over how students used the online quizzes. Compared to laboratory-based research, real classroom research provides more realistic data and results in greater ecological validity but it makes interpretation more challenging and limits controllability due to a concomitant reduction in experimental control of variables.

Implications

This section connects the findings of each research question to previous studies and theories related to online formative assessment. The purpose was to conclude this study by bridging this research with previous research and to provide recommendations for the use of online formative quizzes and directions for online course design in future research.

Implication for Instructional Design

The results of this study indicated that nearly all undergraduate and graduate students completed both formative and summative online quizzes. Although both undergraduate and graduate students agreed that both types of online quizzes were beneficial, they used them for different purposes. Summative quizzes were given higher value by undergraduate students over formative quizzes, while formative quizzes were given higher value by graduate students over summative quizzes. Because summative quizzes counted toward their final grade, undergraduate students found them to be more useful and effective at directing their learning. Graduate students, on the other hand, found formative quizzes to be more useful and effective at directing their online learning because formative quizzes provided opportunities to employ a variety of cognitive and metacognitive strategies, as well as resource management strategies, to close their learning gap. Although this study explored how undergraduate and graduate students used formative and summative quizzes in online courses, the findings of this study reinforce the importance of several key design features of online formative assessment.

Embedded Online Formative Assessment. Both undergraduates and graduates reported that online formative assessment was most useful while they are still in the

process of learning, therefore the online course designer should keep in mind that online formative assessment must occur within the module, while students' learning is ongoing. The purpose of the online formative assessment is to support learning and knowledge construction by identifying learning gaps, providing timely feedback during learning, engaging students in the assessment process, and providing guidance for future learning (Clark, 2010; Heritage, 2007). All of those goals can be achieved only while the learning is taking place, rather than after the module has been completed.

Online Formative Assessment and SRL. Although the study did not find a significant increase in students' SRL before and after online learning, both undergraduate and graduate students stated that the use of formative quizzes supported their SRL. The study also found a bidirectional synergy between online formative quizzes and students' SRL. Students reported that the use of online formative quizzes gave them enough time to practice, to reflect on feedback, and to engage in various learning strategies to bridge the learning gap. Because online learning is more autonomous than traditional learning environments, resource management strategies are critical for their academic performance. Both undergraduate and graduate students reported that formative quizzes encouraged them to use various resource management strategies while learning. Thus, formative quizzes encouraged students to take a more active role in their online learning. On the other hand, students' SRL scores significantly predicted the time spent on and their rating of the value of online formative assessment. Students with higher SRL skills took a more active role while doing formative quizzes, thus increasing their engagement with formative quizzes (Hattie & Timperley, 2007; Panadero et al., 2018). These students make the most use of formative quizzes because they are motivated, can set goals, reflect on prior performance, think critically about feedback, monitor their progress, and manage their time and effort efficiently (Lodge et al., 2018). Thus, the relationship between students' SRL and online formative assessment may create a positive feedback loop, indicating that students' readiness for SRL will boost the potential of online formative assessment which, in turn, further facilitates students' SRL.

However, the SRL skills differed among these online students. Self-regulated learners, both undergraduate and graduate, were more likely to use a variety of cognitive and metacognitive strategies, as well as various resource management

strategies, to evaluate their progress and take initiative to modify their performance, responding positively to formative feedback, and ultimately increasing their effort to achieve their learning goals. Students who struggled with SRL, on the other hand, were less able to advance when they became confused or stuck during learning. Although the quantitative analysis found that students' SRL did not directly predict their final grades, their SRL nonetheless had an impact on factors that predicted their final grades, such as time spent on formative quizzes, as well as predicting course satisfaction. Therefore, instructional designers should use online formative assessment to support students' SRL by including multiple opportunities for online formative assessment and feedback within every module.

Alignment Between Online Quizzes and Final Exam. An unexpected finding was raised by graduate students concerning the alignment in content and format between online quizzes and the final exam. The final exam was criticized by all graduate participants in the focus group for not reflecting the course, not being in the same format as quizzes, mistakes on the questions, and being disconnected from the content. The graduate instructor used the textbook publisher's online modules which included formative and summative quizzes; however, the final exam was written by the instructor himself. The undergraduate instructor, on the other hand, used the textbook publisher's online modules and final exam, which undergraduate students were satisfied with the final exam because its content and format matched to the online quizzes they had taken. This might explain why undergraduates outperformed graduate students in terms of final exam grades. As a result, ensuring an alignment in both format and content between online quizzes and final exams can increase students' academic performance as well as course satisfaction.

The second point raised by students is more likely to influence their perception of online formative assessment. The alignment between online formative and summative assessment was mentioned as a factor that influenced how students perceived online formative assessment. When online formative assessment is less difficult than online summative assessment, it only provides an introductory level of assessment, giving students an inaccurate measure of their learning. Therefore, instructional designers should ensure the alignment of online formative and summative assessment in terms of item difficulty, content, and format. Students are more willing to complete the online formative assessment with greater effort when the two assessments are aligned. Both undergraduate and graduate students emphasized the importance of formative

quizzes to provide an accurate measure of their understanding in order to perform better on subsequent summative quizzes.

Online Formative versus Summative Assessment. The format of online formative and summative assessment can be the same, but their function and use must be different. Students use both kinds of assessments, but they use them for different reasons. The goals of both assessments are distinct. Online formative assessment is used to support students' learning within each module by providing feedback as the learning happens, whereas online summative assessment is used to evaluate students' achievement after the learning. Thus, online formative assessment is diagnostic in nature, as it monitors students' learning and provides them with ongoing feedback to help them determine whether they have mastered the content or require more practice. Online summative assessment is evaluative in that it serves as a checkpoint to determine whether the module's learning objectives have been met and therefore students are ready to move on to the next module.

First, both kinds of assessment take place at different times. Online formative assessment is the evaluation of learning as it takes place, whereas online summative assessment occurs after the end of the module. Online formative assessment, which is embedded within each module, can monitor learning progress and empower students by providing feedback on their learning gaps and misunderstandings. By incorporating online formative assessment directly into the learning process, students can engage in meaningful practice for evolving understanding. Both undergraduate and graduate students reported that they tried several attempts to fill their learning gaps and used cognitive and metacognitive strategies, as well as resource management strategies, to achieve their learning objectives during online formative assessment. As the online learning progresses, online formative assessments also indicate to the instructor whether instructional plans need to be revised to reinforce or extend learning. Online summative assessment, on the other hand, evaluates students at the end of the module and assigns marks indicating students' content mastery in that module, but students reported that they no longer had the opportunity to adjust their learning strategies because the module had ended.

Second, the grading differs between the two types of assessments. Online formative assessment is not graded and allows for multiple attempts, whereas online summative assessment is graded and only allows for a single attempt. While performing online formative assessment, students are free to identify their own

strengths and weaknesses and address any issues that arise. In the focus group, students mentioned that no grading of online formative assessment allowed them to make errors without being held accountable through their grades and learn from them. Online summative assessment, on the other hand, counts towards the final grade. Undergraduate and graduate students both reported increased anxiety and stress during online summative assessment, but not online formative assessment. They were afraid of making mistakes that would adversely affect their summative grade.

Third, the feedback for the two types of assessments differs. Online formative assessment provides feedback that indicates whether the answer is correct/incorrect, as well as additional explanatory information, whereas online summative assessment only indicates whether the answer was correct/incorrect. The findings of this study confirm and extend what is known about providing feedback in an online learning environment. Despite the fact that the feedback provided by both types of assessments was different, both undergraduate and graduate students appreciated the immediate feedback provided by both quizzes, which was more effective than the delayed feedback used in a traditional classroom. Although both quizzes gave immediate feedback, the timing of the feedback varied: formative feedback was given after each item, whereas summative feedback was given after all items were completed. Summative feedback had a short time lag compared to the immediate formative feedback. Such a delay may have an impact on students' perceptions of learning, rendering feedback less effective, and students may choose to ignore the summative feedback. According to Hattie and Timperly (2007), feedback has the greatest impact on supporting learning when it is provided during the learning process, at the moment knowledge is being constructed. This applies to the formative feedback as used in this study. Although summative feedback is provided at the end of the assessment, the delayed feedback nonetheless provided a summary of what students learned or did not learn. As a result, when developing online formative assessment, feedback should be provided immediately after students respond to each item. This study's findings also revealed that the most preferred type of feedback among undergraduate and graduate students was one that indicated whether an answer was correct or incorrect and provided additional explanatory information. This needs to be explored further, comparing which types of feedback are most effective in facilitating learning by providing high-quality directions for students' future learning.

Fourth, multiple choice questions were used for both online formative and summative assessment in this study. The format was well received by the majority of undergraduate and graduate students because multiple-choice questions are objective, quick, and simple to mark electronically. Furthermore, multiple-choice questions can cover a wide range of topics and test a broad range of content while being answered in a short period of time. However, instructional designers must continue to work on item quality so that they can measure a wide range of cognitive skills rather than just recall of facts. To assess higher order thinking, scenario-based multiple-choice questions should be developed in realistic contexts, in line with the social constructivist framework that new learning is constructed based on previous learning, and should be embedded in authentic and real-world contexts that engage students. Thus, more research is needed to investigate the factors underlying the effective use of scenario-based multiple-choice questions in online formative assessment.

Fifth and finally, in order to support students' independent learning, the online formative and summative assessment should be clearly aligned with the learning objectives of the module. The goal of online formative assessment is to inform students about their performance so that they can be prepared for the subsequent online summative assessment, online formative and summative assessment must be aligned in terms of item difficulty, content, and format. Online formative assessment, on the other hand, is designed to give students opportunities to evaluate the learning gained through independent online learning. In this case, online formative assessment must be designed to encourage students to self-assess using cognitive and metacognitive strategies, as well as resources management strategies, to guide their online learning independently.

Overall, both online formative and summative assessment are essential to complement each other in assessing students' progress in online learning environments. Both types of assessment contribute to improving student learning with online formative assessment focusing on the learning process and online summative assessment on the outcome. Taken separately, each has the limitation of only providing a snapshot of students' learning, which does not permit instructors to draw definitive conclusions about students' learning. To maximize the effectiveness of each assessment and present a whole picture of student learning, weaving together the two kinds of assessments provides both students and instructors a comprehensive understanding of student learning. Therefore, when designing online courses,

instructional designers should use a comprehensive assessment strategy that balances online formative and summative assessment.

Implication for Instructors

Online formative assessment is designed to provide students with feedback on their progress, but it can also provide valuable information to instructors. Because online formative assessment occurs while learning is taking place, it allows instructors to determine the needs of each student and then adjust instruction by leveraging technology to meet their learning needs. The ongoing log data collection through the LMS can assist instructors in gaining a complete picture of each student's online learning process, including details of each student's log-in and -out, quiz attempts, time spent on video viewing and formative quizzes, and so on. Instructors can use this information to understand where students are struggling and what they need to keep moving forward. The more data instructors collect, the better equipped they will be to meet the needs of their students. This study's findings offer several suggestions for how instructors can effectively incorporate online formative assessment into their instruction.

Undergraduates and Graduates. Different levels of online students, especially undergraduates versus graduates, use assessment and feedback in different ways. Instructors should take into account these differences.

Marks for Completing Online Formative Assessment. Students in both focus groups were asked to suggest ways to improve the effectiveness of formative quizzes. Some students reported that formative quizzes took up significant time and should be given some weight in terms of grades. Others were skeptical, suggesting that grades on formative quizzes would increase test anxiety and stress. This inherent difference in intrinsic versus extrinsic motivation leads to an important distinction between undergraduate and graduate students. Graduate students were found to have greater intrinsic motivation, which may have resulted in the higher value that they placed on online formative assessment over online summative assessment. Furthermore, graduate students were more concerned with the content and material, while earning a grade for formative quizzes was less important to them. Undergraduate students, on the other hand, were more motivated by extrinsic factors and viewed grades as indicators of the time they devoted to this activity. The results also revealed that undergraduate students put less value on formative than summative quizzes because formative quizzes had no bearing on their final grade. When the instructor fails to

give credit for the activity, undergraduate students dismissed it as valueless. While online formative assessment should not be graded, undergraduate students should receive credit for participating. Therefore, instructors should assign marks for completing online formative assessments, which will make undergraduate students take online formative assessment more seriously. Such a mark for the completion of online formative assessment is intended to encourage students' active participation because online formative assessments are embedded directly into learning, allowing them to make mistakes with no consequences. At the same time, online formative assessment should not be graded so that students treat it as practice rather than as a test, as online summative assessment is. Therefore, they would be willing to make multiple attempts to figure out what they understand and misunderstand during the learning process, and can correct themselves.

Clarification of Purpose of Online Formative Assessment. One clear finding of this study was the greater value that graduate students placed on online formative assessment. This appears to be related to graduate students' reliance on intrinsic motivation while undergraduates were more extrinsically motivated. Some undergraduate students in this study reported that they were unsure of the purpose of online formative assessment. Despite the fact that the purpose of formative quizzes was clearly stated in the syllabus, it appears that some undergraduate students did not understand or adopt the intended purpose of formative quizzes to support their learning, relying instead on their prior experience with online summative assessment. This implies that design for undergraduates necessitates a more thorough explanation of the purpose of online formative assessment at the start of the online course. It is recommended that instructors explicitly give undergraduate students a clear explanation of the uses and benefits of online formative assessment, perhaps by giving examples of how they should use the formative feedback. Graduate students' understanding of the purpose of their formative quizzes, on the other hand, was more often aligned with the instructor's intended purpose. This was made possible by the graduate students' previous exposure to various forms of online formative assessment, perhaps informed by their educational background knowledge. The study also discovered that students' perceived value of online formative assessment was related to their understanding of its purpose and validity. If undergraduate students better understood the purpose of online formative assessment, there is a greater likelihood that they would value online formative assessment more. As a result, undergraduate

students should be given the opportunity to participate in various types of online formative assessments during online learning in order to become acquainted with the nature of online formative assessment and to gain an understanding of its purpose and use.

Adapting Instruction. The findings also revealed the importance of recognizing that students have different backgrounds, with some lacking online learning experience, others having a busy schedule due to work and family obligations, others lacking familiarity with technology, others not as well prepared for maths or English, and still others struggling with taking online courses. As a result, students' decisions to complete as much or as little online formative assessment as they want should not be interpreted as a failure or limitation of the online formative assessment. Instructors need to recognize students' differences by identifying struggling students, adapting their instruction to students with diverse background, and providing timely support while learning is taking place.

Identifying Struggling Students. Previous research has frequently used time on task as a predictor of academic success. However, this was not the case for these statistics courses. The time spent on formative quizzes and final grade were negatively correlated, implying that struggling students spent more time on online formative assessment, as well as reporting higher anxiety. Thus, LMS data on formative quizzes (but not summative quizzes) allow instructors to identify struggling students – those who spend more time on formative quizzes -- and provide timely support. Typically, struggling students do not seek help and are poor at SRL. Instructors can also use students' SRL levels before and during the online course to determine which students are the most vulnerable and require the most support.

Adjusting for Students' Prior Experience. Several participants in the focus group stated that a lack of familiarity with computers, as well as with limited online learning experience and poor math background, all had an impact on their perceptions and use of online formative assessment. Therefore, instructors should recognize the different expectations from different students, and assist students in seeing the connection between the online course elements so that they can understand the alignment of course objectives, assessment, and learning activities from the start of the online course. Then, instructors should provide clear organization, easy navigation, and optimal readability to ensure that students can easily access the required technology and materials through a user-friendly interface. Furthermore,

instructors should clearly state their expectations for student performance, particularly in terms of interaction with course content, assessment, the instructor, and peers. Greater opportunities for students to seek guidance and support from instructors and peers should be created, resulting in a more supportive and effective online learning community.

Providing Timely Support during Online Learning. Instructors should make full use of the log data on online formative and summative assessment as a check to ensure students' understanding. The data collected during learning reveals a wide spectrum of the needs of online students. This requires that instructors make adjustment to instructions to address those needs. When the instructors identify students with learning gaps who require support, they should provide timely feedback and support. Instructors should take advantage of the flexibility offered by online learning to meet virtually and work with the smaller groups of students who share the same needs.

Encouraging the Use of SRL. Qualitative findings from the focus groups revealed that students experienced negative emotions with online summative assessments. One possible way of reducing students' negative emotions is to place a greater emphasis on online formative assessment over online summative assessment, because online formative assessment decreases test anxiety while online summative assessment increases it. Crucial to online learners is the confidence in approaching both online formative and summative assessment with an expectation that they will succeed. After providing feedback, instructors should make effort to encourage students to concentrate on continued use of their SRL skills to engage in effective and undisturbed study by face-to-face or virtual sessions.

Future Research

The findings of this study highlight several implications for online instructional design and instructors, as well as provide insights into future research of online formative assessment. There are three recommendations related to the sample, context of the study, and research design for future research.

Sample

The current study focused on the two online classes that used the same kind of multiple-choices online formative and summative assessment in order to make a

direct comparison between undergraduate and graduate students. Although this does not imply that the results are restricted to these two classes, it does limit the generalizability of the results. Therefore, future research should look into the effects of online formative quizzes on a larger scale, involving post-secondary students from a variety of disciplines. Replicating this study with a larger sample from different programs will provide comparative value in determining whether these results are generalizable to other groups of students. In addition to replicating the study, additional research should focus on addressing the following questions: 1) Can the findings of this study be applied to post-secondary students from different disciplines who are enrolled in various online courses? 2) Are the differences between undergraduate and graduate students in their approach to online formative assessment generalizable across other disciplines, courses, and universities? 3) Is there any difference between K-12 and postsecondary students when it comes to using online formative and summative quizzes?

Context of the Study

The current study examined students in online courses, however the students were enrolled in otherwise traditional face-to-face university programs. Further research should apply the approach used in this study to fully-online programs in higher education to investigate whether the findings of this study can be generalized to fully online students. Some students in this study struggled with online learning due to a lack of prior online experience and a lack of familiarity with technology. Future research should look into whether students' SRL improves as they progress through a fully online program, versus students who are struggling in their only online course. Focus-group participants in this study used their traditional class experience as a lens to reflect on their online courses, indicating that they saw face-to-face classrooms as the default modality. Future research would provide new perspectives in the context of fully online program.

In response to the COV19 pandemic, higher education institutions worldwide have been forced to transition to online course delivery since the beginning of 2020, just a few months after data for this study was collected. Such a massive shift from predominantly face-to-face instruction to nearly entirely online course delivery had a profound and long-lasting impact on postsecondary education, posing exceptional challenges and placing a significant burden on faculty and students, while highlighting the need for additional research to gain a better understanding of how to

effectively implement online formative assessment in an online setting. According to the findings of this study, these undergraduates and graduates used online formative versus summative assessment in different ways. Future research should investigate how different populations of students at various levels, ages, and faculties use online formative and summative assessments in online settings.

Research Design

This study used a sequential mixed-methods design to examine online courses in a university, one undergraduate and the other graduate. Data were collected at the beginning and the end of the course and indicated a change in the relationship between SRL and online formative assessment over the duration of the course. Future studies on online formative assessment should apply a more in-depth and detailed data collection using a longitudinal approach to track this change.

Participants. This study collected qualitative data through two focus groups, one undergraduate and the other graduate. It would be informative for future research to use several focus groups based on students' SRL levels, as well as focus groups with struggling students. Second, future research should include qualitative data from interviews with instructors. Because instructors implement the online course prior to interaction with students, interviews with instructors and course designers would be critical to investigate their understanding of online formative assessment, and its role in supporting and developing students' SRL.

Instrumentation. In this study, the well-known MSLQ was used to assess students' SRL at the beginning and end of the course. These results revealed that students changed their use of SRL over the duration of the course, but did not indicate when and how this change occurred. Future research should employ other SRL measurement approaches to assess students' SRL throughout the duration of the course, such as microanalysis (Cleary, 2011), thinking aloud protocols (Greene et al., 2011), and sequential and temporal analysis (Molenaar & Järvelä, 2014). Furthermore, a number of newer approaches to SRL measurement have been developed and implemented, which combine various features that promote SRL and measure the progress of students' SRL. Future research could, for example, ask students to keep learning diaries during online learning to reflect on their learning process before and after online formative assessment, in order to gain a better understanding of students' use of online formative assessment and the changes in their SRL strategies. At the same time, the ongoing reflection enabled by the learning diary

could support students' SRL. Questions that could be addressed with the help of these new measurements are: (1) Do students with high SRL use online formative assessment in a different way than students with low SRL? (2) Does students' SRL change after engaging in online formative assessment? (3) Do students employ different SRL strategies during the course? (4) Do students alter their SRL strategies when they are struggling? (5) Does the online course design shift students' motivation from intrinsic to extrinsic motivation? What factors might contribute to such a shift in motivation?

Data Collection. First, this study investigated several demographic variables, however, participants in the focus group mentioned that maths and English language background had an effect on their use of online formative assessment. Therefore, it is recommended that future research should conduct a basic survey at the beginning of the online course to help instructors become aware of students' maths and English level, which is needed to determine whether math and English language background, as well as other demographic variables, influence students' use of online formative assessment. Second, while this study investigated students' SRL, it did not directly examine whether students actually used the SRL strategies that they claimed to use. Thus, future research should use the new SRL measurements to identify which SRL strategies students actually use while doing online formative assessment. Third, this study used the time students spent on online formative quizzes to measure students' effort on online formative assessment because time on task is a commonly used measure of student engagement and is used to predict academic success. However, according to the findings of this study, spending more time on formative quizzes did not result in better learning outcomes. It was found that the students who spent more time on online formative assessment were those who struggled with online learning. As a result, time spent on task is a necessary but insufficient measure of student learning. There may be threshold effects such that a minimum amount of time is required for effective online formative assessment. Learning takes time, but more time does not guarantee that more learning will take place. Thus, time on task alone may not be sufficient for evaluating students' effort on online formative assessment. It is critical for future research to identify the threshold beyond which additional time does not facilitate learning. The non-linear relationship between time spent on online formative assessment and academic outcome underscores the need for future research to identify other factors that could measure students' effort on online formative

assessment. Fourth, although this study did not find a significant difference in students' SRL at the beginning and end of the course, it did not rule out the possibility that student use of SRL had changed during the course. Students' SRL may be an adaptation process that varies depending on the design of the online course, or it may be a more stable trait that is applied across multiple online courses. Thus, future research should look into the effect of course design on students' SRL to determine if it is a stable characteristic or a changing state shaped by the course design. Finally, this study only followed undergraduate and graduate students for one course. Research on online formative assessment with different populations of post-secondary students and using longitudinal research design is required to determine how online formative assessment influences students' learning and SRL across courses, as well as change in students' SRL as students gain more online learning experience.

Data Analysis. This study made use of limited LMS log data, which could provide a wealth of data about when students work on online formative assessments, how many attempts they make, how long they spend on those assessments, how long they watch online lectures, how actively they interact with peers, and so on. Future research with a larger sample size should use learning analytics to assess and analyze the LMS log data of students and their actions while using online formative and summative assessments. Such detailed data would be useful in determining whether students with higher SRL log in more frequently on online formative assessment, or are more active in interacting with peers, as well as their study habits when watching online lectures and using the discussion board.

Conclusions

This mixed-methods study first examined the effect of demographic variables on students' use of online formative versus summative assessment. Among all demographic variables studied, only educational level (undergraduate versus graduate) significantly predicted students' use of formative and summative quizzes. Undergraduate students put more effort into online formative assessment than graduate students, while graduate students scored higher on summative quizzes than undergraduate students. The study then looked into how undergraduate and graduate students approached formative and summative online quizzes in different ways. Despite the fact that both undergraduate and graduate students were given the same

type of multiple-choice questions for both formative and summative quizzes, the two groups demonstrated strikingly different patterns. Compared to undergraduate students, graduate students reported greater intrinsic motivation, scored higher on summative quizzes, and higher course satisfaction, but lower anxiety, spent less time on formative quizzes, and earned lower final marks. Furthermore, there was also a significant difference in undergraduate and graduate students' perceptions of online formative versus summative assessment. Undergraduate students were more satisfied with the summative quizzes while graduate students were more satisfied with formative quizzes. This represents an original finding that undergraduate and graduate students approached formative versus summative quizzes differently, providing new guidance for developing and implementing online formative and summative quizzes for different levels of students in higher education.

The study then investigated whether students' SRL influenced their different approaches to online formative and summative assessment. Students' SRL significantly predicted the amount of time spent on online formative assessment and scores on online summative assessment, as well as the reported value of both kinds of assessment. In an original contribution to research on SRL, results revealed a significant positive relationship between SRL during the course and students' effort on formative quizzes. This suggests that students' readiness for SRL increases their use of online formative assessment, which in turn facilitates students' SRL.

Finally, the study investigated what factors predicted students' academic performance and course satisfaction in this online learning context. There were three significant predictors of academic performance: previous online experience, effort on online formative assessment, and scores on summative quizzes. In terms of course satisfaction, students' SRL during the course – but not their pre-course SRL, was the only significant predictor of academic performance for undergraduate students, but did not predict academic performance for graduate students. Contrary to the expectation that more time on task would lead to higher grades, the students who spent the greatest amount of time on formative quizzes earned lower final grades. This finding suggests that instructors have an important source of information to identify struggling students and thereby offer timely support.

Taken together, quantitative and qualitative findings of this study suggest several implications for future research. These include specific features of instructional design for online formative assessment: online formative assessment should be

embedded in the materials; online formative assessment should be carefully aligned with both students' SRL and the final exam format. In addition, there are several recommendations for instructors to effectively use online formative assessment in their instruction: students should receive course credit for completing online formative assessments, the purpose of the online formative assessment should be made clear to the students beforehand, struggling students should be identified by their increased use of online formative assessment, and instructions should be adjusted to take into account students' prior online experience.

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Appendix A. Sample Copy of Demographic Questionnaire

1. Code Number: _____
2. Gender: _____
3. Age: _____
4. Ethnicity: _____
5. School/Faculty: _____
6. Educational Level:

   Undergraduate__ Graduate___
7. Are you a full-time student or apart-time student?

   Full-time___ Part-time___
8. How many other online courses have you taken? _____
9. Which online courses did you take?

   EDPE 375 __ EDPE 575__

Appendix B. Evaluation Questionnaire

Course Satisfaction

INSTRUCTIONS: The following questions ask you about your evaluation of this online course, and your perception of the value of the formative and summative quizzes in the online. THERE ARE NO RIGHT OR WRONG ANSWERS TO THIS QUESTIONNAIRE. THIS IS NOT A TEST. We want you to respond to the questionnaire as accurately as possible, reflecting your own attitudes and behaviors in this ONLINE course.

Background Information

- Code Number: _____
- Gender: _____
- Age: _____
- Which online courses did you take? EDPE 375 __ EDPE 575__
- Prior to this online course, have you ever completed an online course?

○ YES
○ NO

- Where did you complete the online course?

○ Home (off campus)
○ University
○ Other (please specify) _____

General Questions

Question 1

Please rate your overall satisfaction with this online course.

○ Very satisfied
○ Satisfied
○ Neutral
○ Dissatisfied
○ Very dissatisfied

Question 2

Overall, I have learnt a great deal from this course.

○ Strongly agree
○ Agree
○ Neutral
○ Disagree
○ Strongly disagree

Question 3

I would recommend this online course to other students.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 4

This online course increased my interest in statistics.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 5

Having completed the course, I feel knowledgeable in statistics.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 6

I am confident that I achieved the desired learning outcomes.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 7

Taking an online course gives me greater independence and flexibility with regard to the time and place.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 8

Based on this experience, I would take another online course in the future.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Questions on End-of-Video (Formative) Quizzes

There were two kinds of quizzes in your online class: ones that came up automatically at the end of a video, and one that you took for a mark after you had completed a whole module. Formative quizzes refer to the end-of-video quizzes that do not count for the final mark.

Question 9

Please rate the overall usefulness of the end-of-video (formative) quizzes.

- ○ Very useful
- ○ Useful
- ○ Neutral
- ○ Useless
- ○ Very useless

Question 10

What do you believe are the purposes of the end-of-video (formative) quizzes? (Please check **All** that apply.)

- ○ To support me to take more control of my learning.
- ○ To provide the marks in this course.
- ○ To give the instructor information about what I know.
- ○ To help identify my strengths and weakness.
- ○ To let me evaluate the learning at my own pace.

Question 11

The end-of-video (formative) quiz is a good way to direct my learning.

- ○ Strongly agree
- ○ Agree
- ○ Neutral
- ○ Disagree
- ○ Strongly disagree

Question 12

It is very helpful to retake the quiz as many as I want.

- ○ Strongly agree
- ○ Agree
- ○ Neutral
- ○ Disagree
- ○ Strongly disagree

Question 13

The number of questions in each end-of-video (formative) quiz is appropriate in assessing my understanding of the video.

- ○ Strongly agree
- ○ Agree
- ○ Neutral
- ○ Disagree
- ○ Strongly disagree

Question 14

The difficulty level of questions in the end-of-video (formative) quiz is appropriate in assessing my understanding of the video.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 15

The end-of-video (formative) quizzes appropriately test the material presented in the corresponding video.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 16

I become more motivated and engaged after taking the end-of-video (formative) quiz.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 17

The end-of-video (formative) quizzes affect my understanding of how much I had learned about statistics in each video.

- Yes, I realized that I knew MORE than I thought before
- Yes, I realized that I knew LESS than I thought before
- Yes, they confirmed my understanding
- No, they did NOT show what I had learned
- I don’t know.

Question 18

The end-of-video (formative) quizzes make me go through the video-lectures or readings so as to make an outline of important concepts.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 19

The end-of-video (formative) quizzes make me feel safer and under less pressure.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 20

Immediate and prompt feedback from the end-of-video (formative) quizzes help me get a better view of my learning progress and fill in the learning gap.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 21

The end-of-video (formative) quizzes help me identify the important items of the video and memorize the list.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 22

The end-of-video (formative) quizzes let me evaluate the learning at my own pace.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 23

The end-of-video (formative) quizzes make me more interested in studying statistics.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 24

The end-of-video (formative) quizzes help me make connections between readings and video-lectures.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 25

The end-of-video (formative) quizzes help me connect what I am learning in this course with ideas of my own.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 26

The multiple-choice questions are useful in assessing my understanding of the material.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 27

The end-of-video (formative) quizzes have a positive influence on my self-regulated learning.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 28

Please rate the overall usefulness of feedback in the end-of-video (formative) quizzes.

- Very useful
- Useful
- Neutral
- Useless
- Very useless

Question 29

I thoroughly reviewed the feedback after I finish the end-of-video (formative) quizzes.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 30

The end-of-video (formative) quizzes change the way I study in order to fit this online course.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 31

I choose to do the end-of-video (formative) quizzes that I can learn from, even though they do not count for my final mark.

- Strongly agree
- Agree
- Neutral

- Disagree
- Strongly disagree

Question 32

Which type of feedback is the most helpful for your learning?

- Indicate the answer was incorrect
- Indicate the response was incorrect AND provided further information to clarify
- Indicate the answer was correct
- Indicate the answer was correct AND supplemented it with the explanation
- Not sure

Question 33

What do you believe are the factors that may have affected your achievement in the end-of-video (formative) quizzes? (Please check **All** that apply.)

- The end-of-video (formative) quiz is NOT my priority given my other expectations.
- The end-of-video (formative) quizzes do NOT count for my final mark.
- I was too busy to complete the quizzes.
- I am NOT sure of the purpose of the assessment.
- The quizzes are too easy/difficult.

Question 34

Please identify the degree of efforts (seriousness) that you put forth in completing the end-of-video (formative) quizzes.

- Maximum effort
- Hard
- Moderate
- Light
- No effort

Question 35

The results of the end-of-video (formative) quizzes are accurate reflection of my understanding.

- YES
- NO

Question 36

I am able to complete the end-of-video (formative) quizzes at a convenient time and place.

- YES
- NO

Question 37

The end-of-video (formative) quiz is a fair assessment instrument.

- YES
- NO

Question 38

Have you completed all the end-of-video (formative) quizzes?

- YES
- NO

Questions on Summative Quizzes

Summative quizzes refer to module quizzes in each module which counts 20% of the final marks.

Question 39

Please rate the overall usefulness of module (summative) quizzes.

- Very useful
- Useful
- Neutral
- Useless
- Very useless

Question 40

What do you believe are the purposes of module (summative) quizzes? (Please check **All** that apply.)

- To support me to take more control of my learning.
- To provide the marks in this course.
- To give the instructor information about what I know.
- To help identify my strengths and weakness.
- To let me evaluate the learning at my own pace.

Question 41

The module (summative) quiz is a good way to direct my learning.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 42

It is very helpful to retake the quiz as many as I want.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 43

The number of questions in each module (summative) quiz is appropriate in assessing my understanding of the module.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 44

The difficulty level of questions in the module (summative) quiz is appropriate in assessing my understanding of the module.

- Strongly agree
- Agree

- Neutral
- Disagree
- Strongly disagree

Question 45

The module (summative) quizzes appropriately test the material presented in the corresponding module.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 46

I become more motivated and engaged after taking the module (summative) quiz.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 47

The module (summative) quizzes affect my understanding of how much I had learned about statistics in each module.

- Yes, I realized that I knew MORE than I thought before
- Yes, I realized that I knew LESS than I thought before
- Yes, they confirmed my understanding
- No, they did NOT show what I had learned
- I don’t know.

Question 48

The module (summative) quizzes make me go through the video-lectures or readings so as to make an outline of important concepts.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 49

The module (summative) quizzes make me feel safer and under less pressure.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 50

Immediate and prompt feedback from the module (summative) quizzes help me get a better view of my learning progress and fill in the learning gap.

- Strongly agree

- Agree
- Neutral
- Disagree
- Strongly disagree

Question 51

The module (summative) quizzes help me identify the important items of the module.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 52

The module (summative) quizzes let me evaluate the learning at my own pace.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 53

The module (summative) quizzes make me more interested in studying statistics.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 54

The module (summative) quizzes help me make connections between readings and video-lectures.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 55

The module (summative) quizzes help me connect what I am learning in this course with ideas of my own.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 56

The multiple-choice questions are useful in assessing my understanding of the material.

- Strongly agree

- Agree
- Neutral
- Disagree
- Strongly disagree

Question 57

The module (summative) quizzes have a positive influence on my self-regulated learning.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 58

Please rate the overall usefulness of feedback in the module (summative) quizzes.

- Very useful
- Useful
- Neutral
- Useless
- Very useless

Question 59

I thoroughly reviewed the feedback after I finish the module (summative) quizzes.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 60

The module (summative) quizzes change the way I study in order to fit this online course.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 61

I choose to do the module (summative) quizzes so that I can get a better grade for this course.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Question 62

Which type of feedback is the most helpful for your learning?

- Indicate the answer was incorrect

- Indicate the response was incorrect AND provided further information to clarify
- Indicate the answer was correct
- Indicate the answer was correct AND supplemented it with the explanation
- Not sure

Question 63

What do you believe are the factors that may have affected your achievement in the module (summative) quizzes? (Please check **All** that apply.)

- The module (summative) is NOT my priority given other faculty expectations.
- I thought it was just busy work.
- I was too busy to complete the quizzes.
- I am NOT sure of the purpose of the assessment.
- The quizzes are too easy/difficult.

Question 64

Please identify the degree of efforts (seriousness) that you put forth in completing the module (summative) quizzes.

- Maximum effort
- Hard
- Moderate
- Light
- No effort

Question 65

The results of the module (summative) quizzes are accurate reflection of my understanding.

- YES
- NO

Question 66

I am able to complete the module (summative) quizzes at a convenient time and place.

- YES
- NO

Question 67

The module (summative) quiz is a fair assessment instrument.

- YES
- NO

Question 68

Have you completed all the module (summative) quizzes?

- YES
- NO

Appendix C. MSLQ Questionnaire

The attached questionnaire asks you about your study habits, your learning skills, and your motivation for work in this course. THERE ARE NO RIGHT OR WRONG ANSWERS TO THIS QUESTIONNAIRE. THIS IS NOT A TEST. We want you to respond to the questionnaire as accurately as possible, reflecting your own attitudes and behaviors in this ONLINE course.

Part A. Motivation

The following questions ask about your motivation for and attitudes about this class. **Remember there are no right or wrong answers, just answer as accurately as possible. Use the scale below to answer the questions.** If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

1 2 3 4 5 6 7
not at all very true
true of me of me

Questions	1	2	3	4	5	6	7
1. In an online class like this, I prefer course material that really challenges me so I can learn new things.							
2. If I study in appropriate ways, then I will be able to learn the material in this online course.							
3. When I take a test I think about how poorly I am doing compared with other students.							
4. I think I will be able to use what I learn in this online course in other courses.							
5. I believe I will receive an excellent grade in this online class.							
6. I'm certain I can understand the most difficult material presented in this online course.							
7. Getting a good grade in this online class is the most satisfying thing for me right now.							
8. When I take a test I think about items on other parts of the test I can't answer.							
9. It is my own fault if I don't learn the material in this online course.							
10. It is important for me to learn the course material in this online course.							
11. The most important thing for me right now is improving my overall grade point average, so my main concern in this online course is getting a good grade.							
12. I'm confident I can learn the basic concepts taught in this online course.							
13. If I can, I want to get better grades in this online class than most of the other students.							
14. When I take tests, I think of the consequences of failing.							

15. I'm confident I can understand the most complex material presented by the instructor in the online videos.							
16. In an online class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.							
17. I am very interested in the content area of this online course.							
18. If I try hard enough, then I will understand the course material.							
19. I have an uneasy, upset feeling when I take tests.							
20. I'm confident I can do an excellent job on the quizzes and exam in this online course.							
21. I expect to do well in this online course.							
22. The most satisfying thing for me in this online course is trying to understand the content as thoroughly as possible.							
23. I think the course material in this online class is useful for me to learn.							
24. When I have the opportunity in this class, I choose formative quizzes that I can learn from even if they don't guarantee a good grade.							
25. If I don't understand the course material, it is because I didn't try hard enough.							
26. I like the subject matter of this online course.							
27. Understanding the subject matter of this online course is very important to me.							
28. I feel my heart beating fast when I take the exam.							
29. I'm certain I can master the skills being taught in this online class.							
30. I want to do well in this class because it is important to show my ability to my family, friends, employer, or others.							
31. Considering the difficulty of this online course, the teacher, and my skills, I think I will do well in this online class.							

Part B. Learning Strategies

The following questions ask about your learning strategies and study skills for this class. **Again, there are no right or wrong answers. Answer the questions about how you study in this class as accurately as possible.** Use the same scale to answer the remaining questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

1	2	3	4	5	6	7
not at all true of me						very true of me

Questions	1	2	3	4	5	6	7
32. When I study the readings for this online course, I outline the material to help me organize my thoughts.							
33. During the online video time I often miss important points because I'm thinking of other things.							
34. When studying for this online course, I often try to explain the material to a classmate or friend.							
35. I usually study in a place where I can concentrate on my online course.							
36. When reading for this online course, I make up questions to help focus my study.							
37. I often feel so lazy or bored when I study for this online class that I quit before I finish what I planned to do.							
38. I often find myself questioning things I hear or read in this online course to decide if I find them convincing.							
39. When I study for this online class, I practice saying the material to myself over and over.							
40. Even if I have trouble learning in this online course, I try to do the work on my own, without help from anyone.							
41. When I become confused about something for this online course, I go back and try to figure it out.							
42. When I study for this online course, I go through the readings, videos, and my notes and try to find the most important ideas.							
43. I make good use of my study time for this online course.							
44. If course readings are difficult to understand, I change the way I read the material.							
45. I try to work with other students to complete the course assignments.							
46. When studying for this online course, I read my class notes and the course readings over and over again.							
47. When a theory, interpretation, or conclusion is presented in the video or in the readings, I try to decide if there is good supporting evidence.							
48. I work hard to do well in this online class even if I don't like what we are doing.							
49. I make simple charts, diagrams, or tables to help me organize course material.							
50. When studying for this online course, I often set aside time to discuss with a group of students online or face-to-face.							
51. I treat the course material as a starting point and try to develop my own ideas about it.							
52. I find it hard to stick to a study schedule for this							

online course.							
53. When I study for this online course, I pull together information from different sources, such as lectures, readings, and discussion board.							
54. Before I study new course material thoroughly, I often skim it to see how it is organized.							
55. I ask myself questions to make sure I understand the material I have been studying in this online course.							
56. I try to change the way I study in order to fit the online course requirements and the instructor's teaching style.							
57. I often find that I have been reading for this online course but don't know what it was all about.							
58. I ask the instructor to clarify concepts I don't understand well.							
59. I memorize key words to remind me of important concepts in this online course.							
60. When course work is difficult, I either give up or only study the easy parts.							
61. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course.							
62. I try to relate ideas in this subject to those in other courses whenever possible.							
63. When I study for this online course, I go over my notes and make an outline of important concepts.							
64. When reading for this online course, I try to relate the material to what I already know.							
65. I have a regular place set aside for studying this online course.							
66. I try to play around with ideas of my own related to what I am learning in this online course.							
67. When I study for this online course, I write brief summaries of the main ideas from the videos, readings and my notes.							
68. When I can't understand the material in this online course, I ask another student for help online or face-to-face.							
69. I try to understand the material in this online course by making connections between the readings and the concepts from the lectures.							
70. I make sure that I keep up with the weekly readings, online quizzes and assignments for this course.							
71. Whenever I read or hear an assertion or conclusion in this online course, I think about possible alternatives.							
72. I make lists of important items for this online course and memorize the lists.							

73. Although we don’t have to attend daily classes, I still try to distribute my studying time evenly across days.							
74. Even when online course materials are dull and uninteresting, I manage to keep working until I finish.							
75. I try to identify students in this online course whom I can ask for help if necessary.							
76. When studying for this online course I try to determine which concepts I don't understand well.							
77. I often find that I don't spend very much time on this online course because of other activities.							
78. When I study for this online course, I set goals for myself in order to direct my activities in each study period.							
79. If I get confused taking notes in this online course, I make sure I sort it out afterwards.							
80. I rarely find time to review my notes or readings before quizzes or exam.							
81. I try to apply ideas from course readings in other course activities such as online lectures and discussion board.							

Appendix D. Interview Guide

Time of interview:
Date:
Place:
(distribute Letter of Information/Consent Form; once signed, administer pre-Interview Survey)

I am a Faculty of Education graduate student and I am studying the interactions between online formative assessment and students' self-regulated learning in online learning environments. The purpose of this focus group is to gather perspectives from you, as users of the online course, about the online assessment components in the course.

List of topics:

Topic 1 Students' experiences of learning in fully online learning context

Topic 2 Students' initial perception on two kinds of online quizzes

Topic 3 How are those perceptions altered through their experience?

Topic 4 How did you use in-the-video quizzes and module quizzes? Any differences?

Topic 5 How did you use the feedback from the in-the-video quizzes?
(a) immediately upon receiving it?
(b) when preparing for the midterm (or intend to use in preparation for final exam)?
(c) for other learning activities?

Topic 6 What value did the in-the-video quizzes have to your learning (e.g., benefits and challenges)? What do you think of having them online?

Topic 7 How do students evaluate their self-regulated learning skills after taking in-the-video quizzes?

Topic 8 How do students comment on the relationship between their academic performance and in-the-video quizzes?

Topic 9 If you had the opportunity to redesign the way in-the-video quizzes are done in this course to benefit your learning, how would you do it?

That concludes our focus group. I would like to thank you all for coming to participate in today's focus group. Your responses will be valuable to the research I am doing. Be assured that your responses will be confidential. Best of luck in your future studies!

(end recording)

Appendix E. Approval of Research Ethics Board

Research Ethics Board Office
James Administration Bldg.
845 Sherbrooke Street West. Rm 325
Montreal, QC H3A 0G4

Tel: (514) 398-6831

Website: www.mcgill.ca/research/researchers/compliance/human/

Research Ethics Board II
Certificate of Ethical Acceptability of Research Involving Humans

REB File #: 467-0418

Project Title: Students' Perception of the Effectiveness of Online Formative Quizzes in Promoting Self-Regulated Learning in Online Learning Environments

Principal Investigator: Ying Ji

Department: Educational and Counselling Psychology

Status: Ph.D. Student

Supervisor: Prof. Michael Hoover

Approval Period:

The REB-II reviewed and approved this project by delegated review in accordance with the requirements of the McGill University Policy on the Ethical Conduct of Research Involving Human Participants and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans.

Deanna Collin
Ethics Review Administrator, REB I & II

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* Approval is granted only for the research and purposes described.
* Modifications to the approved research must be reviewed and approved by the REB before they can be implemented.
* A Request for Renewal form must be submitted before the above expiry date. Research cannot be conducted without a current ethics approval. Submit 2-3 weeks ahead of the expiry date.
* When a project has been completed or terminated, a Study Closure form must be submitted.
* Unanticipated issues that may increase the risk level to participants or that may have other ethical implications must be promptly reported to the REB. Serious adverse events experienced by a participant in conjunction with the research must be reported to the REB without delay.
* The REB must be promptly notified of any new information that may affect the welfare or consent of participants.

McGill

Research Ethics Board Office
James Administration Bldg.
845 Sherbrooke Street West. Rm 325
Montreal, QC H3A 0G4

Tel: (514) 398-6831

Website: www.mcgill.ca/research/researchers/compliance/human/

Research Ethics Board II
Certificate of Ethical Acceptability of Research Involving Humans

REB File #: 199-1018

Project Title: Exploring the relationship between online formative quizzes and students' self-regulated learning in online learning environments.

Principal Investigator: Ying Ji **Department:** Educational & Counselling Psychology

Status: Ph.D. Student **Supervisor:** Professor Michael Hoover

Approval Period: November 27, 2018 to November 26, 2019

The REB-II reviewed and approved this project by delegated review in accordance with the requirements of the McGill University Policy on the Ethical Conduct of Research Involving Human Participants and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans.

Georgia Kalavritinos
Ethics Review Administrator

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* Approval is granted only for the research and purposes described.
* Modifications to the approved research must be reviewed and approved by the REB before they can be implemented.
* A Request for Renewal form must be submitted before the above expiry date. Research cannot be conducted without a current ethics approval. Submit 2-3 weeks ahead of the expiry date.
* When a project has been completed or terminated, a Study Closure form must be submitted.
* Unanticipated issues that may increase the risk level to participants or that may have other ethical implications must be promptly reported to the REB. Serious adverse events experienced by a participant in conjunction with the research must be reported to the REB without delay.
* The REB must be promptly notified of any new information that may affect the welfare or consent of participants.
* The REB must be notified of any suspension or cancellation imposed by a funding agency or regulatory body that is related to this study.
* The REB must be notified of any findings that may have ethical implications or may affect the decision of the REB.

Appendix F. Recruitment Notice

Subject: Invitation to Participate in a Research Project

Dear students in EDPE 375/575,

I am writing to ask if you would be willing to participate in a study of online quizzes. This study concerns the relationship between online quizzes and students' self-regulated learning. I am also interested in what predicts successful academic outcome and satisfaction in online courses. This research will hopefully lead to a better understanding of online quizzes and eventually be used to help students improve self-regulated learning skills and academic performance in online learning environments.

Your participation is voluntary with the minimum age requirement of 18 years. If you volunteer as a participant in this study, you will be asked to complete online questionnaires twice, which take approximately 1/2 hour of your time. We also ask for your permission to access the information about your quiz-taking, quiz scores and final mark for the class from MyCourses at the end of term. Your responses and information from MyCourses will remain strictly confidential and will be used only for the purposes of this research project.

I would like to assure you that this study has been reviewed and received ethics clearance through McGill Research Ethics Board. Your participation will not have any effect on your academic standing.

If you are interested in participating, please contact me via the email address provided below. I will send, by email, a Consent Form.

If you have any other questions about this study, please contact me at ying.ji@mail.mcgill.ca, or my supervisor, Prof. M.L. Hoover (michael.hoover@mcgill.ca).

Sincerely,
Ying Ji
Doctoral candidate, Faculty of Education

Appendix G. Letter of Information

Study name: Students' Perception of the effectiveness of online formative quizzes in promoting self-regulated learning in online learning environments

Researcher: Ying Ji (doctoral candidate)
Faculty of Education, McGill University
ying.ji@mail.mcgill.ca

Supervisor: Prof Michael Hoover, PhD
Faculty of Education, McGill University
michael.hoover@mcgill.ca

Purpose

The purpose of my study is to understand students' perception of assessment in online university classes, and how this affect their self-regulated learning (SRL). Through your participation in a focus group, I hope to obtain a better picture of the ways in which students use online formative quizzes.

The study

If you agree to participate in the study, you will sit with other students in a focus group lasting approximately one hour. I will ask about your experiences of online courses, your perceptions of online formative quizzes and how you interacted with the online quizzes. None of the questions I ask will involve specific personal issues. I will be audio and video recording the focus group to obtain an accurate transcript of our conversation, which will later be transcribed. The original recording will be deleted once the transcript has been generated. All documents will be transferred to hard-disk and password-protected.

Risks

The risks involved in your participation are minimal. The participation is totally voluntary and will not affect y our grades. You do not need to answer any questions that make your uncomfortable or that you simply do not wish to answer. Your participation is voluntary, and you can withdraw at any time without consequences. Upon withdrawal, you may request removal of all or part of your data.

Confidentiality

All information gathered in this study will be kept completely confidential. Only code names for participants will appear in transcriptions and notes. Every effort will be made to protect your confidentiality to the extent possible. No reference will be made either in written and oral presentations or publications, which could link your name to the study.

Only the researcher and the supervisor listed above will have access to any data or information with your name attached. All data will be stored in a locked facility at McGill University. As part of the qualitative data analysis, quotations will be drawn from transcripts and reported in support of themes that arise. These quotations may be published or presented in the dissertation, at conference presentations, or in journal articles.

Benefits

Exploring how SRL is incorporated into the instructional design of online courses becomes more critical for improving the academic performance and supporting the learners' acquisition of SRL skills in online learning environments. Findings from this research may augment the body of knowledge regarding online formative assessment, especially the use of online quizzes, adding information to the gap that currently exists.

Questions about the study

Any questions about study participation may be directed to Ying Ji, via email (ying.ji@mail.mcgill.ca) or call (613-791-5979) daytimes or evenings, or my supervisor, Prof. M.L. Hoover (michael.hoover@mcgill.ca).

Any ethical concerns about the study may be directed to the McGill Ethics Manager at (514) 398-6831 or lynda.mcneil@mcgill.ca.

Appendix H. Consent Form

Participant Consent Form

for the study of

EXPLORING THE RELATIONSHIP BETWEEN ONLINE FORMATIVE QUIZZES AND STUDENTS' SELF-REGULATED LEARNING IN ONLINE LEARNING ENVIRONMENTS

Researcher: Ying Ji
ying.ji@mail.mcgill.ca
Learning Sciences PhD Program
Faculty of Education, McGill University

Supervisor: Prof Michael Hoover, PhD
michael.hoover@mcgill.ca
Faculty of Education, McGill University

Purpose of the Study

With the increasing popularity of online learning, a variety of online assessments have emerged and been widely used with learning management systems in universities. The purpose of my study is to understand the relationship between online quizzes and online students' self-regulated learning (SRL). This case study will also examine students' use of online formative quizzes versus summative quizzes. In addition, the study also investigates how SRL and student's effort on online quizzes is affected by demographic variables. The researcher will also test whether the interaction between students' SRL and demographic variables affects students' academic achievement and course satisfaction in online courses.

Study Procedures

You are invited to participate in this study which will involve completing two sets of online questionnaires with the option of attending a focus group at the end of the semester. Questionnaires on SRL (MSLQ) will be filled in twice, at the beginning and the end of semester. One online questionnaire on course satisfaction will be completed at the end of semester. Once the course is over, we will analyze your responses to questionnaires in light of your summative quiz marks and final marks, as well as data collected by MyCourses as to the frequency of online quizzes and time spend on online quizzes. At the end of the semester, there is an additional opportunity to take part in focus groups concerning your perception of online quizzes, but participation in the focus group is not a required part of participation in the main study.

Online Questionnaires	When	Time required
MSLQ	Beginning of term	30 minutes maximum
MSLQ	End of term	30 minutes maximum
Course satisfaction	End of term	30 minutes maximum

Voluntary Participation

Your participation in this study is entirely voluntary whether you choose to participate or not, it will not affect your grades on the course. You are free to skip over or not answer any of the questions in the questionnaires. You may withdraw from the study at any time or refuse further participation in the study without consequences. If you

withdraw, your information will not be used in any analysis and destroyed immediately. You are encouraged to ask questions about the study if you have any doubts or questions throughout the study. There are no anticipated risks to you by participating in this research.
All data from this study will be kept for 7 years as per McGill University requirement after which time it will be destroyed. Results will be disseminated to McGill University in partial fulfillment of a Doctor of Philosophy (PhD) degree, to various conferences and publications related to field of the learning sciences.

Benefits
If you participate, you will receive the individual report on your SRL skills and motivation that you may want to improve in the future study. But if you choose not to get the report on your SRL skills, participating in the study might not directly benefit you, but we hope to explore how SRL is incorporated into the instructional design of online assessment and what predicts academic performance and supporting the learners' acquisition of SRL skills in online learning environments. Furthermore, findings from this research may augment the body of knowledge regarding the difference of students' input on online formative and summative quizzes, adding information to the gap that currently exists. We are unable to offer you any compensation for your participation in this study.

Risks
There are no anticipated risks to you by participating in this research.

Confidentiality
All your data from the questionnaires that includes personal and demographic data, as well as any data and marks from MyCourses (if you consent) will be kept confidential and be stored using a code ID and de-identified prior for use in my thesis and public presentations in the form of aggregate results. Only the researcher and the supervisor listed above will have access to any data or information with participant code number attached. All data will be saved in password-protected files or folders on a password-protected computer located in an office in the Faculty of Education building.

Contact Information/Enquiries
Do not hesitate to contact me for any inquiries about the study. You may reach me, Ying, via email (ying.ji@mail.mcgill.ca) or call (613-791-5979) daytimes or evenings, or my supervisor, Prof. M.L. Hoover (michael.hoover@mcgill.ca). If you have any questions or concerns regarding your rights or welfare as a participant in this research study or comments regarding manner in which the study is being conducted, you may directly contact the McGill Ethics Manager at (514) 398-6831 or lynda.mcneil@mcgill.ca.

IMPORTANT: Please print and sign below if you agree to participate in this study. Sign only after having read the consent document and having received answers to any questions you might have. You must be 18 years of age or older to participate in this study. By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) from their legal and professional responsibilities.

IMPORTANT: Please print and sign below if you agree to participate in this study. Sign only after having read the consent document and having received answers to any

questions you might have. You must be 18 years of age or older to participate in this study. By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) from their legal and professional responsibilities.

Please sign below if you have read the above information and consent to participate in this study, and to permit the researcher access to information on MyCourses concerning

- The dataset of my quiz-taking behavior ☐YES ☐NO
- The dataset of my quiz marks ☐YES ☐NO
- The dataset of my mid-term and final course marks ☐YES ☐NO

Agreeing to participate in this study does not waive any of your rights or release the researchers from their responsibilities. A copy of this consent form will be given to you and the researcher will keep a copy.
Participant's Name: (please print)
_____
Participant's Signature: _____ Date:
_____

Focus Group. I further agree to be contacted to invite my participation in the focus group concerning the online quizzes for this course. Signing here does not oblige me to participate, it simply gives the researcher permission to contact me for possible participation in an interview or focus group.

Participant's Name: (please print) _____
Participant's Signature: ____
Date: _____
Email address: _____