Unveiling the Complexities of Student Satisfaction in E-Learning: An Integrated Framework for the Context of COVID-19

RUI LIN

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Abstract

Amidst the global pandemic's reshaping of education, our study investigates e-learning dynamics in Canadian higher education. Integrating the Technology Acceptance Model (TAM), the DeLone and McLean Information Systems Success Model (D&M ISS), and the Expectation Confirmation Model (ECM), we introduce the innovative C-RES framework. This framework, which stands for COVID-19 Remote E-learning System, uniquely addresses the complexities of e-learning systems and their role in student satisfaction during COVID-19. Through Structural Equation Modeling (SEM) analysis of responses from a diverse pool of graduate students across Canada, we uncover relationships among psychological factors, quality dimensions, and social influences. We demonstrate how self-efficacy, IT anxiety, and perceived system and information quality significantly influence students' ease of use and usefulness perceptions, impacting their satisfaction and commitment to Learning Management Systems (LMS). Our findings reveal that e-learning quality lies not only in technology but also in content, and highlight the significant influence of individual confidence and community dynamics on student experiences. These insights provide actionable strategies for enhancing the effectiveness and resilience of e-learning systems, especially in crises. While focusing on the Canadian pandemic context, our research suggests exploring demographic influences in future studies. This thesis serves as a foundation for future e-learning explorations, pushing educational technology boundaries during global disruptions and offering key strategies for resilience and effectiveness in higher education.

Keywords: *COVID-19, E-learning, Student satisfaction, Education Technology, ICT*

To my beloved Parents, Huabin and Qian

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List of Abbreviations

AGFI Adjusted Goodness-of-Fit Statistic 70

AVE Average Variance Extracted 61

C-RES COVID-19 Remote E-learning Systems 25

CFA Confirmatory Factor Analysis 52

CFI Comparative Fit Index 71

COVID-19 Coronavirus Disease 2019 1

CR Composite Reliability 61

D&M ISS DeLone and McLean Information System Success Model 6

ECM Expectation Confirmation Model 5

GFI Goodness-of-Fit Statistic 70

ICT Information Communication and Technology 3

IT Information Technology 12

LMS Learning Management Systems 14

NFI Normed-Fit Index 71

RMSEA Root Mean Square Error of Approximation 70

RMSR Root Mean Square Residual 70

SEM Structural Equation Modeling 8

TAM Technology Acceptance Model 5

UNESCO The United Nations Educational Scientific and Cultural Organization 2

UTAUT The Unified Theory of Acceptance and Use of Technology 17

WHO World Health Organization 1

Chapter 1

Introduction

In the modern era, technological advancements have fundamentally reshaped educational practices, impacting how we learn, teach, and engage professionally. These technologies, far beyond mere conveniences, have assumed a critical role, especially highlighted by the unprecedented challenges posed by the Coronavirus Disease 2019 (COVID-19) pandemic. This research focuses on e-learning satisfaction, particularly in environments where traditional educational methods are supplemented or replaced by digital platforms.

Declared a global health crisis by the World Health Organization (WHO) in 2020, COVID-19 catalyzed a seismic shift in the educational landscape [111, 81]. This sudden disruption transformed e-learning platforms from supplementary tools to the primary medium of instruction, necessitating a conceptual shift in how educational services are delivered and consumed. [111]. Higher education institutions, facing uncharted challenges, had to rapidly adapt. This adaptation was not just to maintain educational continuity but also to ensure its quality [81]. In response to government-imposed lockdowns and social distancing measures, stakeholders, including administrators, faculty, and students, were

compelled to re-evaluate and optimize technological tools to ensure both continuity and quality in education.

1.1 Background of The Study

The global educational landscape has experienced profound transformations in the last three years, notably transitioning from traditional, in-person teaching to remote instruction. As per a recent The United Nations Educational Scientific and Cultural Organization (UNESCO) report, this shift impacted over 1.9 billion students in 190 countries [197]. Originally driven by the COVID-19 pandemic's urgent demands, this swift embrace of e-learning marked a departure from earlier, more planned online education initiatives, characterized by their immediacy and lack of preparation. Unlike previous gradual shifts to online learning, which involved extensive planning and strategy development, the pandemic-driven transition was a reactionary response to an unprecedented crisis [2]. Initially developed for conventional instruction, these educational methods, during the pandemic, quickly adapted course design and evaluation methods to address immediate needs. Despite initial assumptions that educational methods would revert to traditional formats post-crisis, educators and learners found themselves navigating a new, stress-laden landscape fraught with anxiety and uncertainty.

Learning management systems, a cornerstone of educational technology, have significantly influenced higher education [48]. These platforms are not mere information delivery mechanisms; they provide interactive environments that enrich the learning experience. Whether in traditional, blended, or fully online models, they have transformed educational engagement dynamics. The abrupt dependence on e-learning platforms highlighted systemic vulnerabilities, confronting students and instructors with the challenge of rapidly

adapting to new methodologies without adequate support or resources. This shift necessitated not only a technological adjustment but also a pedagogical one, all amidst the pandemic's uncertainties. Concurrently, the increased online activity stressed both internet and Information Communication and Technology (ICT) infrastructure, underlining the need for a resilient re-evaluation of educational systems.

In this thesis, we explore the intricacies of student satisfaction, the perceived usefulness of e-learning platforms, and the effectiveness of online interactions in higher education during the pandemic. By examining these aspects, we seek to understand the transition from an emergency state to a more stable, albeit altered, educational environment.

1.2 Statement of the Problem

While e-learning platforms have been prevalent before COVID-19, their rapid and large-scale adoption during the pandemic was unparalleled. The global health crisis necessitated an urgent transition to online education, putting considerable strain on educators and the supporting technology infrastructure [65]. This abrupt shift exposed various challenges, including digital access disparities, frequent technological disruptions, and an increase in distractions. Such challenges have significantly impacted students' satisfaction with e-learning [131].

The pandemic's forced shift to e-learning revealed a broad spectrum of difficulties. These included not only technological and infrastructural issues but also heightened distractions that were particularly pronounced in the digital learning environment. While e-learning has become a staple in modern education, the factors influencing student satisfaction, particularly among graduate students, are less understood. These students, known for their autonomous learning approach and intensive use of e-learning platforms, provide

unique insights into the e-learning experience. As e-learning continues to play a critical role in education, understanding the determinants of student satisfaction in these settings becomes increasingly important. This research aims to explore these factors, with a focus on the experiences of graduate students, to derive insights that could enhance e-learning systems' resilience and effectiveness, particularly in anticipation of future global disruptions.

1.3 Research Motivation

The advent of the COVID-19 pandemic precipitated a sweeping and unprecedented shift towards e-learning worldwide, fundamentally transforming higher education dynamics. While there have been studies in diverse geographical contexts, like those by Almusharraf et al [20, 181]. and Simsek et al. in Saudi Arabia and Turkey respectively, the unique challenges of e-learning within North American territories, specifically Canada, during the pandemic remain under-explored.

Define the Research Gap: Despite various studies, a significant gap persists in understanding the impact of the rapid e-learning transition on student satisfaction in Canada. The Canadian higher education environment, characterized by its distinct policies, student demographics, and educational culture, requires a more focused analysis of e-learning efficacy and student satisfaction during COVID-19.

Bridging the Research Gap: This study seeks to fill this gap by examining the various factors influencing student satisfaction in the unique socio-educational context of Canada during the pandemic. We aim to understand how these factors interacted with the emergency shift to virtual learning platforms.

Assessing Policy Effectiveness: Additionally, our research will evaluate the effective-

ness of Canadian initiatives like the 'Support for Student Learning During COVID-19' program [39, 38]. By examining these aspects, this study aims to contribute not only to the Canadian higher education sector but also to the broader global discourse on e-learning efficacy in times of crisis.

1.4 Research Purpose

The primary aim of this research is to address specific gaps in the literature regarding student satisfaction within e-learning environments, with a particular focus on the context of the COVID-19 pandemic in Canadian higher education. Our research targets the less explored intricacies and challenges unique to the Canadian context during this pandemic-driven shift in education. To comprehensively analyze the multifaceted nature of e-learning experiences, we employ a multi-pronged strategy, integrating several theoretical models:

- Technology Acceptance Model (TAM): Central to our study, TAM explores students' perceptions of e-learning platforms, particularly in terms of perceived usefulness and ease of use. This model allows us to examine the cognitive and emotional dynamics influencing students' interactions with e-learning technologies, revealing the underlying factors driving their engagement.

- Expectation Confirmation Model (ECM): ECM is crucial in assessing the performance and satisfaction students derive from their actual experiences with e-learning platforms. By focusing on the tangible outcomes, ECM helps us identify elements that either enhance or diminish student satisfaction, offering deeper insights into their lived experiences.

- DeLone and McLean Information System Success Model (D&M ISS): The D&M model provides a comprehensive framework for assessing e-learning platforms, considering technical aspects, content quality, and service experience. Its inclusion ensures a thorough evaluation of all dimensions affecting student satisfaction, from system robustness to content richness.

The integration of these models achieves two main objectives. First, it ensures a multifaceted analysis by addressing distinct dimensions of e-learning. Second, their collective insights offer a holistic view, leaving no critical aspect of the e-learning experience unexamined. Specifically chosen for their relevance to the Canadian higher education context during the pandemic, these models enable a detailed understanding of the factors influencing student satisfaction. Through this synthesis, our research seeks to uncover the complex dynamics shaping student satisfaction in Canadian e-learning environments against the backdrop of the COVID-19 pandemic.

1.5 Research Questions

This study aims to delve into the complex dynamics of student experiences and perceptions regarding the rapid transition to e-learning necessitated by the COVID-19 pandemic. The research questions are designed to unravel the unique challenges and opportunities presented by this exceptional context in Canadian higher education:

RQ1: How satisfied were students in Canadian higher education with the quality and delivery of e-learning during the COVID-19 pandemic? Which specific dimensions of e-learning yielded higher or lower satisfaction levels among Canadian students?

RQ2: What determinants or factors (technical, pedagogical, psychological, etc.) most

significantly impacted student satisfaction or dissatisfaction with e-learning during this pandemic? To what extent did technical glitches, communication barriers, or limitations in learning resources influence this satisfaction?

RQ3: Based on students' experiences and identified challenges, what specific enhancements can be proposed for learning management systems to bolster student satisfaction with e-learning?

The aim of these research questions is not only to provide a comprehensive understanding of the factors influencing the effectiveness and limitations of e-learning but also to offer actionable recommendations. These recommendations are intended to inform educational policymakers, administrators, and instructional designers about ways to improve e-learning platforms in higher education, particularly within the Canadian context.

1.6 Thesis Outline

This thesis is organized into six chapters, each contributing uniquely to our understanding of e-learning in the context of the COVID-19 pandemic within Canadian higher education. Chapter 1 serves as the introduction, setting the stage for the study. In Chapter 2, we dive into the evolving world of e-learning, underscoring its growing significance in higher education. This chapter provides a detailed review of key theories and models essential for comprehending various facets of student engagement, satisfaction, and achievement in online learning environments. Chapter 3 unveils the research model developed for this study. It synthesizes the existing literature while highlighting the gaps and challenges this research seeks to address, forming the basis for our hypotheses. Chapter 4 meticulously outlines the methodological framework, detailing the data collection techniques, sample selection rationale, and data gathering instruments. This methodology sets the stage for Chapter 5's

in-depth analysis using Structural Equation Modeling (SEM), aimed at dissecting the data to uncover the myriad factors influencing e-learning experiences. The thesis conclude with Chapter 6, which engages in a comprehensive discussion of the findings. Here, we contrast our results with existing literature to derive meaningful inferences and implications for the educational field. This chapter also delineates the study's limitations and suggests avenues for future research, offering a road-map for scholars and practitioners interested in further explorations within the e-learning domain. Overall, the structure of this thesis is designed to provide a thorough understanding of the challenges and opportunities presented by e-learning, particularly during the unprecedented times of the COVID-19 pandemic in higher education.

Chapter 2

Literature Review

In this chapter, we embark on a comprehensive exploration of the existing literature relevant to e-learning, focusing on its implications during the COVID-19 pandemic and its potential impact on student satisfaction. The review is critical in contextualizing our study, especially considering the unique context of the COVID-19 pandemic. This approach enables a more focused examination of the various factors that influence student satisfaction in e-learning environments. The literature review is methodically divided into three key sections: Contextual Background of E-learning in the COVID-19 Era: This section delves into the overall landscape of e-learning during the pandemic, providing insights into how this global crisis has reshaped educational paradigm; E-Learning in Higher Education: Here, we explore the specific nuances of e-learning within the realm of higher education, focusing on its evolution, challenges, and opportunities in the context of the pandemic; Foundational Theoretical Models: This section introduces and discusses the critical theoretical models that underpin our study, offering a deep understanding of the frameworks guiding our analysis of student satisfaction in e-learning. Together, these sections weave a

coherent and comprehensive narrative on the current state of e-learning. This narrative not only enriches our understanding but also lays a solid foundation for the research questions and hypotheses that we will investigate in the subsequent chapters. Through this systematic exploration, we aim to anchor our study in a well-established body of knowledge, ensuring that our inquiry is both grounded and expansive in its scope.

2.1 Definition of E-learning

In this research, e-learning is conceptualized as the utilization of information and communication technology for structuring and delivering learning content. This definition, derived from the foundational works of Sun and Liaw, encompasses the creation of virtual learning environments designed to achieve pedagogical objectives like interactivity, assessment, and communication [187, 123]. E-learning encompasses two primary phases: content development and content delivery. Content development includes curriculum planning, instructional design, multimedia creation, and assessment preparation. Content delivery, on the other hand, involves disseminating educational content, engaging students, and conducting evaluations [105]. Our study distinguishes between these phases to analyze their individual contributions to the overall e-learning experience.

Central to modern e-learning efforts are Learning Management Systems (LMS) such as Moodle, Blackboard, and Canvas. These platforms integrate content development and delivery, thereby enhancing the user experience through streamlined access to course materials and facilitating real-time evaluations [32]. In the context of the COVID-19 pandemic, the significance of e-learning in student satisfaction has become increasingly paramount. While the pandemic has shaped the e-learning landscape, our primary focus is to explore the multifaceted nature of e-learning satisfaction, encompassing factors from academic

content quality to resource accessibility and instructor proficiency [187, 151].

Our research delves into these elements, particularly in the pandemic-driven shift towards e-learning. We aim to fill gaps in existing literature regarding the efficacy of digital learning communities, with a special focus on the experiences of graduate students. Their academic needs and expectations may differ significantly from undergraduates [151, 72]. By situating this research within the Canadian context and its widespread use of platforms like Moodle, Blackboard, and Canvas, we introduce a regional perspective to the global discourse on e-learning satisfaction. Ultimately, this study aims to provide insights that will help educational institutions and policymakers navigate the challenges of maintaining quality education during and beyond pandemic times, with a particular focus on the experiences of advanced students in Canadian higher education.

2.1.1 Learning Boundaries: Physical vs. Virtual

Understanding the nuances distinguishing physical from virtual learning environments is critical in identifying factors influencing student satisfaction, a need accentuated by the COVID-19 pandemic. E-learning, vast in its scope, shares inherent similarities with traditional learning. However, the shift to virtual platforms has amplified certain nuances, making this comparison vital. Prior to the pandemic, e-learning was often seen as complementary to traditional classroom learning, typically existing within a blended approach that combined face-to-face instruction with online elements. This model, endorsed by scholars like Ates for its potential to revolutionize higher education, suggested a synergy between physical and virtual learning methods [27]. Sun expanded on this, viewing e-learning not merely as content delivery but as encompassing digital communication, social interaction, and more, contributing to a holistic educational experience [187].

However, the advent of COVID-19 necessitated an abrupt shift to a predominantly remote learning model. This transition, more reactive than deliberate, brought to the fore challenges previously dormant or less pronounced in traditional settings. It transcended mere online accessibility of learning materials, raising concerns about student mental well-being, Information Technology (IT) infrastructure adequacy, and the actual effectiveness of virtual learning platforms [187, 72]. In this reshaped, pandemic-influenced educational landscape, our research aims to dissect how these intensified challenges impact student satisfaction, with a specific focus on graduate program students. By contrasting the physical and virtual learning boundaries, we seek to understand the unique aspects that contribute to or detract from the e-learning experience, particularly in the context of advanced higher education.

2.1.2 E-learning During the COVID-19 Pandemic

The COVID-19 pandemic catalyzed a global shift, transforming e-learning from an auxiliary educational approach to an essential tool for academic continuity [57]. This dramatic shift necessitated a reevaluation of educational efficacy indicators, turning attention towards course design quality, pedagogical innovations, and adaptability in remote teaching environments [19].

While there is extensive research on e-learning, focusing predominantly on technological frameworks and learner-instructor interactions [14, 87], a gap remains in examining the pandemic-specific challenges and opportunities. These challenges are multifaceted, ranging from technological reliability issues to the emotional strain experienced by educators and students in these unprecedented times [66, 14].

In our study, we methodologically approach e-learning satisfaction by considering vari-

ous external factors that influence it. This approach allows us to examine the satisfaction of e-learning in diverse circumstances, isolating its effects from other external challenges. This perspective is particularly crucial in understanding the distinct experiences of graduate students, a group with unique educational needs and expectations. Our research aims to address these identified gaps in the literature. We seek to provide actionable insights to enhance the resilience and effectiveness of e-learning systems in the face of challenges akin to the COVID-19 outbreak. Through this endeavor, we aspire to contribute to the academic conversation on e-learning, extending beyond the current boundaries of scholarly knowledge, especially in the context of advanced education during a global crisis.

2.2 E-learning in Higher Education: A Multidimensional Exploration

In higher education, the integration of e-learning has become a focal point of academic attention, with much of the existing scrutiny centered on its technological attributes and democratization potential [120, 199]. However, to understand e-learning in its entirety, we must recognize it as a transformative shift in pedagogical strategies with significant implications for educational outcomes [137]. Our comprehensive approach to e-learning involves examining it through a tripartite framework [187, 123, 206]:

- **Components**: E-learning encompasses a curated collection of resources, including multimedia presentations, dynamic modules, and tailored assessments, catering to diverse learning needs.
- **Methods**: Its digital foundation introduces innovative content delivery methods,

ranging from virtual classrooms to digital libraries, facilitating a personalized learning experience.

- **Purpose**: E-learning serves not only academic goals but also professional development, fostering continuous learning, community-building, and collaborative learning.

This multidimensional perspective allows us to fully appreciate e-learning's agile and student-focused model.

While e-learning is often touted as a universal solution [36], our study adopts a more boarded view, acknowledging its varied impacts across different contexts. The COVID-19 pandemic provides a consistent backdrop for assessing e-learning dynamics. This approach enables an in-depth examination of e-learning's capabilities and constraints during this unique period. Our study aims to unveil the complex interplay of design of content, technology, and user experience in e-learning and their collective impact on student engagement and satisfaction. For instance, a well-designed user interface coupled with reliable technology can significantly boost student involvement. Our dual objectives are to uncover the roles of students and educators in shaping e-learning and to identify key factors that contribute to a fulfilling e-learning experience. Ultimately, our research seeks to enrich the discourse on e-learning, moving beyond simplistic views to offer a comprehensive analysis that leverages its strengths while addressing its challenges.

2.2.1 Learning Management Systems in Higher Education

In this study, Learning Management Systems (LMS) like Moodle, Blackboard, and Canvas are examined as critical infrastructural components in the e-learning landscape, particularly amidst the COVID-19 pandemic. These platforms transcend the traditional digital

framework for content delivery, acting as dynamic spaces for communication, evaluation, and resource-sharing [178]. However, a key inquiry often overlooked in the literature is how educational institutions tailor these LMS platforms to meet diverse learning objectives, a question of increased relevance during the pandemic [166]. Our research seeks to explore this, focusing on students' experiences and perceptions of these platforms in a predominantly remote learning environment.

We intend to assess the intuitiveness of these platforms, determine which features are most beneficial in remote learning contexts, and identify areas needing improvement. This aligns with our broader research goals, as the functionality and adaptability of LMSs are directly related to student satisfaction in e-learning environments. Moreover, we will explore how these platforms integrate with other digital tools, creating what we term "digitally-augmented learning environments." This concept is distinct from traditional hybrid learning models, highlighting the increased reliance on digital tools during the pandemic and recognizing the unique challenges and opportunities this period presented. By conducting a layered evaluation of LMS platforms during the pandemic, our study aims to contribute to the ongoing discussion on optimizing these systems for enhanced e-learning experiences. We hope to offer insights that will aid in refining these platforms, considering the significant shifts in educational paradigms observed during this period.

2.2.2 Remote Learning During the COVID-19 Pandemic

The COVID-19 pandemic prompted an unprecedented shift to remote online learning. This sudden migration offers a unique vantage point to evaluate the advantages and challenges of this instructional modality. While remote learning has facilitated continued educational access during challenging times, it has also revealed several unforeseen challenges, spanning

from socio-emotional issues like increased student anxiety to logistical constraints such as bandwidth limitations and home-based distractions[54].

Previous research has often highlighted the benefits of online education, but there is a noticeable gap in literature specifically addressing student experiences in an involuntary remote learning environment, as created by emergency situations like a pandemic. This unplanned shift presents a learning environment distinct from typical online education scenarios. Our research aims to address this gap by delving into the lived experiences of students during the pandemic-induced remote learning period. We focus on understanding how these unique challenges impact student satisfaction in a setting where remote learning became the primary instructional mode. This exploration extends academic discussions beyond voluntary online learning to encompass compulsory scenarios triggered by exigencies [54]. By investigating these aspects, our study seeks to provide a nuanced understanding of remote learning under emergency conditions. We aim to evaluate whether traditional e-learning best practices are effective in such unprecedented contexts and how educators can swiftly adapt to sustain educational quality. Our research will identify the spectrum of issues faced by students and examine how these factors collectively influence academic success and emotional well-being. Ultimately, our findings are intended to guide educational institutions in better preparing for and managing potential future scenarios necessitating a rapid transition to remote learning.

2.3 The Evolving of Student Satisfaction

Prior to the COVID-19 pandemic, academic literature often conceptualized student satisfaction as an emotional response based on the gap between expectations and perceived returns on investments like time, effort, and finances [175]. A rich body of research explored

its relationship with motivation and academic performance, offering a comprehensive view of these dynamics [18]. However, the pandemic-induced shift to remote learning has necessitated re-examining student satisfaction in this new context. Traditionally, factors like campus infrastructure and classroom dynamics were central to understanding student satisfaction [51, 175, 64]. Now, with the abrupt transition to remote learning, aspects such as online platform usability, technical support, and remote assessment efficacy have become critical [142, 64].

Frameworks such as TAM, The Unified Theory of Acceptance and Use of Technology (UTAUT), and others have been foundational in exploring e-learning satisfaction but may not fully address the nuances of forced, non-elective online education during crises. To bridge this gap, our study adopts a hybrid approach, integrating models like the Technology Acceptance Model and Expectation Confirmation Model with the DeLone & McLean Information Systems Success Model. This approach aims to capture a detailed understanding of student satisfaction in involuntary remote learning environments.

Our research seeks to adapt and expand the framework for measuring student satisfaction, acknowledging the complex realities of the pandemic-driven educational shift. We aim to identify a broader set of factors influencing satisfaction in this unique context, particularly emphasizing the involuntary nature of this shift, a facet largely overlooked in pre-pandemic research. By doing so, we hope to provide actionable insights and comprehensive recommendations for educational institutions to enhance remote learning experiences, applicable both in current crisis conditions and in future educational strategies.

2.4 Key Theories and Models

In the context of e-learning, various theoretical models offer insights into different aspects of the learning process. For a comprehensive study like ours, aimed at understanding student satisfaction during the pandemic, it is crucial to employ models that collectively address technological acceptance, system efficacy, expectation, and overall success measures. Upon reviewing the literature and considering our research context, three models stood out as particularly relevant: the Technology Acceptance Model (TAM), the DeLone and McLean Information Systems Success Model (D&M ISS), and the Expectation Confirmation Model (ECM).

The TAM is central to our study, particularly under the rapid technology shifts prompted by the pandemic, as it focuses on user perceptions of technology. The D&M ISS model, with its focus on system and information quality, is vital in understanding the demands and challenges e-learning platforms faced during this period. Meanwhile, the ECM is key to examining the actual experiences with e-learning during these challenging times. These models are widely recognized for their effectiveness in explaining user behavior, system quality, and satisfaction in e-learning environments. Each brings a unique perspective, and their integration offers a comprehensive approach to dissecting the e-learning experience in the context of the COVID-19 pandemic. In the following subsections, we will explore each model in depth, discussing its constructs, relevance to e-learning, and application against the backdrop of the pandemic. This multi-model approach will enable us to gain a holistic understanding of student satisfaction in e-learning during these unprecedented times.

2.4.1 Technology Acceptance Model

The Technology Acceptance Model (TAM) in Figure 2.1 , developed by Davis, Bagozzi, and Warshaw in 1989 [53], is a fundamental framework for understanding user perceptions and attitudes towards new technologies. At its core are two constructs: perceived usefulness and perceived ease of use, both of which are crucial in shaping how users interact with technology [53].

TAM has evolved significantly since its inception. Venkatesh and Davis's 1996 extension of TAM highlighted how these core constructs could predict an individual's system use [202]. This evolution continued with TAM2, which incorporated additional factors like subjective norm and output quality, and culminated in TAM3, integrating variables such as computer self-efficacy and perceived enjoyment [203, 201].

In e-learning, TAM's relevance is underscored by numerous studies. For instance, Lee's research amalgamated components from various models, focusing on user satisfaction as crucial for continued technology engagement [117]. Its effectiveness in predicting user acceptance and satisfaction in e-learning has been affirmed by studies globally, including those in Spain [63]. As we navigate the challenges of e-learning during the COVID-19 pandemic, TAM provides a robust framework for exploring user satisfaction and technology adoption. Its evolution, reflecting the changing landscape of technology use, makes it particularly relevant for understanding the dynamics of remote learning in these unprecedented times. Thus, the Technology Acceptance Model, with its comprehensive approach to user engagement, remains instrumental in our exploration of e-learning systems during the pandemic.

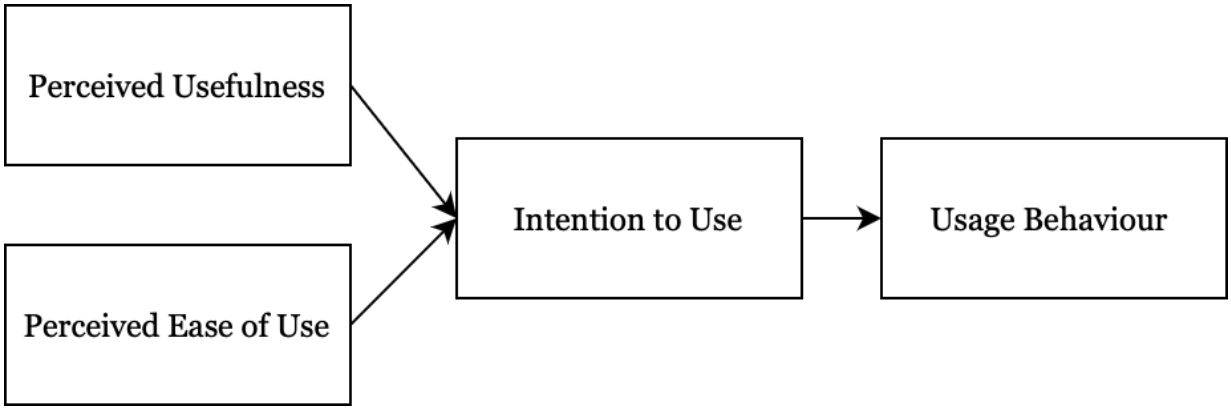

Figure 2.1: Technology Acceptance Model[53]

2.4.2 DeLone and McLean Information Systems Success Model

The DeLone and McLean Information Systems Success Model (D&M ISS Model) in Figure 2.2, is a pivotal model for evaluating information system success. Originally developed for e-commerce platforms [55], its application has expanded to e-learning, highlighting its adaptability across diverse educational contexts [214]. The model's core components—system quality, information quality, and user satisfaction—have established it as a key tool in understanding the success of online learning ecosystems [155].

Incorporating insights from the Technology Acceptance Model (TAM) enriches the D&M ISS Model, particularly in the context of e-learning. The combination of TAM's focus on user perceptions with the D&M Model's emphasis on system and information quality offers a comprehensive view of e-learning system success. This integration aligns with findings from scholars like Mohammadi and Cidral, who have shown the benefits of merging these models in [145, 45]. However, the D&M ISS Model is not without its criticisms. Some scholars have highlighted its potential shortcomings in fully capturing the complexities of e-learning environments, such as diverse teaching methods and learner backgrounds [208, 12].

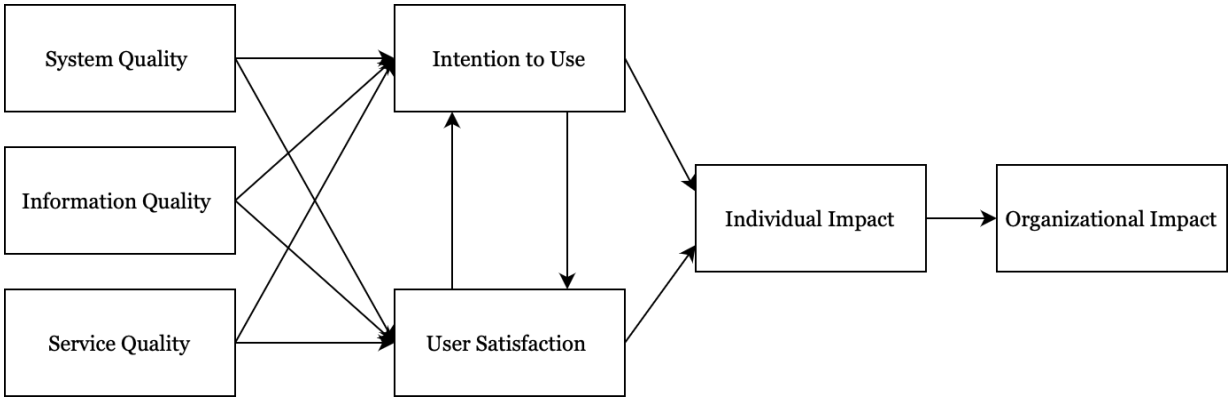

Figure 2.2: The DeLone & McLean IS Success Model [55]

Our study aims to address these limitations by empirically testing the model in various e-learning settings, considering factors like cultural diversity, pedagogical approaches, and learner differences.

Our research goes further by infusing the model with new dimensions, such as instructor content delivery and the quality of digital interactions. We plan to incorporate metrics evaluating instructors' digital literacy, engagement strategies, and online discussion facilitation skills. This approach acknowledges the significant changes in educational dynamics brought about by the COVID-19 pandemic and the need for rethinking traditional pedagogical models. In summary, our study intends to re-calibrate the D&M ISS Model to better suit the unique demands of the pandemic era. We propose adaptations that consider the shift towards asynchronous learning, the necessity of robust digital infrastructure, and strategies for maintaining student engagement in virtual classrooms. These refinements aim not only to address the immediate challenges posed by the pandemic but also to enhance the model's relevance in the broader context of e-learning research.

2.4.3 Expectation Confirmation Model

The Expectation Confirmation Model (ECM), illustrated in Figure 2.3, originally developed to analyze consumer behavior across various sectors [192, 191, 147], has found significant application in understanding user behavior in information systems, including e-learning. Bhattacharjee's work in re-contextualizing ECM for the information system sector has been particularly influential, focusing on users' continued usage behaviors [35].

Within e-learning, a primary focus of our thesis, ECM has been a key tool for analyzing student satisfaction and continued engagement [117]. However, the abrupt and involuntary shift to e-learning brought about by the COVID-19 pandemic introduces new challenges not yet fully explored within the ECM framework. These include technological readiness, emotional and cognitive impacts on students, and the effectiveness of digital pedagogical approaches.

To address these new dimensions, our study synthesizes ECM with the Technology Acceptance Model (TAM) and the DeLone and McLean Information Systems Success Model (D&M ISS). This integrated approach is designed to capture a broad spectrum of factors influencing student satisfaction and engagement during forced transitions to e-learning. It examines not only the initial expectations and their confirmation regarding e-learning systems but also incorporates elements such as perceived usefulness, ease of use, system quality, and information quality from the other models. By combining these models, we aim to leverage their collective strengths, providing a comprehensive framework to dissect and understand the complex experiences of students who have abruptly transitioned to remote learning due to the pandemic. This approach will allow us to delve deeper into the nuanced dynamics of e-learning satisfaction during such unprecedented times.

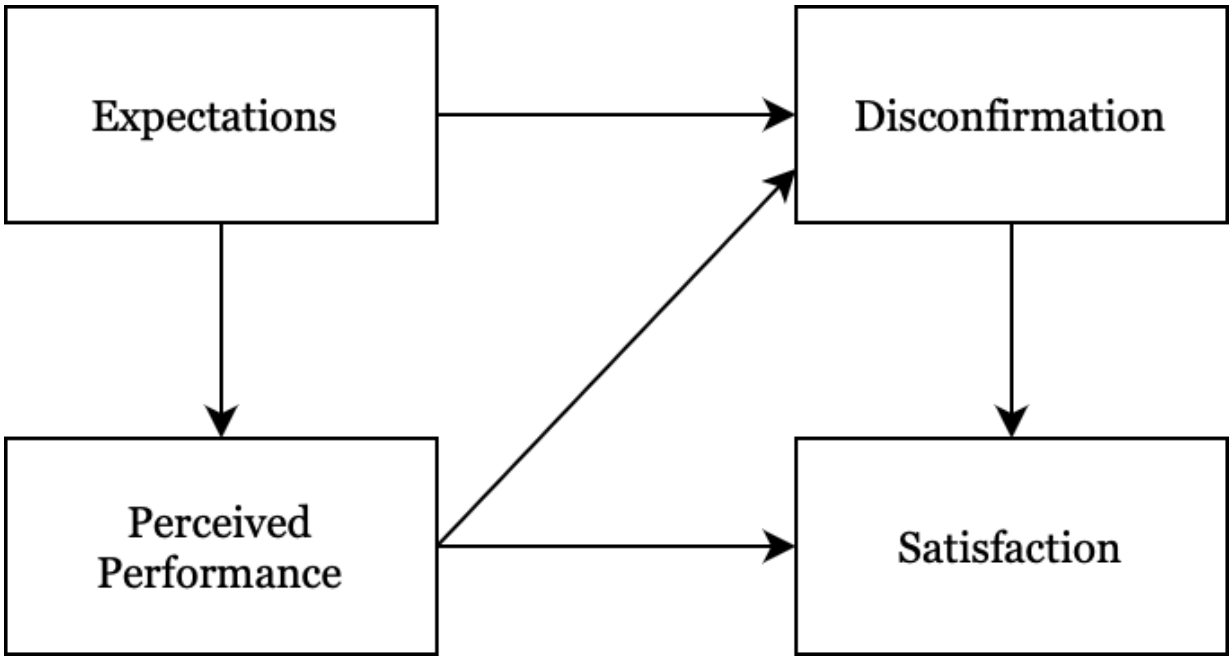

Figure 2.3: Expectation Confirmation Model[152]

2.5 Summary

In conclusion, this literature review has navigated the intricate terrain of remote learning, with a special focus on the transformative changes induced by the COVID-19 pandemic. We have leveraged established theoretical models like TAM, D&M ISS, and ECM to identify key determinants of student satisfaction and the effectiveness of e-learning infrastructures. However, it is acknowledged that these models, while providing a solid foundational understanding of user interactions and system efficacy, fall short in addressing the unique challenges posed by the emergency shift to online learning during a global health crisis. Our research aims to fill this gap by evolving these traditional models to incorporate critical yet previously overlooked elements. These include factors such as instructor effectiveness, the psychological implications of prolonged remote learning, and disparities in access to educational resources, all of which have gained prominence during the pandemic. By expanding the scope of these models, we seek to offer a more comprehensive view of e-learning in the context of a pandemic-affected world. Our study contributes to the academic need for models that encompass a wide range of factors influencing e-learning, from technological infrastructure and educator and student readiness to broader socio-economic influences on educational accessibility. As the higher education sector continues to navigate both current and future disruptions, our theoretical tools must evolve accordingly. This study aims to contribute to this endeavor by providing refined insights that will be valuable for educational policymakers and practitioners. Our goal is to aid in the development of more inclusive, resilient, and responsive e-learning systems, capable of meeting today's challenges and adapting to tomorrow's unforeseen demands.

Chapter 3

Conceptual Framework and Hypothesis Development

Building upon the extensive analysis presented in the literature review, this chapter introduces the C-RES framework, termed the COVID-19 Remote E-learning Systems (C-RES), a novel and integrative model designed for the evaluation of e-learning systems. The C-RES framework is specifically tailored to address the constraints and challenges unique to the COVID-19 pandemic era. C-RES synthesizes critical variables from established models: the Technology Acceptance Model (TAM), the Expectation Confirmation Model (ECM), and the DeLone and McLean Information Systems Success Model (D&M ISS). From TAM, it incorporates aspects like perceived usefulness and ease of use, essential for understanding user acceptance in digital learning [203, 53]. ECM contributes insights on user satisfaction and the impact of prior expectations, especially relevant for continued system usage [117, 220]. D&M ISS brings in multifaceted evaluative criteria like system quality, service quality, and information quality, crucial for a holistic assessment of e-learning platforms

[63, 145]. The genesis of C-RES lies in the synergistic strengths of these models. TAM provides a psychological perspective on user acceptance [203], ECM offers insights into satisfaction and continuous usage [220], and D&M ISS presents a comprehensive view of systemic factors crucial for effective e-learning environments [63, 145]. The C-RES framework is thus designed to navigate the unique challenges posed by the pandemic, aiming to provide a robust tool for evaluating e-learning systems in these extraordinary times. We acknowledge the atypical conditions under which e-learning systems are operating. This approach ensures that the C-RES framework not only reflects standard variables of e-learning system success but is also attuned to the unique context of a global health crisis. In the subsequent sections, we will develop and validate hypotheses within the C-RES framework. These hypotheses aim to identify key determinants crucial for the success of e-learning systems during the pandemic. This endeavor seeks to fill a significant gap in current academic research, offering educational stakeholders a comprehensive tool to understand and navigate the complexities of e-learning in this era.

3.1 Conceptual Framework

The core of this chapter introduces the C-RES framework, a framework that amalgamates and extends elements from established models like TAM, ECM, and D&M ISS, specifically tailored for the e-learning environment during the COVID-19 pandemic. As depicted in Figure 3.1, C-RES integrates new dimensions to address the heightened need for effective online interactions and adapts cognitive components to reflect the emotional and technological challenges students face in this era [44, 63, 187, 162, 59, 138]. The C-RES framework is structured around four redefined primary dimensions:

Student Dimension: This now includes pandemic-related factors affecting self-efficacy

and IT anxiety, along with the ongoing relevance of perceived usefulness.

System Dimension: It emphasizes the demand for robust system and service quality and user-friendly interfaces, given the increased dependence on e-learning platforms.

Course Structure Dimension: This dimension adjusts for potential variations in course content quality and delivery resulting from the rapid transition to online learning models.

Social Interaction Dimension: It accounts for the changed dynamics and challenges in effective communication between instructors and students, and among peers, due to pandemic-induced physical distancing.

C-RES aims to precisely quantify 'Student Satisfaction' as its pivotal outcome, reflecting the unique challenges of pandemic-era education. By integrating these dimensions and variables, C-RES equips educational stakeholders with a comprehensive tool for navigating and improving the e-learning experience during the pandemic. The inclusion of the pandemic as a control variable is crucial, as it provides insights into the altered dynamics of e-learning and guides the necessary adjustments in educational strategies during the tumultuous period.

3.2 Hypotheses Development

3.2.1 Perceived Ease of Use

In the C-RES framework, perceived ease of use is identified as a critical factor influencing an individual's acceptance and sustained engagement with e-learning systems. This concept, rooted in the work of Venkatesh, suggests that early perceptions of ease of use are dynamic and deeply influenced by broader attitudes and beliefs towards technology [204]. In the context of the COVID-19 pandemic, these perceptions might undergo significant

Figure 3.1: COVID-19 Remote E-learning Systems (C-RES) Framework

changes due to evolving user experiences and needs. Given the heightened psychological stressors during the pandemic, variables such as self-efficacy and technology anxiety become increasingly relevant. The pandemic's unique challenges could exacerbate these factors, potentially impacting how users perceive the ease of use of e-learning platforms.

Self-efficacy

Self-efficacy, as originally formulated by Albert Bandura, is a critical psychological construct in understanding individuals' perceptions of their capabilities to perform various tasks [31]. In the context of ICT and e-learning, self-efficacy takes on a important role, particularly under the unique conditions of the COVID-19 pandemic. This period has reshaped the educational landscape, altering how users interact with e-learning platforms.

Adapting Bandura's model, Compeau and others defined computer self-efficacy as an individual's belief in their ability to effectively utilize computers for specific objectives [31, 30, 47]. This adaptation has become a cornerstone in technology adoption studies and is integrated into the C-RES framework to enhance our understanding of e-learning systems. Within the C-RES framework, self-efficacy is not an isolated variable but interacts synergistic-ally with other factors such as system quality and social support. The transition to remote education during the pandemic can significantly influence computer self-efficacy. A user-friendly and well-structured system may boost self-efficacy, whereas a poorly designed system could undermine it. Additionally, social factors, reshaped by the pandemic, play a role in influencing self-efficacy, as students increasingly rely on virtual networks for support.

In light of these considerations, self-efficacy is pivotal in the C-RES framework, particularly given the challenges brought about by the pandemic. It affects not only user

engagement with e-learning platforms but also how students and educators adapt to the new learning environment, influencing satisfaction and educational outcomes. The pandemic context may amplify or mitigate the impact of self-efficacy on e-learning outcomes. Considering the vital role of self-efficacy in e-learning, particularly during the COVID-19 pandemic, we propose the following hypothesis:

H1: In the context of the COVID-19 pandemic, higher levels of self-efficacy are expected to positively correlate with increased perceived ease of use of e-learning systems.

This hypothesis aims to explore the interplay between self-efficacy and the adoption of e-learning platforms, providing insights into how individuals' confidence in their abilities influences their engagement with remote learning technologies

Technology Anxiety

In the C-RES framework, technology anxiety emerges as a crucial psychological variable, defined as the discomfort, apprehension, or fear individuals may experience when engaging with new or complex technological systems. This form of anxiety has been widely recognized as a significant barrier to the adoption and use of technology [44, 63, 162, 187, 117].

Traditional research, including studies by Sun et al., suggests a negative relationship between technology anxiety and perceived ease of use, where anxiety acts as a deterrent to comfortable interaction with technological systems [187]. However, within the C-RES framework, set against the backdrop of the COVID-19 pandemic, the interplay of technology anxiety is more distinction, interacting with factors like system quality and user support. Considering the accelerated transition to e-learning during the pandemic, technology anxiety may have become more prominent. To explore this in more depth, we propose the following hypothesis within the C-RES framework:

H2: In the COVID-19 pandemic context, technology anxiety can negatively influence per-

ceived ease of use when e-learning systems offer effective user support and guidance.
This hypothesis posits that the heightened dependency on e-learning systems could motivate users to overcome their technology anxiety. E-learning platforms that provide robust user support mechanisms, such as tutorials, FAQs, or real-time chat assistance, might transform anxiety into a driving force for engagement. Such user support could alleviate initial anxiety, leading to a more positive perception of ease of use. This perspective on technology anxiety within the C-RES framework represents a shift from viewing it solely as a barrier to considering it as a potential catalyst for deeper engagement with support resources. The pandemic context, which has increased reliance on technological competency, may turn technology anxiety from a passive barrier to an active motivator for seeking assistance, enhancing users' comfort and competency in complex e-learning environments.

3.2.2 Perceived Usefulness

Perceived usefulness remains an integral component of the Technology Acceptance Model (TAM) and is central to its advanced iterations, such as TAM2 [203, 202]. Within the C-RES framework, perceived usefulness emerges as a critical determinant influencing various aspects of the student experience in e-learning environments. Traditionally, it is understood as the belief that using a specific technology will enhance one's ability to achieve goals in work or educational contexts, affecting factors like engagement, satisfaction, and academic performance. In the context of the COVID-19 pandemic, the concept of perceived usefulness gains new dimensions. Students who perceive an e-learning platform as useful are more likely to engage actively, find the experience rewarding, and achieve better academic outcomes [203]. However, in the pandemic-driven shift to remote learning, traditional factors influencing perceived usefulness might be complemented or even

overshadowed by new, pandemic-specific considerations.

Social influences, as outlined in TAM2, play a significant role in shaping users' perceptions of usefulness. The opinions and behaviors of peers and instructors can significantly impact students' views of e-learning platforms. Additionally, the relationship between perceived usefulness and other variables, such as system quality and ease of use, becomes more critical in the context of increased reliance on e-learning systems. For example, a system that is high in quality and user-friendly can enhance the perception of its usefulness, leading to greater user satisfaction and a higher likelihood of continued use [203]. The sudden transition to remote learning due to the pandemic amplifies the importance of these system attributes and their interaction with perceived usefulness.

The C-RES framework aims to explore how the pandemic has reshaped the construct of perceived usefulness in e-learning. We intend to investigate the evolving relationship of perceived usefulness with variables like social influence and interaction, considering the heightened dependence on technology for educational continuity during the pandemic. By doing so, we aim to provide educational stakeholders with insights into the dynamic nature of perceived usefulness, particularly under the challenging conditions of the COVID-19 pandemic. This understanding is crucial as we navigate the lasting impact of the pandemic on the educational landscape and the critical role of technology within it.

Social Influence

Social influence, a foundational construct within the technology adoption literature, significantly impacts individual behavior and decision-making in the context of technology use [71, 204]. This construct encompasses the complex interplay of societal norms, peer opinions, and attitudes that collectively shape an individual's perception of a technology's

utility. In the C-RES framework, social influence is seen as a dynamic force that interacts with other factors driving technology adoption and usage, particularly in e-learning contexts. In traditional learning environments, social cues like face-to-face interactions and non-verbal communication play a significant role in shaping social influence. However, the shift to remote learning during the COVID-19 pandemic transforms these cues into more digital forms, necessitating a reevaluation of their impact in online settings. Recognizing these changes, our research within the C-RES framework posits the following hypotheses:
H3a: In remote learning contexts during the COVID-19 pandemic, social influence positively influences perceived usefulness.
H3b: Social influence positively influences student satisfaction in remote learning contexts during the COVID-19 pandemic.
These hypotheses draw upon Bandura's social cognitive theory, particularly the idea that self-efficacy can be influenced by social interaction[31], including en-active mastery experiences and vicarious experiences. In remote learning settings, these experiences are redefined to include digital interactions and achievements, suggesting that online interactions can become new sources of social influence, impacting self-efficacy and perceived usefulness. The C-RES framework thus diverges from traditional models by emphasizing the role of social influence in online settings. We propose that in the unique environment of the COVID-19 pandemic, social influence may manifest in powerful new forms. The absence of traditional social cues in remote learning may increase the importance of online cues, influencing not just technology adoption but also sustained engagement and satisfaction among students. This shift in the dynamics of social influence highlights the need for further study to understand its evolving role in the digital learning landscape.

Interaction

As the COVID-19 pandemic has revolutionized educational paradigms, online interaction has become a critical component of the learning experience, moving beyond a supplementary feature to a central element of e-learning [111]. While digital tools and remote learning platforms have expanded educational accessibility, they have also underscored the need for meaningful and effective online interactions [81]. In the C-RES framework, the quality of these interactions plays a significant role and intersects with the construct of perceived usefulness, a key factor in technology acceptance [203]. We propose that the perceived usefulness of an e-learning system is notably enhanced by the quality of interactions it facilitates, thereby impacting users' acceptance and continued engagement with the technology.

Effective online interactions, characterized by dynamic discussions, timely feedback, and collaborative opportunities , can significantly improve the perceived usefulness of an e-learning platform [81]. However, these interactions transcend academic utility, providing essential social and emotional support in a landscape often marked by isolation. Thus, the effectiveness of an e-learning platform hinges not only on its educational content but also on its capacity to replicate the immediacy and personal touch of traditional classroom interactions. Given these considerations, we posit the following hypotheses within the C-RES framework:

H4a: In remote learning settings necessitated by the COVID-19 pandemic, effective interaction between students and instructors positively impacts perceived usefulness.

H4b: Effective interaction between students and instructors has a generally positive influence on student satisfaction, particularly in the context of remote learning during the COVID-19 pandemic.

These hypotheses aim to explore how the nature and quality of online interactions shape both the perceived utility and overall satisfaction with e-learning platforms, acknowledging the critical role these interactions play in the pandemic-altered educational landscape.

3.2.3 Influence of Perceived Ease of Use on Perceived Usefulness

The relationship between perceived ease of use and perceived usefulness, a key component of the Technology Acceptance Model (TAM) [53], becomes particularly relevant in the evolving landscape of e-learning, accelerated by the COVID-19 pandemic. Theoretical foundations for this interplay can be understood through cognitive efficiency. In e-learning, cognitive efficiency is facilitated by the ease of use of the platform, allowing students to allocate mental resources more effectively towards learning. According to cognitive load theory , a user-friendly system reduces cognitive load, enabling students to concentrate on the content rather than struggling with system functionalities [188]. This relationship also extends into the psychological domain. A system that is easy to use can lower technology anxiety, leading to increased engagement and persistence—critical in remote learning environments marked by isolation. However, it's essential to recognize that the impact of perceived ease of use on perceived usefulness is not always linear and can be influenced by various moderating factors such as coursework type, online material quality, and individual learning styles. Considering these factors, we propose the following hypothesis within the C-RES framework:

H5: Perceived ease of use is positively correlated with perceived usefulness, particularly in remote learning contexts where intuitive and user-friendly interfaces are crucial for student engagement and satisfaction.

This hypothesis aims to underscore the heightened importance of usability in remote learn-

ing, where the user interface is the primary medium of educational interaction. It highlights the critical link between ease of use and usefulness, emphasizing its increased relevance in the era of remote education. Understanding this relationship is vital for developing e-learning platforms that are academically robust and cater to users' needs for simplicity and accessibility.

3.2.4 Service, System, and Information Quality

The adaptability of the DeLone and McLean Information Systems Success (D&M ISS) model, initially developed for e-commerce platforms, to various information systems underscores its robustness and relevance for e-learning platforms [56, 214]. This adaptability is especially pertinent within our C-RES framework, as the model emphasizes three critical factors —service quality, system quality, and information quality—that are key drivers of user satisfaction in e-learning contexts. Service quality in e-learning refers to the support and assistance provided to users within the platform. This includes aspects such as technical support, user guidance, and responsiveness to user queries, which are vital in facilitating a smooth learning experience. System quality denotes the technical performance of the e-learning platform, encompassing user-friendliness, reliability, and overall functionality. An efficient, reliable, and easy-to-navigate system is crucial for ensuring that technical issues do not hinder the learning process. Information quality pertains to the educational content delivered through the platform. It involves the relevance, accuracy, and timeliness of the learning materials, which are essential for ensuring that the content meets the educational needs and expectations of learners.

The integration of these three factors in the C-RES framework allows for a comprehensive understanding of what constitutes an effective e-learning system. Each factor

offers a distinct perspective on the user experience and satisfaction, and their collective impact is crucial for a holistic evaluation of e-learning effectiveness. While these factors are established in the context of e-commerce, their application to e-learning necessitates the consideration of unique educational factors. These include pedagogical effectiveness, content engagement, and alignment with learning objectives, which may not be as central in other types of information systems. Understanding these factors and their interplay is vital for the design and evaluation of e-learning platforms, ensuring they are not only technically robust but also pedagogically effective and engaging for learners.

Service Quality

Service quality, a key concept in consumer satisfaction, is crucial in the context of e-learning platforms. As defined by Parasuraman et al.[157], service quality is the consumer's assessment of the overall excellence and superiority of a service. Grönroos expands on this definition by describing service quality as the outcome of a comparison process where consumers measure their initial expectations against the actual service received [82].

In e-learning environments, service quality encompasses various aspects, such as the quality of technical support, responsiveness of the platform to user needs, and the effectiveness of communication channels provided for user assistance. Users typically form expectations about these services and then assess the actual services they experience on the platform. This assessment plays a critical role in determining their overall satisfaction with the e-learning experience. Considering the significance of service quality in shaping user experiences, this study proposes the following hypothesis within the C-RES framework:
H6: There is a positive relationship between higher service quality and user satisfaction in e-learning environments.
This hypothesis posits that superior service quality on e-learning platforms, which aligns

with or exceeds user expectations, is likely to result in higher levels of user satisfaction. The implication of this hypothesis is significant for e-learning platform developers and educators. By understanding and focusing on enhancing service quality, e-learning platforms can potentially increase user satisfaction, thereby improving the overall effectiveness of the online learning experience.

System Quality

The DeLone and McLean Information Systems Success (D&M ISS) model highlights system quality as a crucial factor for user satisfaction [55]. Research supports this assertion, identifying ease of learning, usability, and effective communication as key indicators of user satisfaction [160, 41, 89]. However, the relationship between system quality and user satisfaction isn't always linear, as high-quality features may not guarantee increased usage or satisfaction [176]. In the C-RES framework, we propose the following hypotheses considering this complex relationship:

H7a: Higher system quality, characterized by usability and functionality, positively influences student satisfaction. Functionality here includes features that facilitate learning outcomes, such as multimedia support and interactive assessments.

System quality also affects students' self-efficacy beliefs, potentially influenced by the frequency of system updates and the availability of supportive resources. Regular updates with advanced tools and comprehensive support resources can enhance self-efficacy. Therefore, we propose:

H7b: Higher system quality, marked by usability and functionality, positively influences students' self-efficacy.

Furthermore, system quality impacts the quality of online interactions among students.

Features like real-time communication tools, discussion forums, and collaborative workspaces play a crucial role in enabling effective peer engagement. Hence, our final hypothesis in this section is:

H7c: Higher system quality positively influences the quality of online interactions among students.

These hypotheses aim to capture the multifaceted impact of system quality on various aspects of the e-learning experience. Understanding the interplay between system quality and these educational outcomes is vital for designing e-learning systems that not only meet technical standards but also align with user needs and preferences, thereby enhancing the overall effectiveness of remote education.

Information Quality

In the context of e-learning, the DeLone and McLean Information Systems Success (D&M ISS) model underlines the critical role of information quality in influencing user behavior, decision-making processes, and overall satisfaction [55, 56]. Empirical studies have consistently demonstrated the correlation between high information quality and increased user satisfaction [172, 196, 80]. However, the impact of information quality on system usage is not always direct. Studies like those conducted by Özlem suggest that while high information quality is essential, it does not guarantee increased usage if it does not align with user needs or is perceived as overly complex [58, 12, 193, 126]. In the C-RES framework, we propose the following hypotheses to explore the multifaceted impact of information quality:

H8a: High information quality positively impacts user satisfaction and their intention to continue using the e-learning platform.

Information quality also plays a significant role in shaping self-efficacy, particularly when it is aligned with the user's knowledge level and course complexity. Thus, we propose:

H8b: High information quality positively impacts students' self-efficacy.

Finally, the relationship between information quality and perceived usefulness of an e-learning platform is expected to vary depending on the context and the user's familiarity with the subject matter. Therefore, our final hypothesis in this section is:

H8c: Information quality has a positive impact on perceived usefulness, particularly in contexts where the subject matter is new to users.

These hypotheses aim to elucidate the complex role of information quality in e-learning environments. Understanding this role is crucial for designing and curating e-learning content that is not only high in quality but also tailored to meet the varying needs and knowledge levels of users, thereby enhancing their learning experience, satisfaction, and perceived utility of the system.

3.2.5 Quality of Content and Delivery

The quality of content and delivery in e-learning, encompassing course information, instructional objectives, layout, and outcomes, is a critical determinant of students' satisfaction [212, 116, 198, 75]. These elements, recognized as components of information quality and course design quality, play a pivotal role in shaping the overall e-learning experience. During the COVID-19 pandemic, the quality of content and delivery has faced unique challenges, particularly due to the abrupt and unprepared transition to online learning by institutions and instructors. This situation has necessitated a re-evaluation of content delivery methods and their impact on service quality and user satisfaction in e-learning platforms. In light of these considerations, our study proposes the following hypotheses within the C-RES framework:

H9a:The quality of content delivery positively impacts service quality in e-learning plat-

forms.

This hypothesis reflects the belief that well-designed and delivered content enhances the overall service experience for learners.

H9b: The quality of content delivery positively influences user satisfaction with e-learning platforms.

We posit that effective and engaging content delivery is key to ensuring user satisfaction, especially under the constraints and rapid shift to online learning during the pandemic. These hypotheses aim to explore the integral role of content quality and delivery in e-learning, emphasizing their importance in service quality and user satisfaction. Understanding these relationships is crucial for designing and delivering e-learning courses that meet the evolving needs of students, especially under the constraints imposed by the pandemic.

3.2.6 Satisfaction

Satisfaction within e-learning platforms is a multifaceted construct that extends beyond mere user contentment, incorporating crucial factors such as retention, loyalty, and overall engagement [152, 40]. Although extensively explored in traditional service sectors, the unique interactive and educational nature of e-learning environments presents distinct challenges and opportunities for academic investigation [124]. User satisfaction is acknowledged as a critical element for encouraging the continued use of e-learning systems and functions as a key mediator influencing user activity on online platforms [35]. Empirical studies, such as those by Han, support the notion that student satisfaction significantly shapes their future intentions to use the system, thus influencing its long-term success [86].

In an era increasingly focused on the user's perspective, the concept of e-satisfaction, or a user's overall assessment of their online educational experience, is gaining prominence

[44, 45, 123, 187]. Instructional strategies like collaborative learning have been found to enhance satisfaction, indicating the importance of social learning aspects in online settings [189, 187]. To understand the complex dynamics of student satisfaction in e-learning, we propose the following hypotheses:

H10a: Perceived ease of use of the e-learning platform is hypothesized to positively impact students' satisfaction.

H10b:Perceived usefulness, defined as the extent to which students believe the platform enhances their learning, is also expected to positively influence satisfaction.

These hypotheses aim to dissect the various facets of student satisfaction within e-learning, providing insights crucial for both academic research and practical application in designing and managing e-learning platforms.

3.3 Summary

This chapter has thoroughly examined the theoretical underpinnings central to our investigation into e-learning, a domain significantly impacted by the COVID-19 pandemic. While the pandemic provides a crucial backdrop, our research goes beyond the immediate crisis to delve into the fundamental aspects of e-learning, ensuring enduring relevance. We began with an exploration of the Technology Acceptance Model (TAM), focusing on the interplay between perceived ease of use and perceived usefulness as key predictors of technology acceptance in e-learning environments. This model sheds light on user perceptions of platform functionality and benefits, crucial for technology adoption. Transitioning to the DeLone and McLean Information Systems Success (D&M ISS) model, we discussed vital aspects such as service quality, system quality, and information quality, all integral to shaping user satisfaction in e-learning contexts. Despite existing insights into e-learning,

there remains a notable gap in comprehensive studies contextualized within the unique challenges of the COVID-19 pandemic. Our research seeks to bridge this gap, offering a broader perspective that encompasses not only standard quality metrics but also the intricacies of student-instructor dynamics, peer interactions, and quality of content, all of which have been reshaped by the pandemic. The aim of our multifaceted exploration is to provide a comprehensive understanding of the determinants of e-learning platform success. The theoretical constructs and propositions outlined in this chapter will guide our empirical inquiries, informing our methodological and analytical approaches. Our goal is to unearth actionable insights that enhance e-learning systems both during and beyond the pandemic era. By summarizing these theoretical frameworks, we set the stage for the empirical research that follows, endeavoring to contribute to a deeper understanding of the dynamic e-learning landscape in these rapidly evolving times.

Chapter 4

Experimental Design

4.1 Research Design

In order to empirically assess our proposed research framework, a questionnaire-based approach has been adopted, drawing inspiration from seminal works in the e-learning literature [35, 45, 56, 123, 155, 187, 201]. An online survey serves as the primary data collection tool, with its design rooted in established literature to ensure validity and reliability. The survey questions, validated in prior research within the e-learning domain, are compiled to comprehensively cover the study's constructs. The complete survey is provided in Appendix B. The questionnaire is structured into two phases:

Phase One: This phase collects demographic data, including age, gender, academic level, field of study, and primary learning management system used. This demographic information will aid in understanding any moderating or controlling effects on the study's main constructs, allowing for a more in-depth analysis.

Phase Two: Participants respond to questions related to the core constructs of our re-

search model, such as system quality, information quality, service quality, self-efficacy, perceived usefulness, and user satisfaction. Some questions are selected or adapted from existing validated surveys to maintain the integrity of our research approach [35, 45, 56, 123, 155, 187, 201].

This dual-phase approach is designed to achieve a holistic understanding of the theoretical constructs and the demographic factors that may influence their interrelationships. The study aims to distinguish the unique effects of the pandemic from other variables, providing a focused analysis of e-learning dynamics during this period. This methodology is crucial for exploring the complex relationships affecting student satisfaction and intentions towards the continued use of LMS in higher education, especially under the pervasive influence of the COVID-19 pandemic.

4.2 Pre-test and Pilot Test

To ensure the validity and reliability of our study, a dual-tiered testing strategy was implemented, comprising a pre-test and a pilot test prior to the comprehensive roll-out of the questionnaire. The pre-test, conducted with a small group of participants representing our target demographic, aimed to identify and rectify any technical or operational issues in the survey platform, such as loading times, navigation problems, or unclear instructions. This phase primarily focused on examining the technological aspects of the online survey platform.

Participants for the pre-test were carefully chosen to represent a diverse cross-section of our study population, providing relevant and constructive feedback. Addressing concerns at this stage facilitated a seamless deployment of the primary survey. Following the pre-test, a pilot test was conducted with 15 participants, selected based on criteria like familiarity with

e-learning platforms and demographic diversity. Their feedback was rigorously analyzed to identify any inconsistencies or ambiguities in question phrasing or scaling. Additionally, statistical analysis of pilot data was carried out to assess reliability coefficients and validate the construct measures. This process enabled timely adjustments to the survey instrument, enhancing its overall efficacy.

Both the pre-test and pilot test were instrumental in refining our research methodology, playing crucial roles in minimizing potential errors, improving data integrity, and strengthening the study's conclusions. Through this rigorous preparatory phase, our study is well-positioned to provide precise and dependable insights into the factors influencing student satisfaction and sustained engagement with e-learning platforms, particularly in the context of the COVID-19 pandemic.

4.3 Sample

The sampling strategy is a crucial element of our empirical research, significantly impacting the reliability and generalizability of the outcomes. As McDonald suggests, effective sampling is vital for accurately representing a larger population through a smaller group [140] . This study adopts a non-probability sampling technique, favored for its capacity to yield consistent and trustworthy results. Contrary to probability sampling, our study utilizes a non-probability sampling technique, specifically a voluntary sampling approach. Participants for the study were selected based on their voluntary participation, with graduate students across Canada being invited to participate through various social media forums. This method allows us to reach a broad and diverse group of students, although it's important to note that this approach may introduce certain biases, as the sample comprises individuals who chose to participate and had access to the social media platforms used for

recruitment.

The sample size of 375 respondents was determined to provide a substantial breadth of data in Appendix C, while also considering the practical constraints of data collection. Initially, we have received over 398 responses. However, after removing incomplete responses and those with missing values, we were left with a final count of 375 responses. These participants contribute to the richness of the data collected, offering insights from a diverse range of academic fields and experiences. While the sample's diversity, encompassing students from different academic disciplines, adds depth to the study, the voluntary nature of participation is particularly significant given our focus on e-learning experiences during the COVID-19 pandemic. This sampling approach ensures that the study captures a wide array of perspectives and experiences in the context of e-learning.

This carefully considered sampling strategy, while divergent from probability techniques, is expected to offer valuable insights into the factors influencing student satisfaction and their intentions to continue using LMS in the context of higher education during the pandemic. Through this approach, the study aims to establish a methodological foundation that, while acknowledging its limitations, provides meaningful insights into the dynamics of e-learning in the current educational landscape.

4.4 Study Participants

This study, focusing on e-learning systems within Canadian higher education institutions, engaged with established platforms such as Moodle, Blackboard, and Canvas, which are widely used in this sector. To collect responses, an online survey was made accessible for one month, inviting voluntary participation from students, with a strong emphasis on maintaining the confidentiality and anonymity of their responses.

Participants were selected based on specific inclusion criteria: they had to be master or Ph.D. students in Canadian higher education institutions and have substantial experience with e-learning platforms, defined as using the platform for at least one semester for academic purposes during the COVID-19 pandemic lockdown (2020 to 2022). To enhance the representatives and diversity of our data, the sample was stratified based on demographic variables, ensuring proportional representation across various age groups, genders, and fields of study. This stratification aimed to ensure that the findings could be more broadly applicable across the diverse student population.

Through these methods, the study sought to recruit a sample reflective of the broader student demographics in terms of e-learning usage, while also capturing diverse experiences and satisfaction levels among different student groups. This approach was designed to provide a comprehensive understanding of the dynamics of e-learning experiences in the Canadian higher education context during the pandemic.

4.5 Measurement

In this study, quantitative research methods were employed, aligning well with the goal of establishing relationships among various constructs within the domain of e-learning. These methods, widely used in social sciences, provide a robust framework for investigating complex interrelations. The primary data collection tool is an online questionnaire, featuring a five-point Likert scale. This scale enables respondents to express their level of agreement with a series of statements, with ratings ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree"). The use of this scale is strategic, offering a standardized method to capture participants' attitudes, perceptions, and opinions in a quantifiable manner.

The study focuses on a range of multifaceted constructs, categorized into independent

and dependent variables. Key constructs include such as system quality, information quality, service quality, social influence, interaction, and quality of content delivery. Each construct is measured using multiple items, some of which were adapted from established scales in existing literature [35, 45, 56, 123, 155, 187, 201]. This adaptation was carried out with careful consideration to ensure they accurately reflect the context of Canadian higher education e-learning during the COVID-19 pandemic.

Additionally, the survey instrument underwent extensive pre-testing and pilot testing. These steps were crucial in validating the measurement items, ensuring they are clear, relevant, and reliable for our study's context. By adhering to these well-established quantitative methods and measurement techniques, this study aims to provide valid and reliable insights. It seeks to unravel the complex relationships affecting student satisfaction and the continued intention to use LMS in higher education settings, especially against the backdrop of the COVID-19 pandemic.

4.6 Data Collection

Data collection is a crucial phase in any research project, directly influencing the quality and reliability of the analysis and findings. For this study, a digital approach was adopted for disseminating and collecting the questionnaire. Utilizing a multi-channel strategy, the questionnaire was distributed electronically through social media platforms like Facebook academic groups, LinkedIn academic groups, Twitter, and university mailing lists. To specifically reach graduate students from various universities, we made efforts to contact each university's Facebook, LinkedIn academic groups, or other social platform groups to obtain permission to join. This involved demonstrating our request for participation and, in some cases, where groups were separated between undergraduate and graduate

students, we specifically reached out to graduate groups to disseminate our questionnaire for their voluntary participation in the study. This approach was specifically designed to maximize reach and participation among academic and student groups within Canadian higher education.

A high priority was placed on ensuring the privacy and confidentiality of participants. Robust security measures, including data encryption during transmission and storage, were implemented. Participants provided informed consent online, acknowledging their understanding and agreement to the study's terms before accessing the questionnaire. All personally identifiable information will be anonymized or deleted post data collection.

Ensuring the privacy and confidentiality of our participants is of paramount importance. As such, we have implemented robust security measures. These measures include encryption of the data during transmission and storage. Participants provided their informed consent online, acknowledging their understanding and agreement to the terms of the study before proceeding to the questionnaire. All personally identifiable information will be anonymized or deleted once the data collection phase is completed.

Addressing potential concerns regarding the sample size for methodologies like Structural Equation Modeling (SEM), a power analysis was conducted to ensure adequacy in detecting the expected effects within our framework. The sample size's suitability was further validated using chi-square tests and goodness-of-fit indices, confirming its capacity to yield reliable and valid results in the SEM analysis. Despite the sample size, these measures assure that the study maintains statistical rigor.

4.7 Ethics Approval and Consent to Participate

Ethical considerations are paramount in this research, equalling the importance of the scientific aspects. Upholding the highest ethical standards is essential, both for maintaining the integrity of the study and safeguarding the rights and well-being of participants. This study has received formal ethics approval from the Human Participants Review Sub-Committee of York University's Ethics Review Board, ensuring compliance with ethical standards for research involving human subjects and highlighting our dedication to ethical research practices.

All respondents are required to provide informed consent before participating. This process involves them being fully informed about the research details, potential risks, and their rights as subjects through a comprehensive consent document. The informed consent agreement, available in Appendix A, outlines the study's purpose, procedures, privacy measures, and emphasizes the voluntary nature of participation.

The agreement assures participants of their right to withdraw from the study at any time without adverse consequences. Should a participant choose to withdraw, their data will be excluded, and support will be provided if they have concerns regarding their participation. In line with ethical best practices, strict anonymity will be maintained, and no data that could identify a participant will be included in any reports or publications. All personally identifiable information will be securely stored and eventually anonymized or deleted. In a commitment to transparent research practices, participants will be offered access to the study's findings, providing them an understanding of how their data contributed and the chance to discuss the outcomes with the researchers. This approach not only fulfills their right to information but also adds a layer of accountability to the research process.

Chapter 5

Data Analysis and Results

To analyze the data gathered in our study, a two-phase analysis strategy, as proposed by Anderson and Gerbing, was employed [23]. This approach begins with the assessment of the measurement model, ensuring that the survey items accurately measure the intended constructs. Utilizing the C-RES framework, which stands for COVID-19 Remote E-learning Systems, Confirmatory Factor Analysis (CFA), was first conducted using SPSS v.29. This step is crucial for evaluating the reliability and both convergent and discriminant validities of our constructs. CFA plays a pivotal role by confirming that each survey item significantly loads on its intended factor, thereby validating the items' alignment with the conceptualized constructs. Following the measurement model assessment, the hypotheses were tested through path analysis using the AMOS v.28 software package. Path analysis, an advanced form of multiple regression, is instrumental in modeling the direct and indirect relationships between variables. This method allows for a thorough verification of the cause-and-effect linkages posited within our research model. It provides quantitative means to assess the strength and direction of the proposed causal relationships between

the variables outlined in our hypotheses, thereby offering a rigorous test of our theoretical framework. Through these analytical methods, we aim to not only validate the constructs of our study but also to quantitatively explore the intricate relationships within the C-RES framework. This process is vital for understanding the dynamics of e-learning systems in the context of the COVID-19 pandemic, aligning with the overarching objectives of our research.

5.1 Descriptive Statistics

The demographic profile of respondents, as detailed in Table 5.1, varies across different categories. The majority of respondents were male in Figure 5.2, accounting for 54.7% (n=205), followed by females at 45.1% (n=169). A small representation was observed for those identifying as non-binary or other genders at 0.3% (n=1). It is important to note that 'other genders' refers to respondents who do not categorize themselves strictly as male or female. This distribution is reflective of a growing recognition and inclusion of diverse gender identities in academic research.

Regarding age in Figure 5.1, a significant portion of participants (64.8%, n=243) were aged between 25-34 years, followed by 14.8% (n=56) in the 20-24 age range. The skew towards younger demographics might influence the results' applicability to older student populations, and the lack of representation in age groups below 20 and above 44 could limit the findings' comprehensiveness across the graduate student age spectrum. Additionally, 20% (n=75) were between 35-44 years, with only 0.3% (n=1) aged 45 years and above.

As presented in Table 5.2, respondents were almost evenly split between master's (46.7%, n=175) and doctoral (Ph.D.) levels (53.3%, n=200), allowing for comparative

Name		Frequency	Percentage
Gender	Male	205	54.7%
	Female	169	45.1%
	Non-Binary/Others	1	0.3%
Age	20-24	56	14.9%
	25-34	243	64.8%
	35-44	75	20%
	45 Above	1	0.3%

Table 5.1: Demographic Background of Respondents

insights between these two academic levels. The field of study distribution showed diversity, with humanities and social sciences being the most prevalent at 32.8% (n=123) and 31.5% (n=118) respectively, followed by STEM at 18.7% (n=70), which we define to encompass fields such as engineering, technology, and mathematics, thereby providing a broad overview of these areas. Natural sciences at 13.9% (n=52), and business at 3.2% (n=12). This distribution offers a broad overview of different academic areas, though the lower representation of business students may affect the generalized of our findings to this particular field.

In Table 5.3 and Figure 5.3, we present the distribution of primary educational tools used by respondents, selected based on their prevalence in academic settings and their mention in prior literature. Participants had the option to choose from pre-listed tools or specify others not listed. Moodle emerges as the most prevalent LMS, used by 25.9% of the sample (n=97), indicative of its widespread use in online coursework. Canvas follows with 17.9% usage (n=67), and D2L/Brightspace is preferred by 18.4% of respondents (n=69). Blackboard, Edmodo, and Sakai are also represented, with usage percentages of 10.9%

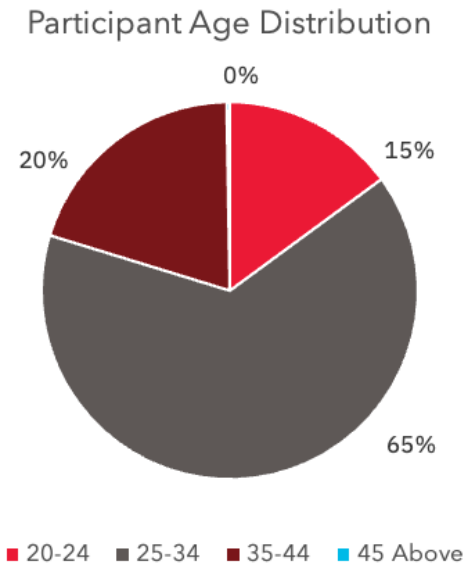

Figure 5.1: Percentage Age Distribution

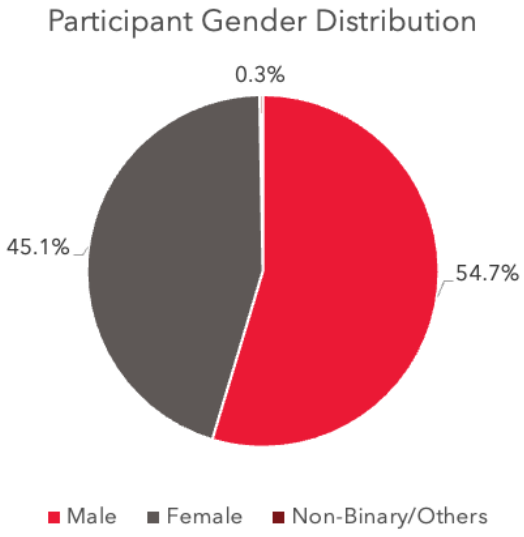

Figure 5.2: Percentage Gender Distribution

Name		Frequency	Percentage
Academic Level	Master	175	46.7%
	Doctoral (Ph.D.)	200	53.3%
Field of Study	STEM	70	18.7%
	Humanities	123	32.8%
	Social Sciences	118	31.5%
	Natural Sciences	52	13.9%
	Business	12	3.2%

Table 5.2: Academic Background of Respondents

(n=41), 12.3% (n=46), and 7.7% (n=29), respectively. This diversity in LMS usage could influence the generalized of findings across various platforms.

For communication tools in Figure 5.4, Google Meets is the most adopted, used by 34.4% (n=129), closely followed by Microsoft Teams with 29.9% (n=112). Zoom and Webex are used by smaller fractions of the sample, 6.9% (n=26) and 8.8% (n=33), respectively, while Blackboard Collaborate and Skype have even lesser usage. A variety of other tools are used by 9.4% of respondents (n=35), pointing to a fragmented communication tool landscape. The diverse range of tools used for e-learning reflects varied preferences and possibly institutional affiliations. This variation highlights the need to understand the specific features and user experiences of these tools to gain deeper insights into aspects of e-learning valued by students. The data suggests a trend towards specific tools, like Google Meets and Microsoft Teams, which could be driven by institutional policies or individual familiarity, potentially influencing participants' experiences and responses in the context of our study.

In Table 5.4, the learning modes adopted by respondents during the COVID-19 pan-

Name		Frequency	Percentage
Primary LMS Used	Blackboard	41	10.9%
	Canvas	67	17.9%
	Moodle	97	25.9%
	D2L/Brighspace	69	18.4%
	Sakai	29	7.7%
	Edmodo	46	12.3%
	Schoology	25	6.7%
	Others	1	0.3%
Primary Communication Tool Used	Zoom	26	6.9%
	Microsoft Teams	112	29.9%
	Google Meets	129	34.4%
	Webex	33	8.8%
	Blackboard Collaborate	29	7.7%
	Skype	11	2.9%
	Others	35	9.4%

Table 5.3: Primary Tool Used from Respondents

Name		Frequency	Percentage
Learning Mode During the Pandemic	On-Campus	74	19.7%
	Remote	188	50.1%
	Hybrid	113	30.1%
Duration of Study During the Pandemic	Fully	240	64%
	Partially	135	36%

Table 5.4: Learning Modes and Duration of Study During the COVID-19 Pandemic

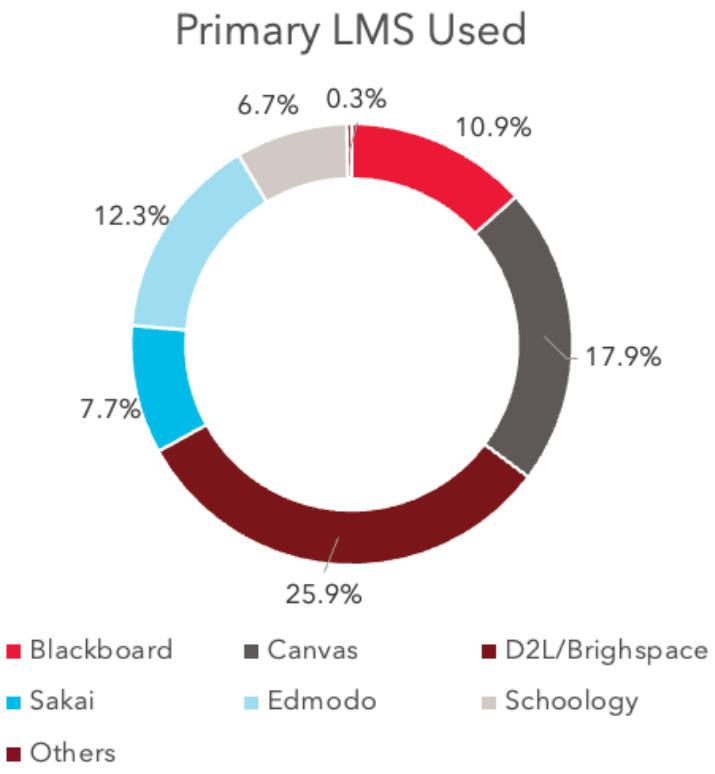

Figure 5.3: Primary LMS Used

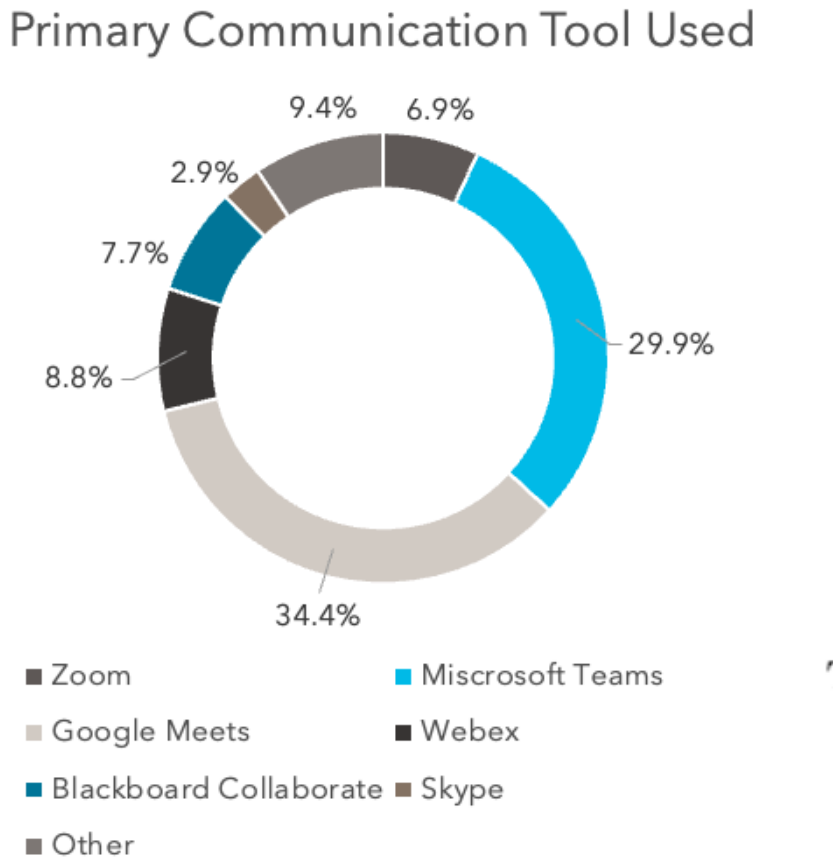

Figure 5.4: Communication Tool Used from Respondents

demic varied significantly. Half of the respondents (50.1%, n=188) engaged exclusively in remote learning, indicating a fully online attendance and coursework completion. This mode of learning likely influenced their interaction with LMS platforms, potentially affecting their perceived ease of use and satisfaction with these systems. Another 30.1% (n=113) of participants experienced a hybrid model of learning. In this context, hybrid learning entailed a combination of online classes and limited in-person attendance, guided by public health recommendations. This model may have presented unique challenges and experiences as students adapted to the fluctuating conditions of the pandemic. On-campus learning was less common, with only 19.7% (n=74) attending in-person classes. These students' experiences could offer insights contrasting those of remote learners, influencing their engagement with and perceptions of e-learning tools.

Furthermore, the study duration during the pandemic was diverse: 64% (n=240) of respondents completed their studies entirely during the pandemic, while the remaining 35% (n=135) experienced a partial completion, likely involving a transition from traditional to remote or hybrid models, or conversely, from remote or hybrid back to traditional models. This variation in study duration may have implications for students' adaptation strategies and overall satisfaction with their educational experience. It should be noted that the total percentages may not sum up to exactly 100% due to rounding errors or the presence of respondents with unique or non-standard educational trajectories during the pandemic. This variance is crucial for interpreting the data, reflecting the diverse educational experiences encountered by students in this extraordinary period.

5.2 Reliability and Validity Analysis

In our study, the primary goal is to identify key factors contributing to the success and reduced attrition in e-learning environments. We employed Cronbach's alpha to evaluate the internal consistency of ten indicators and one construct within the C-RES framework. The alpha values, presented in Table 5.5 and Figure 5.6, range from 0.927 to 0.954, well above the accepted minimum of 0.7. This result, including an overall Cronbach's alpha of 0.927, indicates strong internal consistency among items within each construct.

To further confirm the reliability of our composite measurements, Composite Reliability (CR) scores were computed, ranging from 0.928 to 0.954 in Figure 5.5. These values surpass the recommended threshold of 0.7 [74, 73], affirming the high reliability of our constructs and their suitability for subsequent analysis. Convergent validity, which assesses agreement between different measures of the same construct, was also examined. Our indicators showed significantly positive loading's on their intended constructs, suggesting accurate capture of the constructs' essence [73, 74].

For the measurement scales to be considered reliable, factor loading's (k) should ideally not be less than 0.5, ensuring clarity in the factor structure. Additionally, the Average Variance Extracted (AVE) by each construct should exceed the variance due to measurement error, with an ideal AVE being above 0.5 [73, 74]. Our study's AVE values ranged from 0.719 to 0.805, R-squared (R^2) values from 0.695 to 0.893, and factor loadings from 0.834 to 0.945. These figures surpass the minimum criteria and indicate a strong convergent validity of our measurement model, as detailed in Table 5.5.

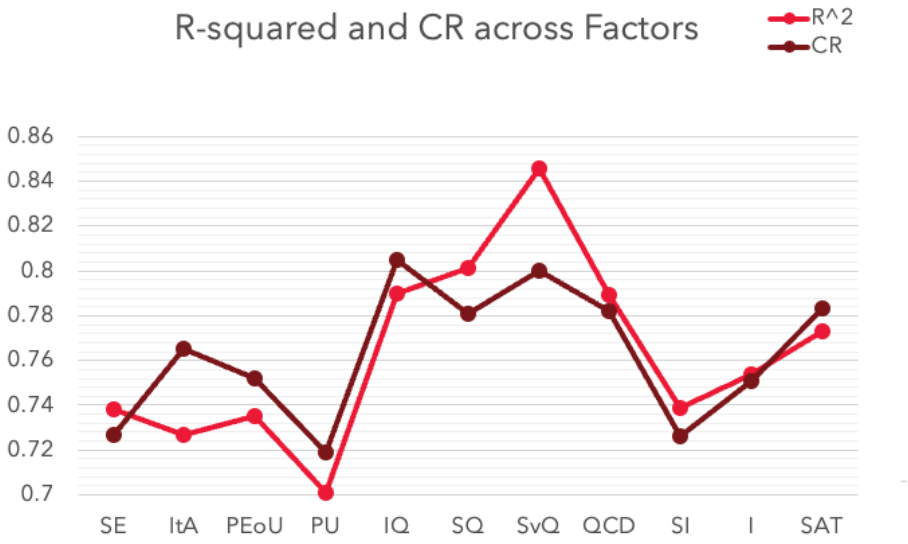

Figure 5.5: R-Squared and CR Across Factors

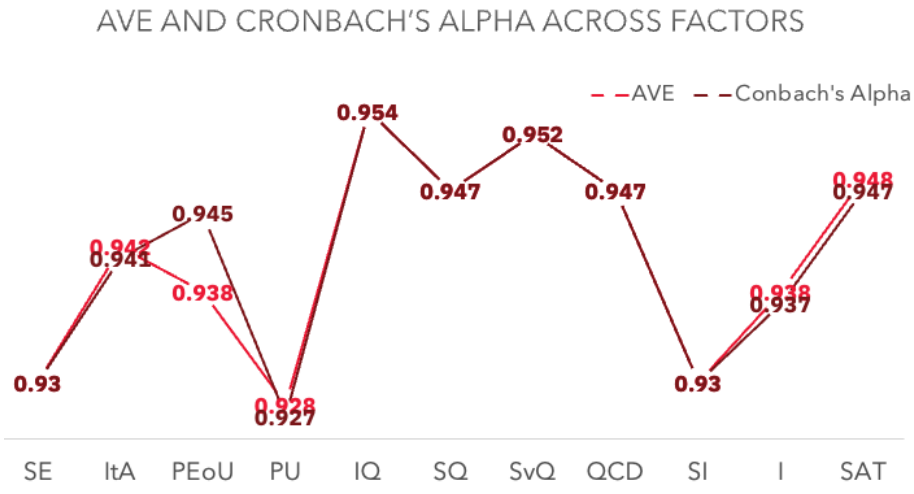

Figure 5.6: AVE and Cronbach's Alpha Across Factors

Table 5.5: Reliability and Convergent Validity

Factor	**Variables**	$\boldsymbol{k}$	R^2	**CR**	**AVE**	**Cronbach's** α
Self-Efficacy	SE1	0.859	0.738	0.727	0.930	0.930
	SE2	0.852	0.726			
	SE3	0.852	0.726			
	SE4	0.844	0.713			
	SE5	0.855	0.731			
IT Anxiety	ItA1	0.853	0.727	0.765	0.942	0.941
	ItA2	0.873	0.761			
	ItA3	0.843	0.711			
	ItA4	0.855	0.731			
	ItA5	0.945	0.893			
Perceived Ease of Use	PEoU1	0.858	0.735	0.752	0.938	0.945
	PEoU2	0.860	0.740			
	PEoU3	0.864	0.746			
	PEoU4	0.881	0.775			
	PEoU5	0.937	0.878			
Perceived Usefulness	PU1	0.837	0.701	0.719	0.928	0.927
	PU2	0.841	0.708			
	PU3	0.834	0.696			
	PU4	0.881	0.776			
	PU5	0.846	0.716			
Information Quality	IQ1	0.889	0.790	0.805	0.954	0.954
	IQ2	0.906	0.821			

Factor	**Variables**	k	R^2	**CR**	**AVE**	**Cronbach's α**
	IQ3	0.879	0.773			
	IQ4	0.901	0.811			
	IQ5	0.910	0.829			
System Quality	SQ1	0.895	0.801	0.781	0.947	0.947
	SQ2	0.884	0.781			
	SQ3	0.895	0.801			
	SQ4	0.875	0.766			
	SQ5	0.870	0.756			
Service Quality	SvQ1	0.920	0.846	0.800	0.952	0.952
	SvQ2	0.889	0.790			
	SvQ3	0.889	0.790			
	SvQ4	0.897	0.804			
	SvQ5	0.877	0.769			
Quality of Content Delivery	QCD1	0.888	0.789	0.782	0.947	0.947
	QCD2	0.864	0.747			
	QCD3	0.895	0.801			
	QCD4	0.889	0.790			
	QCD5	0.886	0.785			
Social Influence	SI1	0.860	0.739	0.726	0.930	0.930
	SI2	0.834	0.695			
	SI3	0.869	0.755			
	SI4	0.842	0.709			
	SI5	0.855	0.732			
Interaction	I1	0.868	0.754	0.751	0.938	0.937

Factor	**Variables**	k	R^2	**CR**	**AVE**	**Cronbach's α**
	I2	0.862	0.742			
	I3	0.849	0.720			
	I4	0.860	0.740			
	I5	0.892	0.795			
Satisfaction	SAT1	0.879	0.773	0.783	0.948	0.947
	SAT2	0.889	791			
	SAT3	0.875	765			
	SAT4	0.853	0.727			
	SAT5	0.928	0.861			

In the initial phase of our data analysis, we rigorously assessed the discriminant validity of the constructs to ensure that each scale uniquely measures a specific concept, distinct from others in the C-RES framework. This step is vital to verify that the constructs are not only reliable but also distinctly separate from one another, which is a prerequisite for accurate hypothesis testing. Following the criteria outlined by Fornell and others [73, 74], discriminant validity is established when the square root of AVE for a construct exceeds its correlations with other constructs. This assessment is crucial to confirm that each construct shares a closer relationship with its own indicators than with those of other constructs, thereby affirming the distinctiveness necessary for a valid measurement model. The results of this assessment are presented in Table 5.6 and in Figure 5.7, where the diagonal elements (the square roots of the AVEs for each construct) are compared against the off-diagonal elements, representing the inter-construct correlations detailed in Table 5.7 and in Figure 5.8. Our findings reveal that the diagonal elements are consistently larger than the off-diagonal elements in their respective rows and columns. This observation

	SE	ItA	I	SI	PEoU	PU	QCD	IQ	SQ	SvQ	SAT
SE	**0.852**										
ItA	0.237	**0.875**									
I	0.252	0.209	**0.866**								
SI	0.311	0.21	0.285	**0.852**							
PEoU	0.393	0.202	0.325	0.380	**0.867**						
PU	0.276	0.126	0.265	0.436	0.301	**0.848**					
QCD	0.271	0.369	0.339	0.299	0.223	0.132	**0.884**				
IQ	0.347	0.260	0.321	0.273	0.316	0.288	0.265	**0.897**			
SQ	0.266	0.241	0.420	0.305	0.307	0.309	0.271	0.324	**0.884**		
SvQ	0.230	0.190	0.410	0.313	0.320	0.299	0.320	0.318	0.503	**0.895**	
SAT	0.413	0.399	0.484	0.372	0.416	0.329	0.454	0.475	0.513	0.463	**0.885**

Table 5.6: Discriminant Validity

indicates that each construct is more closely related to its indicators than to those of other constructs. Consequently, these results support the presence of discriminant validity in our measurement model, confirming that our constructs are appropriately distinct and suitable for the subsequent hypothesis testing.

5.3 Analysis of the Structural Equation Model

In the subsequent phase of our research, after establishing the measurement model's convergent and discriminant validity, we utilized Structural Equation Modeling (SEM) for hypothesis testing. SEM is an advanced statistical framework ideal for path analysis, which uses maximum likelihood estimation to examine the relationships between observed and latent variables. This method is particularly apt for our study due to its capacity

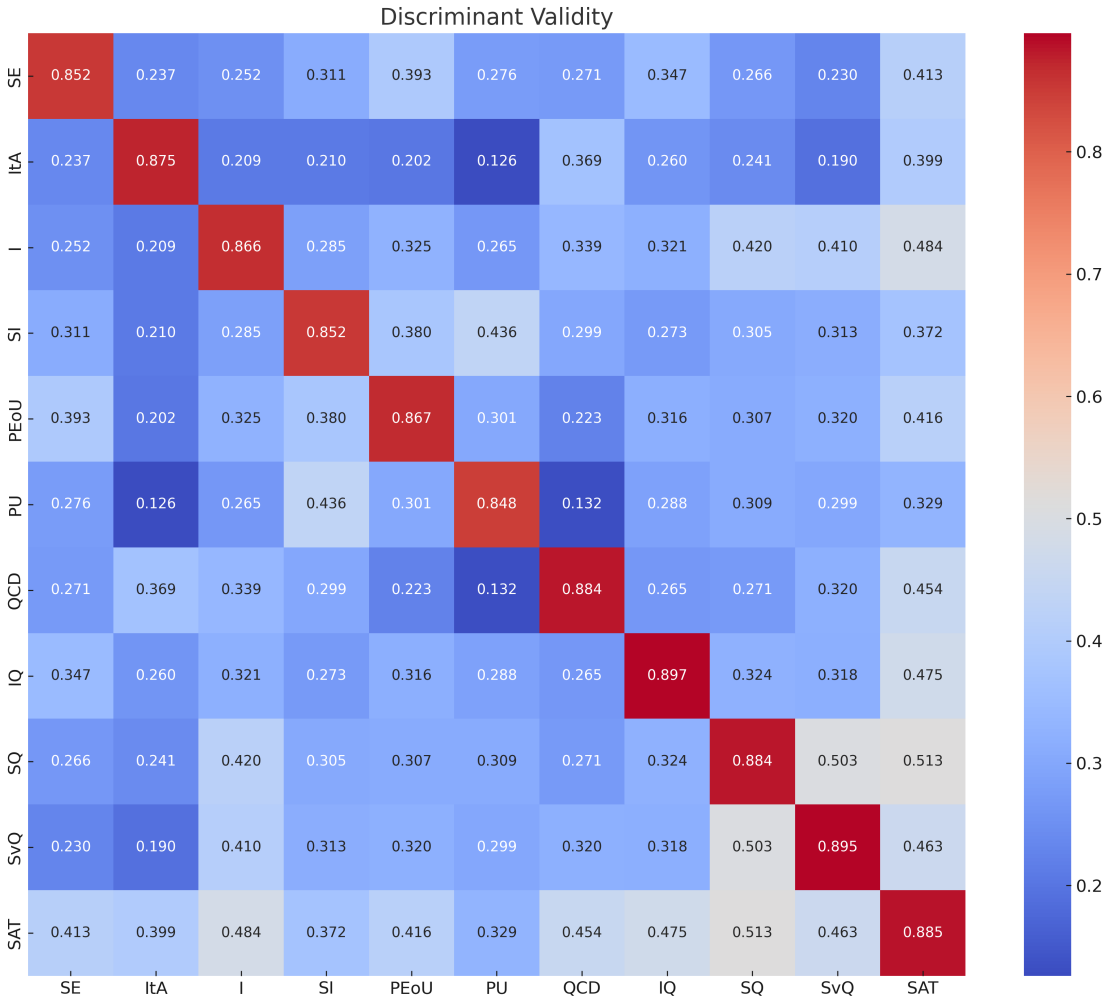

Figure 5.7: Discriminant Validity Heat Map

	SE	ItA	I	SI	PEoU	PU	QCD	IQ	SQ	SvQ	SAT
SE	1										
ItA	0.225	1									
I	0.234	0.203	1								
SI	0.288	0.201	0.267	1							
PEoU	0.372	0.192	0.307	0.359	1						
PU	0.256	0.117	0.245	0.402	0.284	1					
QCD	0.255	0.350	0.320	0.282	0.217	0.125	1				
IQ	0.324	0.243	0.301	0.256	0.304	0.272	0.249	1			
SQ	0.250	0.236	0.397	0.285	0.286	0.291	0.256	0.304	1		
SvQ	0.218	0.180	0.387	0.293	0.306	0.281	0.306	0.299	0.478	1	
SAT	0.390	0.381	0.462	0.353	0.400	0.316	0.432	0.458	0.491	0.450	1

Table 5.7: Correlation Matrix

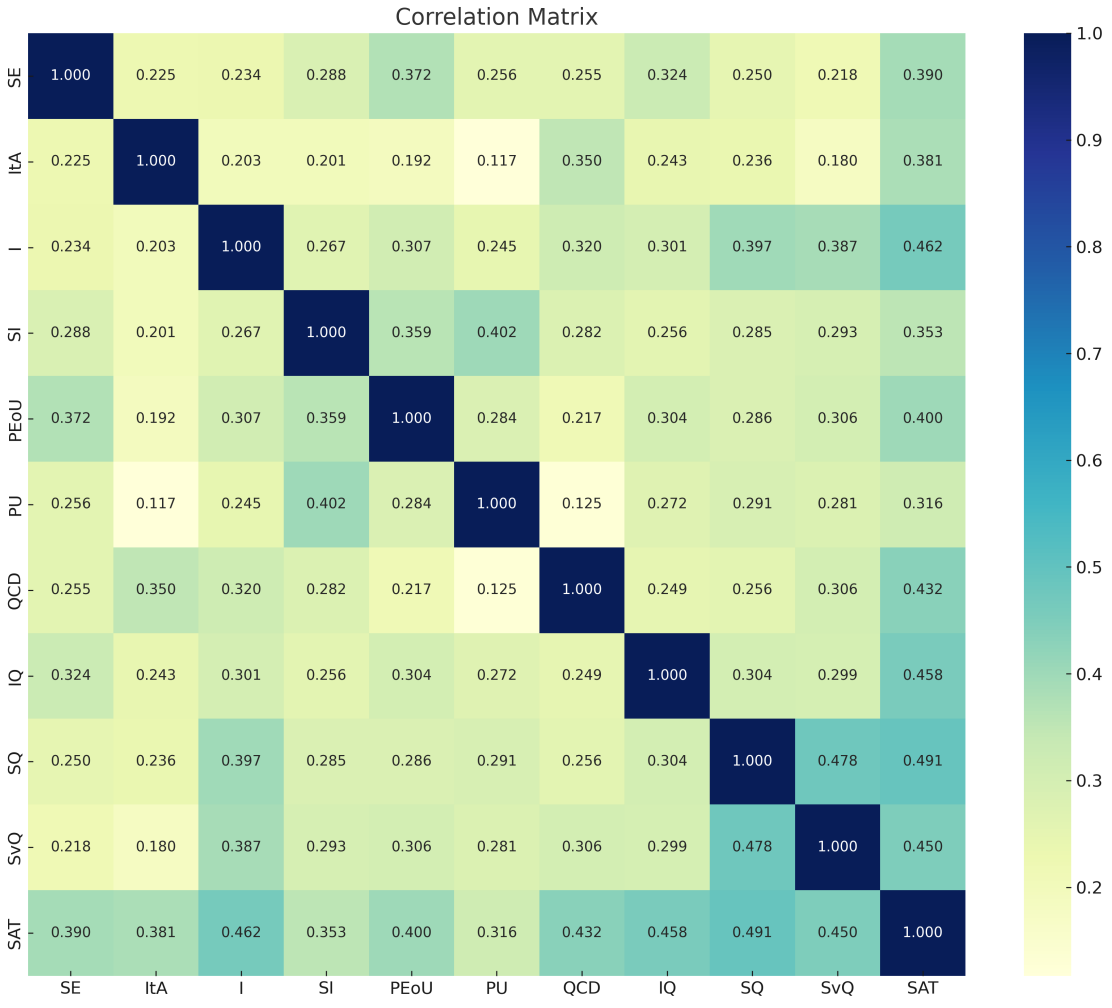

Figure 5.8: Correlation Matrix Heat Map

to handle intricate models involving multiple interrelated variables. The comprehensive nature of SEM is a significant asset in testing complex models like ours. It enables the simultaneous examination of multiple relationships within the model, providing a cohesive visual representation of these interrelations. This capability marks a significant advancement over traditional multiple regression methods, offering a more in-depth and holistic view of the data.

To appraise the adequacy of our SEM model, we relied on various fit indices as recommended by Schumacker et al. [171, 170]. These indices are categorized into three types, as presented in Table 5.8: absolute fit indices, incremental fit indices, and parsimony fit indices. Each category plays a vital role in evaluating the model from different perspectives, ensuring a comprehensive assessment of its overall soundness and appropriateness. Absolute fit indices evaluate how well the model fits the observed data, incremental fit indices compare the model to a baseline model, and parsimony fit indices assess the model's simplicity and efficiency. Together, these fit indices provide a multi-faceted evaluation of the SEM model, ensuring its validity and effectiveness in testing our research hypotheses.

In our study, absolute fit indices were employed to evaluate how well the SEM model corresponds with the empirical data [139]. These indices are essential in confirming that the model accurately reflects the patterns observed in the data. Notably, the Chi-Squared test (X^2) yielded a value of 1973.093. While a lower Chi-Squared value typically indicates a better fit, it should be noted that this index is sensitive to sample size. The Goodness-of-Fit Statistic (GFI)) was 0.847, and the Adjusted Goodness-of-Fit Statistic (AGFI) was 0.832. Though slightly below the recommended threshold of 0.9, these values still suggest an acceptable fit. The Root Mean Square Error of Approximation Root Mean Square Error of Approximation (RMSEA) at 0.033 and the Root Mean Square Residual (RMSR) at 0.146 indicate a good fit overall, although the RMSR is marginally above the ideal,

Fit Index	Obtained Value	Recommended Value	Remarks
Absolute Fit Indices			
Chi-Squared (X^2)	1973.093	-	Good Fit
GFI	0.847	≥ 0.9	Acceptable Fit
AGFI	0.832	≥ 0.9	Acceptable Fit
RMSEA	0.033	≤ 0.08	Good Fit
RMSR	0.146	≤ 0.10	Marginal Fit
Incremental Fit Indices			
NFI	0.906	> 0.9	Good Fit
CFI	0.971	> 0.9	Good Fit
Parsimony Fit Indices			
X^2/df	1.407	< 2 or < 3	Good Fit

Table 5.8: Fit Indices for the Structural Equation Model

pointing to minor areas of mismatch in the model.

Incremental fit indices such as the Normed-Fit Index (NFI) and the Comparative Fit Index (CFI) were also calculated. Our model achieved an NFI of 0.906 and a CFI of 0.971. Both values exceed the recommended threshold of 0.9, indicating that our model provides a significantly better fit than a basic model assuming no correlations among variables.

Incremental fit indices, which compare the model to a basic model assuming no correlations among variables, included the NFI and the CFI. Our model achieved an NFI of 0.906 and a CFI of 0.971, both above the recommended value of 0.9, signifying that the model provides a significantly better fit than the baseline model with no relationships among variables.

Lastly, parsimony fit indices like the Chi-Squared to degrees of freedom ratio (X^2/df),

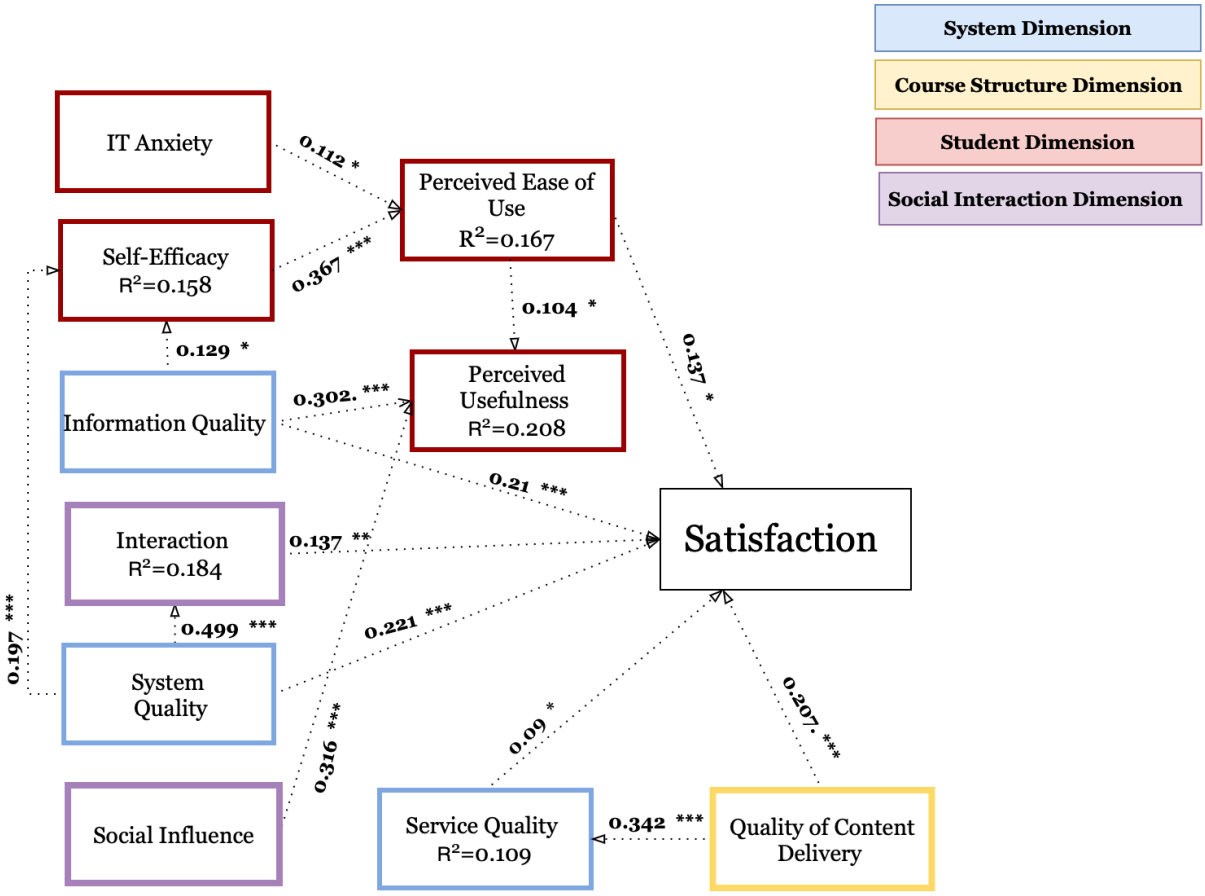

Figure 5.9: Results of Structural Model Assessment ($*p < 0.05$, $**p < 0.01$, $***p < 0.001$)

which stood at 1.407 in our study, were considered. This ratio indicates a model that is not overly complex but sufficiently explains the data. A value below 2 or 3 is generally considered ideal, suggesting that the model does not over-fit the data while capturing the necessary complexity [139]. Our model's ratio, being well within this range, suggests that it is appropriately calibrated, avoiding over-fitting and maintaining robust explanatory power.

In our research, the Structural Equation Modeling (SEM) methodology was utilized

to rigorously test the hypotheses within the C-RES framework. The results, as detailed in Table 5.9, were evaluated using several key statistical measures: Standardized Path Coefficients (β, γ): These coefficients indicate the magnitude and direction of the effect each independent variable has on the dependent variable. A larger absolute value signifies a stronger relationship. This measure clarifies the strength and direction of the relationships within our mode. Critical Ratios (t-values): These values estimate the influence of random variation on the hypothesis outcomes, assessing the statistical significance of the path coefficients. A t-value exceeding ± 1.96 indicates significant factor covariance, following standard criteria for SEM analyses. Significance Levels (p-values): Reflecting the probability of making a Type I error, a lower p-value indicates a lower risk of incorrectly rejecting the null hypothesis. In social science research, a p-value of less than 0.05 is typically considered significant. Variance Explained (R^2): This measure denotes the percentage of variance in the dependent variable explained by the independent variables, offering insight into the explanatory power of the independent variables.

Figure 5.9 presents the consolidated results of our tested hypotheses. Our analysis revealed that nine hypotheses were highly significant with p-values less than 0.001, one was significant at p-values less than 0.01, five were marginally significant at p less than 0.05, and three did not achieve significance. This detailed examination elucidates the various factors influencing user satisfaction in e-learning environments. The C-RES framework accounted for 44.70% of the overall variance in satisfaction, further breaking down into specific components such as perceived ease of use (16.7%), perceived usefulness (20.8%), service quality (10.9%), self-efficacy (15.8%), and interaction. These findings are crucial in highlighting the factors that most significantly contribute to user satisfaction in e-learning environments, providing valuable insights for future improvements and strategies in online education.

Hypotheses	**Path**	β, γ	**t-value**	**p-value**	**Support**
H1	SE $\rightarrow$ PEoU	0.367	6.832	< 0.001	Yes
H2	ItA $\rightarrow$ PEoU	0.112	2.393	0.017	Yes
H3a	SI $\rightarrow$ PU	0.316	5.836	< 0.001	Yes
H3b	SI $\rightarrow$ SAT	0.043	0.883	0.377	No
H4a	I $\rightarrow$ PU	0.085	1.821	0.069	No
H4b	I $\rightarrow$ SAT	0.137	3.156	0.002	Yes
H5	PEoU $\rightarrow$ PU	0.104	1.982	0.048	Yes
H6	SvQ $\rightarrow$ SAT	0.09	1.984	0.047	Yes
H7a	SQ $\rightarrow$ SE	0.197	3.371	< 0.001	Yes
H7b	SQ $\rightarrow$ SAT	0.221	4.186	< 0.001	Yes
H7c	SQ $\rightarrow$ I	0.499	8.196	< 0.001	Yes
H8a	IQ $\rightarrow$ SAT	0.21	4.558	< 0.001	Yes
H8b	IQ $\rightarrow$ PU	0.129	2.502	0.012	Yes
H8c	IQ $\rightarrow$ SE	0.302	5.335	< 0.001	Yes
H9a	QCD $\rightarrow$ SvQ	0.342	6.232	< 0.001	Yes
H9b	QCD $\rightarrow$ SAT	0.207	4.713	< 0.001	Yes
H10a	PEoU $\rightarrow$ SAT	0.135	2.959	0.003	Yes
H10b	PU $\rightarrow$ SAT	0.053	1.056	0.291	No

Table 5.9: Summary of Hypotheses Tests

5.4 Hypotheses Examination

As shown in Table 5.9, self-efficacy (SE) was found to have a positive impact on perceived ease of use (PEoU) with a coefficient of 0.367, a t-value of 6.832, and a p-value less than 0.001, supporting hypothesis H1. This result indicates a strong relationship between users' confidence in their abilities and their perception of the e-learning platform as easy to use. Additionally, the relationship between technology anxiety (ItA) proficiency and perceived ease of use (PEoU) was significant with a coefficient of 0.112, t-value of 2.393, and a p-value of 0.017, confirming hypothesis H2. This highlights the positive impact that managing technology-related anxiety has on users' ease of use perception.

Social influence (SI) was shown to have a substantial positive effect on perceived usefulness (PU) with a coefficient of 0.316, t-value of 5.836, and a p-value less than 0.001, thus supporting hypothesis H3a. This suggests that social factors play a significant role in how users perceive the utility of the e-learning platform. However, SI's effect on satisfaction (SAT) was not supported ($\beta = 0.043, t = 0.883, p = 0.377$), rejecting hypothesis H3b. This indicates that while social influence affects perceived usefulness, it may not directly translate into satisfaction with the e-learning platform.

Interaction (I) in hypothesis H4a, which was not significant, refers to the potential modifying effect that another variable may have on the relationship between perceived usefulness and satisfaction. The lack of significance here suggests that the interaction variable considered does not significantly alter the relationship between perceived usefulness and satisfaction. However, interaction impact on satisfaction was positive and significant ($\beta = 0.137, t = 3.156, p = 0.002$), confirming hypothesis H4b. This confirms the importance of social interaction as a factor contributing to user satisfaction with e-learning platforms. Perceived enjoyment's influence on PU was also significant

($\beta = 0.104, t = 1.982, p = 0.048$), supporting hypothesis H5. This finding indicates that users who enjoy the e-learning experience are more likely to find the platform useful.

System quality (SvQ) was found to positively affect SAT with a coefficient of 0.09 and a t-value of 1.984, with a p-value of 0.047, thus confirming hypothesis H6. This result emphasizes the role of system quality in contributing to user satisfaction, underscoring the need for high-quality e-learning systems. Service quality (SQ) significantly influenced SE, SAT, and I, with respective coefficients of 0.197, 0.221, and 0.499, all with p-values less than 0.001, thus supporting hypotheses H7a, H7b, and H7c. TThe strong influence of service quality suggests it is a critical factor in enhancing users' self-efficacy, satisfaction, and interactions with the e-learning system. Information quality (IQ) was observed to have a significant positive impact on both SAT and PU, with coefficients of 0.21 and 0.129 respectively, confirming hypotheses H8a and H8b. This indicates that high-quality information positively impacts both user satisfaction and the perceived usefulness of the platform. IQ's effect on SE was also significant ($\beta = 0.302, p < 0.001$), supporting hypothesis H8c.

Quality of content delivery (QCD) was found to significantly improve both SvQ and SAT with coefficients of 0.342 and 0.207 respectively, and p-values less than 0.001, confirming hypotheses H9a and H9b. This highlights the critical role of content delivery quality in enhancing both system quality and user satisfaction. The relationship between PEoU and SAT was supported with a coefficient of 0.135, t-value of 2.959, and a p-value of 0.003 (hypothesis H10a). However, the effect of PU on SAT was not supported ($\beta = 0.053, t = 1.056, p = 0.291$), thus rejecting hypothesis H10b. This suggests that while the ease of using the system contributes to satisfaction, the perceived usefulness does not significantly influence satisfaction in this context, a finding that may warrant further investigation to understand the underlying reasons.

Chapter 6

Discussion and Conclusion

6.1 Discussion

The findings of our study reveal intricate relationships that shape user satisfaction with e-learning platforms, particularly learning management systems (LMS), during the COVID-19 pandemic in Canada. Table 6.1 illustrates the direct, indirect, and combined impacts among elements within the C-RES framework, uncovering a complex interplay of factors influencing student perceptions in a technological context amid the pandemic.

Table 6.1: Summary of Direct, Indirect and Total Effects

Path	**Direct**	**Indirect**	**Total**
Self-efficacy → Perceived ease of use	0.367	-	0.367
IT anxiety → Perceived ease of use	0.112	-	0.112
System quality → Perceived ease of use	-	0.072	0.072
Information quality → Perceived ease of use	-	0.111	0.111

Path	Direct	Indirect	Total
Self-efficacy → Perceived usefulness	-	0.038	0.038
IT anxiety → Perceived usefulness	-	0.012	0.012
Social influence → Perceived usefulness	0.316	-	0.316
Interaction → Perceived usefulness	0.085	-	0.085
System quality → Perceived usefulness	-	0.042	0.042
Information quality → Perceived usefulness	0.129	-	0.129
Perceived ease of use → Perceived usefulness	0.104	-	0.104
Information quality → Self-efficacy	0.302	-	0.302
System quality → Self-efficacy	0.197	-	0.197
Quality of content delivery → Service quality	0.342	-	0.342
System quality → Interaction	0.499	-	0.499
Self-efficacy → Satisfaction	-	0.050	0.050
IT anxiety → Satisfaction	-	0.015	0.015
Information quality → Satisfaction	0.210	-	0.210
System quality → Satisfaction	0.221	-	0.221
Quality of content delivery → Satisfaction	0.207	-	0.207
Service quality → Satisfaction	0.09	-	0.09
Social influence → Satisfaction	0.043	-	0.043
Interaction → Satisfaction	0.137	-	0.137
Perceived ease of use → Satisfaction	0.135	-	0.135
Perceived usefulness → Satisfaction	0.053	-	0.053

Key among these findings is the significant role of self-efficacy and IT anxiety, both exerting direct effects on perceived ease of use. System and information quality also play

critical roles, influencing perceived ease of use indirectly through intermediary variables, thus underlining the multifaceted nature of technological interactions in e-learning. This aligns with our research objective to understand how individual psychological attributes and system characteristics collectively influence user satisfaction.

Furthermore, self-efficacy indirectly influences perceived usefulness, complemented by direct impacts of social influence, interaction, and perceived ease of use. These results elucidate the intricate relationship between individual confidence, social dynamics, and system usability, addressing our objective to explore these complex interactions in e-learning systems.

Regarding satisfaction, factors like self-efficacy, IT anxiety, information quality, system quality, service quality, social influence, and interaction all contribute directly, reflecting the multifaceted nature of user satisfaction in e-learning platforms. Notably, system quality and information quality demonstrate multiple direct and indirect effects, emphasizing their pivotal role in shaping user experiences.

The direct impact of content delivery quality on service quality and user satisfaction highlights its critical role in determining how students perceive the overall quality of e-learning services. The pandemic context likely amplified the importance of these quality dimensions as users increasingly relied on digital platforms for learning.

In conclusion, our study addresses the research objectives and questions through a thorough analysis of factors influencing user satisfaction in e-learning platforms. The findings offer valuable insights for designing effective, user-centric LMS, particularly under pandemic conditions. They underscore the need to consider a broad spectrum of factors, from individual psychological aspects to quality dimensions and social influences, to enhance user satisfaction and technology perceptions. This comprehensive understanding is piv-

otal for developing technology systems that meet user needs and expectations, particularly during challenging times like a pandemic, thereby fulfilling the overarching goal of this research.

6.2 Implication

The outcomes of this study hold significant implications for higher education institutions, particularly in understanding and enhancing student learning outcomes and satisfaction with e-learning amidst the COVID-19 pandemic or similar crises. Our analysis indicates that students value the capabilities of e-learning systems in supporting their learning journey, especially in overcoming challenges posed by the pandemic. This observation resonates with findings that a positive correlation exists between students' intention to use e-learning systems and their satisfaction with e-learning outcomes [167].

We advocate for higher education decision-makers and policymakers to prioritize enhancing student satisfaction with e-learning. This includes not only improving the user interface of e-learning platforms but also ensuring resilient and reliable IT infrastructure capable of handling high traffic and providing consistent access. Strengthening the IT infrastructure is key to maintaining continuity in education during unexpected shifts to online learning. Investment in high-quality digital content, encompassing academic materials, resources for skill development, and virtual laboratories, is essential. This will cater to various disciplines, particularly those requiring practical engagement, and will enrich the overall e-learning experience.

Furthermore, we propose that institutions should develop comprehensive long-term strategies for remote learning. This includes integrating feedback mechanisms for continuous improvement, ensuring equitable access for all students, and preparing comprehensive

policies for online education. The development of a blended learning system that effectively integrates digital tools for interactive and engaging learning experiences is crucial. Blended learning combines the benefits of traditional face-to-face interaction with the flexibility and accessibility of online resources. Consequently, ongoing teacher training programs focusing on digital literacy and innovative teaching methods are vital. Educators must be skilled in using digital tools effectively and engaging students in a virtual environment. Significant investment in ICT equipment and infrastructure is pivotal. Such initiatives should aim to improve the quality of e-learning and prepare educational institutions for future contingencies like pandemics or emergency shutdowns. Institutions must be prepared for future emergencies or disruptions. Last, not the least, preparing for future contingencies, this involves having established protocols for transitioning to remote learning and ensuring students and faculty have the necessary resources and support.

In summary, these findings offer profound insights for developing user-centric and effective LMS, particularly in pandemic conditions. They highlight the importance of considering a wide range of factors, from individual psychological aspects to quality dimensions and social influences, to enhance user satisfaction and perceptions of technology. By focusing on these areas, higher education institutions can not only navigate the challenges posed by the pandemic but also build a more inclusive, flexible, and resilient educational environment for the future.

6.3 Limitations

Like all research projects, this study has its limitations that need to be recognized. Firstly, the generalizability of our findings needs careful consideration. While our participant selection and conceptual framework are grounded in contemporary literature and aimed to

reflect the realities of e-learning during the COVID-19 pandemic in Canada, the sample may not fully represent the diverse demographics of the entire Canadian student population, particularly in terms of geographical distribution and academic disciplines. The factors influencing student satisfaction identified here may primarily pertain to the specific context of this research. The unique circumstances of the pandemic, such as the sudden shift to online learning, might have influenced student attitudes and experiences in ways not typical of more traditional e-learning contexts.

Additionally, despite our sample size being adequate for comprehensive statistical analysis, a larger and more diverse sample could potentially yield different insights. This includes diversity in terms of cultural background, learning styles, and access to technology, which can all influence e-learning experiences. Therefore, while the structural results and findings are indicative of the trends within our sample, they should be cautiously extrapolated to broader populations. Another limitation arises from the research's geographical and cultural context. Conducted within the Canadian educational system, the findings should be interpreted with an understanding of the cultural and educational nuances specific to this region. Differences in educational policies, infrastructure, and student demographics may limit the applicability of our findings to other cultural and educational contexts.

Furthermore, while our study has explored various factors impacting e-learning satisfaction, it is not exhaustive. The exclusion of certain factors like system usability and instructor attitudes was primarily due to the focused scope of our study, aiming to concentrate on specific aspects within the constraints of our resources and time. Future research could benefit from incorporating these elements to offer more comprehensive insights.

This research contributes to understanding the multifaceted impacts of COVID-19-related factors on students' satisfaction with e-learning. Future studies could apply our proposed model in other contexts to ascertain its applicability and uncover additional in-

sights. Additionally, exploring how the rapid adaptation to e-learning during the pandemic could inform long-term strategies for e-learning in higher education would be a valuable area of research. Moreover, further research should investigate how educational institutions might better prepare for future events similar to the current pandemic, enhancing their resilience and adaptability in the face of such challenges.

6.4 Conclusion and Future Work

In our study, we endeavored to unravel the factors influencing student satisfaction with e-learning, particularly focusing on Learning Management Systems (LMS) during the COVID-19 pandemic within the Canadian higher education context. The study's foundation on the Technology Acceptance Model and the DeLone and McLean Information Systems Success Model culminated in the development of the C-RES model. This model, validated through Structural Equation Modeling, illuminated the complex interplay of self-efficacy, IT anxiety, system and information quality, and social influences in shaping students' perceptions and satisfaction with e-learning platforms.

While our research provides valuable insights into the determinants of e-learning satisfaction during a global health crisis, its primary focus on the Canadian context during the COVID-19 pandemic presents limitations in terms of generalizability. The findings offer a specific lens on e-learning experiences influenced by the pandemic's unique challenges, which may not directly translate to other educational systems or cultural contexts. Looking ahead, there is significant potential for applying the C-RES framework in diverse educational settings worldwide. Expanding this research to various cultural contexts could validate the model's applicability and uncover unique e-learning perceptions and challenges faced in different regions. Incorporating both quantitative and qualitative research

methods would enrich this exploration, providing a comprehensive global perspective on e-learning satisfaction and effectiveness.

Furthermore, future research endeavors should delve deeper into the impact of demographic factors on e-learning satisfaction. Understanding how diverse groups, varying in age, gender, and educational backgrounds, interact with and benefit from e-learning systems could yield profound insights into creating more inclusive and effective digital learning environments. Additionally, examining how educational institutions can refine their e-learning strategies to better handle future crises remains an essential area of focus. This might involve exploring advanced techniques for rapid adaptation and strategies to enhance the resilience of e-learning systems against unforeseen challenges [213, 221, 207, 113, 91, 42, 92, 216, 128, 93].

Moreover, the integration of AI technologies in e-learning opens a myriad of research possibilities, especially in the context of personalized education. Artificial Intelligence, like the capabilities seen in ChatGPT[1], has demonstrated exponential growth over the past few years, becoming an integral tool in educational and research settings [112, 99]. The adaptability and interactivity of AI systems offer a unique opportunity to tailor educational content to individual learning styles, pace, and preferences, thereby enhancing student engagement and satisfaction.

In the future, research could delve into how AI-driven analytics can predict learning outcomes, identify areas where students struggle, and provide targeted interventions. This could lead to a more understanding of student behavior and learning patterns, enabling educators to craft more effective and adaptive learning strategies. Furthermore, the potential of AI to facilitate a more interactive and responsive learning environment, through tools such as intelligent tutoring systems and conversational agents, represents a significant

[1]https://chat.openai.com/

leap forward in e-learning. These systems could simulate one-on-one tutoring experiences, providing instant feedback and personalized guidance, thereby bridging gaps in traditional e-learning models.

Another promising area of research is the exploration of AI in developing dynamic course content that evolves based on student interactions and feedback. This could revolutionize the design of e-learning platforms, making them more agile and responsive to the changing educational needs and preferences of students. Moreover, integrating AI with advanced user interface design could create more intuitive and engaging e-learning experiences, which are particularly crucial in maintaining student motivation and participation in online learning environments. The recent global shift towards digital education, accelerated by challenges such as the COVID-19 pandemic, has highlighted the need for more resilient and adaptable e-learning systems. AI's potential in customizing education paths based on individual needs and preferences, and its capacity for developing AI recommender systems for personalized learning, are areas ripe for exploration. Such innovations could lead to a more inclusive and effective digital learning landscape, catering to a diverse array of learning needs and styles. The exploration of AI in e-learning not only offers opportunities to enhance the current educational models but also paves the way for groundbreaking research in personalized and adaptive learning. The integration of AI technologies in e-learning promises to transform the educational landscape, making it more responsive, engaging, and effective for learners worldwide.

As we look towards the future, the promise of AI in revolutionizing e-learning forms an integral part of our study's implications. The exploration of AI technologies, particularly in creating personalized and adaptive learning experiences, aligns with the core findings of our research. The shift towards AI-enhanced educational tools reflects a natural progression from our current understanding of factors like self-efficacy, IT anxiety, system and

information quality, and social influences in e-learning. This transition to more technologically advanced e-learning environments speaks to the evolving nature of educational needs and preferences. It underscores the importance of continuous research and adaptation in educational technology, particularly in response to global challenges and changing learning dynamics. As we integrate these advanced tools, such as AI-driven platforms, into our educational frameworks, they offer a new lens through which we can view and enhance student satisfaction and the overall effectiveness of e-learning.

Our study contributes significantly to the understanding of e-learning dynamics during an unprecedented global crisis and lays the groundwork for further research to expand and adapt these insights to a broader, more diverse educational landscape. In this journey, we have identified key factors influencing student satisfaction and the success of e-learning, with a particular focus on the use of Learning Management Systems (LMS) during the COVID-19 pandemic in the Canadian higher education context. Our analysis, highlighting the crucial roles of self-efficacy, IT anxiety, system and information quality, and social influences, has painted a comprehensive picture of the e-learning platform's ease of use and usefulness. As we move forward, the integration of advanced technologies like AI in e-learning presents an exciting frontier for research and practice. This not only enriches our current understanding but also opens doors to innovative approaches in enhancing the educational experience. Thus, our study, while rooted in the challenges of the recent global crisis, serves as a catalyst for future explorations in a rapidly evolving educational landscape, steering us towards a future where technology and learning seamlessly converge for the greater benefit of learners worldwide.

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APPENDICES

Appendix A

Informed Consent Form

Study Name: Unveiling the Complexities of Student Satisfaction in E-Learning: An Integrated Framework Controlled for the Context of COVID-19

Researchers: Rui Lin, Master's Student in School of Information Science and Technology at York University, ruilin@yorku.ca; supervised by Dr. Jimmy Huang, School of Information Science and Technology at York University.

Purpose of the Research: This study aims to explore the factors affecting student satisfaction of e-learning, with a specific emphasis on Learning Management System (LMS) during the COVID-19 pandemic. The research outcomes will be presented in various formats, including a comprehensive written report. Measure will be taken ensure participant confidentiality in both presentations and written output.

What You Will Be Asked to Do in the Researchh: Participants will complete a

survey covering details learning behaviours, instructor interactions, and other factors related to their remote learning experience. The estimated time for completing this survey is approximately 20 minutes.

Risks and Discomforts: We do not foresee any risks or discomfort from your participation in the research.

Benefits of the Research and Benefits to You: The research is designed to benefit the fields of information technology and education by gaining new insights and preparing for unforeseen situations. You may not benefit personally from participating in this research study.

Voluntary Participation: Your participation in the study is completely voluntary and you may choose to stop participating at any time. Your decision not to volunteer will not influence the nature of your relationship with York University either now, or in the future.

Withdrawal from the Study: You can stop participating in the study at any time, for any reason, if you so decide. Your decision to stop participating, or to refuse to answer questions, will not affect your relationship with the researchers, York University, or any other group associated with this project. In the event you withdraw from the study, all associated data collected will be immediately destroyed wherever possible.

Confidentiality: All information you provide during the research will be treated with utmost confidentiality unless you specifically grant permission, your name will not appear in any report or publication steaming for this research. Your data will be collected through

Google Forms, and we recognize that online survey platforms may automatically gather additional data like IP addresses. While such information may be accessible to us, we commit not to use or store it without your explicitly consent. It's essential to note that because this project employs web-based data collection techniques, data transmission over the internet can potentially be accessed by third parties due to security legislation in many countries. As such, we cannot guarantee the confidentiality and privacy of your data during its online transmission. Upon collection, your data will be stored securely on a local laptop dedicated to this research. It will be housed in a locked facility to which only the research staff have access. This data will be retained for the duration of the thesis project and will be destroyed by December 2023. We are committed to ensuring your privacy and will protect your confidentiality to the fullest extent permitted by law.

Questions About the Research?: If you have questions about the research in general or about your role in the study, please feel free to contact Rui Lin by e-mail ruilin@yorku.ca, Graduate Program: The Master of Arts in Information System and Technology (MAIST); Contact School of Information Technology Graduate Program by email lapsitec@yorku.ca . Graduate supervisor: Dr. Jimmy Huang by email jhuang@yorku.ca. This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Director, Research Ethics in the Office of Research Ethics, 3rd Floor, Kaneff Tower, York University e-mail ore@yorku.ca.

Legal Rights and Consent Agreement: I consent to participant in studying "Unveiling the Complexities of Student Satisfaction in E-Learning: An Integrated Framework

Controlled for the Context of COVID-19" conducted by Rui Lin. I have understood the nature of this study and which to participate. I am not waiving any of my legal right by signing this form.

☐ **I agree to participate in the research**

Appendix B

Questionnaire Survey

The survey instrument has been prepared and is accessible via Google Form. The access link to the survey is provided below: `https://forms.gle/dDvqD99tUjNnCrE87`.

Note: Please take a few moments to complete this questionnaire about your experiences with e-learning during and after the COVID-19 pandemic. For the purposes of this study, the term "e-learning" specifically refers to educational experiences facilitated by learning management systems such as Blackboard, Canvas, Moodle, as well as communication tools like Zoom and Microsoft Teams used for academic purposes. Your responses will be recorded on a scale of 1 to 5, from "Strongly Disagree" to " Strongly Agree"

Constructs	Items	Contents
Self-efficacy	SE1	During the pandemic, I felt confident in my ability to use learning management systems effectively for my studies (e.g., Moodle, Canvas, Blackboard, etc.)
	SE2	Despite the challenges of remote learning, I felt I could complete my assignments on the LMS on time.
	SE3	Using the LMS to adopt to new remote learning methods was within my capabilities.
	SE4	I believe I could handle the demands of remote learning on this LMS.
	SE5	The pandemic influenced my confidence and self-belief in effectively using the LMS for my studies.
IT Anxiety	ItA1	During the pandemic, using LMS and communication tools for academic purposes (e.g., Moodle, Canvas, Blackboard, Zoom, Microsoft Teams) made me anxious.
	ItA2	The transition to remote classes using the LMS made me anxious.
	ItA3	The shift to remote learning through the LMS during the COVID-19 increased my technological anxieties.

Constructs	Items	Contents
	ItA4	The extensive functionalities of the LMS felt overwhelming at times.
	ItA5	I hesitated to explore unfamiliar features on the LMS and communication tools during the pandemic.
Perceived Ease of Use	PEoU1	Navigating the LMS for my remote classes during the COVID-19 was straightforward.
	PEoU2	Adapting to the remote mode of education through LMS and communication tools (e.g., Moodle, Canvas, Blackboard, Zoom, Microsoft Teams) was seamless for me.
	PEoU3	The user interface pf the LMS felt intuitive during my remote learning experience.
	PEoU4	Overall, the LMS facilitated a smooth transition to remote learning during the COVID-19 pandemic.
	PEoU5	The support (e.g., technical help, instructional guidance, institutional policies) provided during the pandemic influenced my ease of using the LMS and communication tools.
Perceived Usefulness	PU1	Given the challenges of the COVID-19 pandemic, to what extend did the LMS enhance your effectiveness in academic tasks?

Constructs	Items	Contents
	PU2	The LMS provided valuable features that helped me cope with challenges brought about by the pandemic.
	PU3	The LMS played a critical role in ensuring that I could continue my academic progress without significant disruption during the pandemic.
	PU4	Despite the pandemic, I found that the LMS enabled me to achieve my learning objectives.
	PU5	I believe that the LMS was indispensable in facilitating successful remote learning during the pandemic.
Information Quality	ImQ1	The content available on the LMS was always up-to-date during the pandemic.
	ImQ2	The LMS provided relevant content that met my education needs.
	ImQ3	The information on the LMS was presented in a clear and understandable manner.
	ImQ4	I found the information on the LMS during the COVID-19 to be accurate and reliable.
	ImQ5	The quality of information on the LMS assisted me in navigating my course during the pandemic.

Constructs	Items	Contents
System Quality	SQ1	The LMS was consistently available and relabel during the pandemic.
	SQ2	I experienced minimal technical glitches or down times on the LMS during the remote learning.
	SQ3	Feature and tools on the LMS were responsive and didn't lag.
	SQ4	The LMS supported various format (videos, documents, etc.) efficiently during remote classes.
	SQ5	The design of the LMS was aesthetically pleasing and facilitated easy navigation.
Service Quality	SvQ1	The LMS provided clear instructions or tutorials with remote learning during the pandemic.
	SvQ2	There are sufficient resources available on the LMS to aid in my remote learning experience.
	SvQ3	I felt that the LMS was proactive in addressing the updating any system-related concerns.
	SvQ4	When I faced the issues on the LMS, there are timely technical support available.

Constructs	Items	Contents
	SvQ5	The service quality or support provided by the LMS aided in my remote learning experience during the pandemic.
Quality of Content Delivery	QCD1	The arrangement of course content on the LMS was logical and sequential, aiding my learning progression during the COVID-19.
	QCD2	Course materials were delivered in formats that were easy to access and comprehend.
	QCD3	Multimedia components (like videos, animations, and simulations) on the LMS enhanced my understanding of the content.
	QCD4	The LMS allowed for dynamic interaction with course content (e.g. quizzes, discussion forum) during the pandemic.
	QCD5	Course modules on the LMS were organized in digestible chunks, making it easier to manage my learning.
Social Influence	SI1	During the COVID-19 pandemic, how significant was the LMS in ensuring the continuation of your education?
	SI2	The endorsement and emphasis by the institution on the LMS influenced my trust and reliance on it during the pandemic.

Constructs	Items	Contents
	SI3	Most of my peers considered the LMS as an essential tool for our learning continuity. How strongly do you agree with this statement?
	SI4	The LMS's reputation and widespread adoption during the pandemic influenced my willingness to actively use it for my studies.
	SI5	During the pandemic, I felt that the LMS was an indispensable platform for academic success.
Interaction	I1	The LMS facilitated effective communication between instructors and students.
	I2	The LMS successful replaced the face-to-face interactions I missed during the pandemic with effective virtual communication.
	I3	The LMS forums and chat rooms become more active and vital during the pandemic. How strongly do you agree?
	I4	I found that the feedback and communication from instructors through the LMS were more frequent due to the pandemic.
	I5	I felt that the LMS's tool, like discussion boards and chat functions, helped maintain a sense of academic connection during the pandemic's isolation.

Constructs	**Items**	**Contents**
Satisfaction	S1	Considering the constrains of the COVID-19 pandemic, how satisfied were you with your overall LMS experience?
	S2	Considering the challenges of remote learning during the pandemic, the LMS met most of my education needs.
	S3	The LMS provided a stable and reliable platform for learning during the disruptions caused by the pandemic.
	S4	Even in the context of the pandemic, the LMS facilitated a seamless learning experience.
	S5	I would recommend the LMS as an effective learning platform, especially in the pandemic-like situation.

Table B.1: Questionnaire Survey

Appendix C

Raw Statistical Data

In this appendix, we present the raw statistical data as a data source for future research. For access to this data, interested parties are encouraged to reach out to Rui Lin and her supervisor, Dr. Jimmy Huang, with requests.

SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
4	4	4	4	5	4	3	4	4	4	3	3	5	3	3	3	3	3	3	4
2	4	4	3	3	1	2	3	2	2	5	5	5	5	5	5	5	5	5	5
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2	4	4	4	3	2	2	4	3	3	5	5	5	5	5	3	5	3	3	4

SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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4	4	5	4	3	4	4	3	5	4	4	4	3	4	4	4	4	5	4	5
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3	4	2	4	3	4	4	4	3	4	5	4	5	5	5	3	4	3	4	3
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3	4	3	3	4	4	4	4	4	4	2	2	3	3	3	5	4	5	5	5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
1	2	1	2	2	2	3	2	4	2	4	4	4	4	4	2	4	3	4	3
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3	3	4	3	2	2	2	1	2	2	4	3	3	4	4	2	2	2	2	2
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4	4	5	4	3	4	4	3	5	4	4	4	3	4	4	4	4	5	4	5
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SE1	SE2	SE3	SE4	SE5	ItA1	ItA2	ItA3	ItA4	ItA5	I1	I2	I3	I4	I5	SI1	SI2	SI3	SI4	SI5
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3	4	3	3	4	4	4	4	4	4	2	2	3	3	3	5	4	5	5	5
2	3	4	5	2	3	3	3	4	3	4	3	3	3	3	5	4	5	5	5

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
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5	5	5	5	5	2	2	2	2	3	5	5	5	5	5
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3	4	4	4	4	4	4	3	3	4	4	3	3	4	5
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3	3	4	3	3	3	2	4	5	4	1	2	1	2	2
5	3	5	5	5	5	5	4	5	5	4	3	2	3	4
4	4	4	3	3	4	3	4	3	5	2	3	3	4	4
3	3	3	3	3	3	3	4	4	3	2	3	3	3	4

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
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3	3	4	3	3	2	3	4	3	3	4	5	5	5	5
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1	1	1	1	1	3	3	4	3	3	1	1	1	1	1
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4	3	4	4	4	2	4	3	3	3	1	2	2	1	2
3	3	2	2	2	3	3	3	3	4	5	5	5	5	5
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3	5	4	3	3	2	3	3	2	2	5	5	5	5	5
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4	4	4	4	4	3	4	4	4	3	4	4	5	5	4
5	4	5	5	5	3	3	5	3	3	5	5	5	5	5
4	4	2	4	4	2	2	2	2	2	5	5	5	5	5

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
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4	4	4	3	3	1	1	1	2	1	4	5	5	5	5
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3	4	5	5	5	4	4	4	4	4	4	3	4	4	4
4	4	5	4	4	5	5	5	5	5	2	2	2	2	3
3	3	3	2	2	4	2	2	4	4	3	4	3	4	4
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5	5	5	5	5	3	3	4	4	3	2	2	1	2	1
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3	5	3	4	4	3	3	3	5	4	4	4	4	4	3
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2	2	4	3	3	2	3	2	2	2	5	5	4	5	5
3	3	3	3	3	3	4	5	4	3	2	3	3	4	3
2	2	2	2	2	2	1	2	2	2	1	1	1	1	1
4	3	2	4	4	4	4	5	3	4	3	4	3	4	3

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
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3	2	3	5	5	5	4	4	4	5	3	4	3	2	3
3	4	4	4	4	3	3	4	3	3	3	4	4	4	3
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3	3	4	4	4	3	3	5	3	5	5	5	5	5	5
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2	3	4	4	4	5	5	5	5	5	2	3	3	3	3
2	3	2	2	2	5	5	5	4	5	5	5	5	5	5
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3	4	3	4	3	4	4	4	3	4	3	2	3	4	4
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3	3	5	4	5	4	3	3	2	5	1	1	1	1	1
4	5	5	5	5	2	2	2	2	2	2	2	2	2	2
5	5	5	5	5	2	2	2	2	3	2	2	3	2	2
1	1	1	2	1	3	4	4	4	4	5	5	5	5	5

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
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5	5	5	5	5	5	4	3	4	4	2	2	2	2	2
5	5	5	5	5	1	1	1	1	1	4	2	3	2	3
3	3	5	3	5	2	1	1	1	1	3	3	2	3	4
4	4	3	3	3	5	5	5	5	5	2	2	2	4	3
3	4	3	5	3	3	2	5	3	2	4	3	3	3	4
4	5	5	5	5	2	2	2	2	3	4	4	4	4	5
2	2	2	2	2	3	4	3	4	4	2	3	2	3	2
4	4	3	4	3	1	1	1	2	1	1	1	2	2	1
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4	4	4	3	4	4	3	4	3	4	4	3	4	4	5
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3	4	4	4	4	4	4	3	4	4	4	4	4	3	5
3	4	4	5	4	3	4	2	4	3	3	3	2	3	5
5	5	5	5	5	4	3	4	4	4	4	3	3	4	4
1	1	1	1	1	3	2	2	2	2	1	1	1	1	1
4	4	4	5	4	3	4	4	5	4	3	3	4	3	4
4	4	4	4	4	4	5	3	4	4	3	4	4	3	4
2	2	2	2	2	2	2	2	1	2	5	5	5	5	5
4	4	3	5	3	2	4	3	3	2	4	4	5	3	4

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
4	3	3	4	3	4	2	4	3	4	2	3	4	4	4
1	3	4	2	4	4	5	5	5	5	4	3	4	3	3
1	1	1	1	1	1	1	2	1	1	1	1	1	1	1
2	4	3	4	3	2	4	4	3	3	3	3	4	3	3
1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
4	5	5	5	5	5	5	5	5	5	3	2	2	3	2
3	4	3	5	3	4	4	5	4	3	3	3	3	2	3
4	2	4	4	4	3	5	4	4	4	3	4	2	3	3
4	3	3	4	3	4	3	4	3	3	4	4	3	4	5
5	4	5	5	5	2	2	5	2	2	3	4	4	2	3
4	4	4	4	4	4	4	3	3	4	3	4	4	3	4
3	4	4	3	4	2	3	4	3	4	4	4	3	4	4
3	4	4	3	4	4	3	2	5	5	4	3	4	4	4
3	4	4	4	4	2	2	2	2	2	2	2	2	2	2
3	4	3	4	3	3	3	4	4	3	3	4	3	3	3
1	1	1	1	1	5	5	5	5	5	2	2	2	2	3
4	4	3	3	3	4	4	4	3	4	4	4	4	4	4
1	1	2	1	2	5	5	5	5	5	2	2	2	2	3
4	3	4	4	4	4	4	4	4	5	1	2	1	1	2
5	5	5	5	5	4	2	3	3	4	2	3	2	3	3
1	1	1	1	1	5	5	5	5	5	3	4	3	3	4
3	4	3	3	3	5	5	5	5	5	2	4	4	3	4
2	2	2	2	2	2	1	2	2	2	2	2	4	4	2
4	4	3	3	3	3	4	4	4	3	4	4	3	3	4

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
3	4	3	4	3	4	5	3	3	4	2	2	2	2	2
5	5	5	5	5	3	4	5	4	3	4	4	4	3	3
3	4	3	3	3	5	5	5	5	5	2	1	2	2	2
2	4	5	3	5	3	2	3	4	3	2	1	2	2	2
4	4	4	4	4	2	4	5	5	5	3	3	3	3	3
5	5	5	5	5	4	3	4	4	4	1	2	2	2	2
3	4	5	4	5	4	4	4	5	4	3	3	5	4	2
2	2	1	1	1	1	2	2	2	2	2	1	1	2	2
3	3	3	4	3	3	4	3	4	3	3	5	4	5	5
1	2	2	2	2	4	4	4	5	4	1	1	1	1	1
4	4	3	4	3	3	2	3	4	3	5	4	4	4	4
5	5	5	5	5	4	3	3	3	3	5	5	5	5	5
4	4	4	5	4	3	4	3	2	4	5	5	5	5	5
3	4	5	4	5	3	3	3	3	3	3	4	4	4	4
1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
4	4	3	3	3	2	2	3	3	4	2	4	4	4	4
4	4	4	4	4	3	4	4	4	4	4	3	4	4	3
3	3	4	4	4	3	3	3	3	3	2	1	2	2	1
3	3	4	3	4	4	5	5	5	5	2	4	2	2	2
4	4	3	4	3	4	4	4	4	3	2	4	4	4	3
2	1	2	1	2	5	5	5	5	5	2	2	2	3	2
2	3	3	3	3	1	1	1	1	1	3	3	4	3	3
3	4	3	4	3	4	4	4	3	5	5	5	5	5	5
5	5	5	5	5	2	4	4	3	5	3	3	3	4	4

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
4	4	4	5	4	2	2	3	4	4	3	2	3	3	4
2	2	2	3	2	4	4	4	3	4	4	3	3	5	5
2	4	5	3	4	3	4	4	3	5	3	4	3	3	5
5	5	5	5	5	5	5	5	5	5	1	2	2	1	2
3	4	5	4	4	3	3	4	4	4	4	4	4	5	4
4	4	4	4	4	3	2	3	2	4	3	3	4	3	3
3	3	3	5	3	4	3	4	3	3	3	3	4	4	4
3	3	4	5	3	4	3	4	4	4	3	3	4	4	4
4	2	5	3	2	4	3	4	3	3	4	3	3	3	4
4	4	5	3	4	2	2	4	4	4	3	3	4	4	4
2	2	2	2	2	3	4	3	4	4	3	4	4	4	3
2	1	2	2	1	4	3	4	4	4	1	2	2	1	3
3	5	3	3	5	3	3	3	3	4	3	3	4	5	5
3	3	4	5	3	4	3	4	4	3	2	2	3	4	3
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	3	4	3	3	2	2	5	3	3	3	3	2	3	5
4	3	4	4	3	2	4	5	3	3	4	5	5	5	5
4	4	4	4	4	4	3	4	3	4	4	3	4	3	5
2	2	2	2	2	2	1	2	1	2	1	1	1	1	1
3	3	4	4	3	4	3	4	3	5	3	3	4	5	5
4	3	5	4	3	2	3	4	3	3	4	4	5	4	4
3	3	3	5	3	4	3	4	4	4	3	2	3	4	3
3	2	2	2	2	3	3	3	3	3	2	2	2	2	2
4	4	4	4	4	3	4	4	3	4	2	3	3	3	3

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
3	4	4	4	4	3	3	3	2	3	3	4	4	4	4
3	4	4	4	4	4	2	3	2	3	1	1	1	1	1
4	3	4	5	3	3	2	4	4	3	4	3	4	4	4
3	5	3	5	5	2	3	3	4	4	4	3	4	4	5
4	4	5	5	4	1	2	2	1	1	5	5	5	5	5
4	4	3	4	4	3	4	4	4	4	3	4	3	4	3
3	3	3	4	3	4	3	4	3	3	4	4	3	3	4
4	3	3	3	3	2	4	4	2	3	4	4	3	4	5
3	4	2	4	4	4	3	3	4	3	4	3	3	4	3
3	2	4	3	2	5	5	5	5	5	4	5	5	5	5
4	5	5	5	5	4	3	3	4	3	4	4	4	4	4
3	4	3	4	4	5	5	5	5	5	3	2	2	3	3
3	4	4	3	4	3	4	3	4	4	2	1	2	2	2
1	1	1	1	1	3	4	3	3	3	1	2	2	2	2
3	5	5	5	5	3	4	2	3	4	4	3	4	4	5
3	4	4	4	4	3	3	4	3	4	4	3	5	4	4
3	2	2	4	2	4	3	4	3	2	3	3	4	3	3
4	4	4	5	4	3	2	5	4	3	2	2	2	2	2
3	3	3	4	3	3	3	3	4	5	3	3	4	4	4
4	5	4	4	5	5	4	4	4	4	3	3	4	4	3
4	4	3	3	4	4	4	4	3	4	3	4	3	4	4
4	3	3	4	3	4	4	3	4	4	4	4	3	4	3
2	3	2	2	3	4	4	4	4	3	4	2	4	5	4
3	3	4	5	3	3	5	5	4	5	1	1	1	1	1

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
4	3	4	3	3	4	4	2	3	3	4	3	2	5	3
5	5	5	5	5	3	3	4	3	4	3	3	4	3	3
4	4	4	4	4	4	3	3	3	3	1	1	2	2	2
5	4	3	5	4	4	4	4	4	4	2	3	4	3	3
1	2	1	2	2	3	3	3	3	2	1	2	2	2	1
4	4	5	4	4	4	4	4	4	4	3	4	3	4	4
2	2	2	3	2	2	2	1	1	1	1	1	1	1	1
3	4	4	4	4	2	3	2	4	4	2	2	1	1	2
3	4	4	4	4	4	3	3	3	5	4	3	3	4	3
4	3	4	3	3	4	3	3	3	4	4	4	4	4	2
4	4	4	4	4	5	4	5	5	5	1	2	1	2	2
4	3	4	3	3	5	5	4	5	5	1	1	1	2	2
2	4	3	4	4	2	2	3	2	2	2	2	3	2	3
3	4	4	4	4	3	4	3	4	3	3	3	3	3	4
5	5	5	5	5	3	3	3	3	3	4	4	4	4	2
5	5	5	5	5	3	4	5	5	5	1	1	1	1	1
5	4	5	5	4	5	5	5	5	5	4	5	5	5	5
4	4	3	4	4	5	5	5	5	5	5	5	5	4	5
4	5	3	4	5	3	4	2	3	4	4	4	4	5	5
2	5	4	4	5	4	4	3	3	4	2	2	2	2	1
3	3	4	5	3	3	3	4	4	3	4	2	3	4	4
1	1	2	2	1	4	3	4	3	3	1	1	1	1	1
3	5	5	5	5	4	3	5	4	3	4	5	5	5	5
2	2	2	2	2	3	4	4	4	4	3	2	3	3	2

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
5	5	5	5	5	4	2	4	4	3	4	2	3	4	5
3	3	3	3	3	2	1	2	3	2	4	2	3	2	4
1	2	2	1	2	1	2	2	1	2	1	1	1	1	1
4	3	4	4	3	4	5	5	5	5	1	1	2	2	1
4	2	3	5	2	5	5	5	5	5	4	4	4	4	4
3	4	3	4	4	4	4	4	4	5	3	3	2	2	2
5	5	5	5	5	3	3	3	3	4	2	2	2	2	2
1	1	2	1	1	4	4	5	4	5	3	4	3	5	3
3	3	2	4	3	4	3	5	4	4	4	2	3	3	4
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3	3	3	3	3	2	4	5	4	4	3	3	3	2	4
4	5	5	5	5	5	5	5	5	5	3	3	3	3	4
3	3	3	5	3	2	2	2	1	1	2	2	2	2	2
3	4	5	4	4	4	5	3	4	4	3	3	3	3	3
4	4	4	4	4	3	4	4	4	4	3	4	4	3	2
5	4	3	4	4	3	3	4	4	4	4	4	4	4	5
2	1	1	2	1	1	1	1	1	1	4	3	3	3	3
5	5	5	5	5	3	3	2	3	4	4	5	4	3	4
1	1	1	1	1	1	2	2	2	1	1	1	1	1	1
3	3	3	4	3	4	4	4	3	5	2	4	3	3	3
3	3	3	4	3	1	2	1	1	1	2	2	2	1	2
4	3	4	4	3	3	3	4	3	3	2	4	3	3	4
1	2	1	2	2	1	1	1	1	1	3	5	4	4	3
4	4	3	3	4	3	4	5	4	3	2	3	3	3	4

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
3	2	2	3	2	3	4	4	4	3	4	4	3	3	4
1	1	1	2	1	1	1	1	1	1	1	2	2	1	2
5	5	4	5	5	4	4	4	3	3	1	1	1	1	1
4	4	5	3	4	4	3	4	3	4	4	4	4	4	4
2	1	2	2	1	1	1	1	1	2	1	1	1	1	1
4	3	4	4	3	4	3	5	4	4	3	3	4	3	3
5	5	5	5	5	3	3	3	4	5	2	1	2	2	2
3	3	4	3	3	5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	3	4	3	2	4	3	5	5	5	5
1	2	1	1	2	1	1	1	1	2	4	4	4	3	3
3	4	3	4	4	4	4	3	5	5	4	5	4	4	4
4	4	4	3	4	4	3	4	4	4	3	2	2	2	2
3	4	3	3	4	3	4	3	3	4	3	3	4	3	5
3	4	3	3	4	2	2	2	2	4	4	4	3	5	4
3	4	3	3	3	4	2	3	5	3	3	4	3	3	5
4	3	4	3	4	5	5	5	5	5	4	3	4	4	4
5	5	5	5	5	2	2	2	3	3	2	3	2	3	2
3	4	4	4	3	1	2	1	2	2	1	1	1	1	2
4	4	4	4	4	4	3	4	4	3	2	4	3	3	4
3	3	3	3	3	3	3	3	4	3	4	3	4	5	4
4	3	4	4	4	2	2	2	3	2	4	3	4	5	5
4	2	4	3	4	3	4	4	2	3	4	4	5	4	4
3	4	4	4	3	2	3	3	4	4	2	3	4	3	4
2	2	2	2	2	5	5	5	5	4	4	4	5	4	4

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
4	2	3	3	4	3	3	3	3	3	4	4	3	4	4
5	5	4	5	5	4	3	3	3	4	4	4	4	4	4
2	4	3	4	2	3	3	4	3	4	4	3	4	5	4
2	2	2	2	2	2	2	2	3	2	4	3	4	3	4
3	4	4	4	3	2	4	3	4	4	3	4	3	4	3
2	3	2	3	2	2	2	1	2	2	3	5	3	3	3
4	4	3	3	4	2	3	3	3	4	3	4	4	4	3
4	4	4	4	4	5	5	5	5	5	2	2	2	2	2
5	5	5	5	5	5	5	5	5	5	2	2	2	2	2
4	4	4	4	4	5	4	3	4	3	2	2	2	1	2
5	5	5	5	5	4	4	4	4	4	2	4	3	3	3
4	4	3	4	4	3	4	4	3	5	3	3	4	4	3
3	4	3	4	3	3	4	4	3	3	4	3	5	3	4
5	5	5	5	5	4	3	4	4	5	3	3	5	3	3
4	3	3	5	4	4	2	4	4	4	3	3	4	2	3
1	1	1	1	1	3	3	2	3	3	2	1	2	2	2
3	3	3	3	3	3	3	4	3	4	1	1	1	1	1
4	5	4	5	4	2	1	2	2	2	5	5	5	5	5
3	2	4	3	3	4	4	4	4	4	3	2	3	4	3
3	4	4	3	3	4	3	4	4	4	4	4	4	3	4
5	5	5	5	5	4	5	5	5	5	3	2	3	4	4
5	4	5	5	5	3	3	3	3	3	1	2	1	1	2
4	4	4	4	4	3	3	4	4	3	3	3	3	2	3
4	4	3	3	4	4	3	4	4	3	4	3	3	3	3

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
4	3	4	4	4	3	4	3	2	4	2	1	2	2	2
4	5	5	5	4	3	4	3	4	4	3	4	3	3	3
3	3	3	4	3	3	4	3	3	4	3	3	4	4	3
2	3	3	2	2	2	1	2	2	2	5	5	5	5	5
3	3	4	5	3	5	5	5	5	5	2	2	2	2	2
5	5	5	5	5	5	5	5	5	5	4	5	5	5	5
2	3	3	4	2	3	4	4	4	4	3	4	5	4	4
4	3	3	5	4	4	4	5	4	3	2	4	4	3	3
3	2	4	3	3	2	2	2	2	3	5	4	5	5	5
4	4	4	4	4	3	2	3	3	5	3	4	4	4	4
3	3	3	3	3	3	4	4	2	4	3	3	3	3	3
5	5	5	5	5	4	4	4	4	5	4	4	5	4	4
2	3	3	3	2	2	4	4	3	4	3	5	5	4	4
1	2	1	2	1	1	1	2	1	1	1	1	2	2	2
3	3	4	3	3	3	4	4	3	4	4	2	3	3	4
4	5	5	5	4	2	3	3	2	4	2	1	2	2	2
3	5	3	3	3	5	5	5	5	5	2	2	2	2	2
5	5	4	5	5	3	4	3	4	3	5	5	5	5	5
3	3	3	4	3	5	5	5	5	5	4	4	3	4	5
4	4	3	4	4	2	3	3	3	4	3	3	3	3	2
1	1	2	2	1	4	3	3	3	4	1	1	1	1	1
4	3	4	4	4	4	2	5	4	4	3	2	4	2	5
5	4	5	5	5	5	5	5	5	5	2	1	2	2	2
3	4	4	3	3	2	3	4	3	3	3	2	3	4	3

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
4	4	4	4	4	5	4	3	4	3	2	2	2	1	2
5	5	5	5	5	4	4	4	4	4	2	4	3	3	3
4	4	3	4	4	3	4	4	3	5	3	3	4	4	3
3	4	3	4	3	3	4	4	3	3	4	3	5	3	4
5	5	5	5	5	4	3	4	4	5	3	3	5	3	3
4	3	3	5	4	4	2	4	4	4	3	3	4	2	3
1	1	1	1	1	3	3	2	3	3	2	1	2	2	2
3	3	3	3	3	3	3	4	3	4	1	1	1	1	1
4	5	4	5	4	2	1	2	2	2	5	5	5	5	5
3	2	4	3	3	4	4	4	4	4	3	2	3	4	3
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2	3	3	4	2	3	4	4	4	4	3	4	5	4	4
4	3	3	5	4	4	4	5	4	3	2	4	4	3	3
3	2	4	3	3	2	2	2	2	3	5	4	5	5	5

PEoU1	PEoU2	PEoU3	PEoU4	PEoU5	PU1	PU2	PU3	PU4	PU5	QCD1	QCD2	QCD3	QCD4	QCD5
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3	3	3	3	3	3	4	4	2	4	3	3	3	3	3
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2	3	3	3	2	2	4	4	3	4	3	5	5	4	4
1	2	1	2	1	1	1	2	1	1	1	1	2	2	2
3	3	4	3	3	3	4	4	3	4	4	2	3	3	4
4	5	5	5	4	2	3	3	2	4	2	1	2	2	2
3	5	3	3	3	5	5	5	5	5	2	2	2	2	2
5	5	4	5	5	3	4	3	4	3	5	5	5	5	5
3	3	3	4	3	5	5	5	5	5	4	4	3	4	5
4	4	3	4	4	2	3	3	3	4	3	3	3	3	2
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4	3	4	4	4	4	2	5	4	4	3	2	4	2	5
5	4	5	5	5	5	5	5	5	5	2	1	2	2	2
3	4	4	3	3	2	3	4	3	3	3	2	3	4	3

IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
4	4	5	4	4	5	4	4	4	4	5	5	4	5	5
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5	4	4	4	4	4	4	5	4	5	3	3	3	3	3
4	4	5	4	5	4	4	5	4	4	4	5	4	4	5
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3	3	3	3	3	1	2	2	3	2	1	1	2	1	1
4	5	4	4	4	4	5	5	4	4	4	4	4	5	4
4	4	4	5	4	5	5	5	4	5	4	5	4	4	4
4	4	5	4	5	4	5	5	5	5	5	4	5	5	4
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5	5	5	5	5	5	4	5	5	4	5	5	5	5	5
2	2	3	3	3	4	4	4	4	4	4	4	5	4	5
4	5	5	4	5	4	4	5	5	4	4	4	4	4	5

IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
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3	3	3	2	3	5	5	5	5	5	5	5	5	5	5
3	3	1	3	1	5	5	5	5	5	5	5	5	5	5
3	3	4	3	2	2	2	1	1	2	2	3	2	3	4
2	3	3	3	3	2	1	2	2	1	2	2	3	2	4
3	2	2	1	3	3	2	3	2	3	1	2	2	2	3
4	4	4	4	4	5	4	5	4	5	4	4	4	4	4
5	5	4	4	5	4	5	5	5	4	5	5	5	5	5
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4	4	4	4	4	3	2	3	3	3	4	4	4	4	4
5	5	5	5	5	4	5	5	5	5	3	3	3	3	4
5	4	4	4	4	4	5	4	5	4	4	4	4	4	5
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4	5	5	4	5	5	5	5	5	5	2	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	4
5	5	5	5	5	5	5	5	4	5	3	3	3	3	2
4	4	4	4	4	5	4	4	5	5	5	5	4	5	5
4	5	5	5	5	4	4	4	4	5	5	5	5	4	4
4	5	5	5	5	5	5	4	4	5	5	4	5	4	5
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1	1	3	3	1	4	4	5	4	5	4	4	5	4	4
5	5	5	5	5	4	3	4	4	4	5	5	5	4	5
2	3	3	2	4	5	5	5	5	5	3	2	3	3	3
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IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
5	5	5	4	5	4	5	4	5	4	5	5	5	5	5
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3	3	4	4	4	5	5	4	4	5	4	3	3	4	4
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4	5	5	5	5	4	4	5	3	4	5	4	4	5	5
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1	2	1	1	2	2	1	1	3	3	1	3	3	2	3
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2	2	3	2	3	5	5	4	4	4	3	2	1	4	2
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5	5	5	5	5	4	4	4	4	4	2	1	1	3	3
4	5	5	5	5	4	5	4	4	4	5	5	4	4	4

IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
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5	4	5	5	5	4	5	5	5	4	5	5	5	4	4
5	4	5	5	5	5	4	5	5	4	4	5	4	4	5
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3	2	2	3	3	4	4	4	4	4	2	1	3	1	3
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5	4	5	5	5	4	4	4	4	4	5	5	5	5	5
5	5	4	4	4	5	4	4	4	4	5	4	4	5	5
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1	1	2	1	3	2	3	4	4	4	1	1	1	2	3
4	4	4	4	4	3	1	4	3	2	1	2	1	1	4
5	5	5	5	5	5	4	4	4	4	1	2	3	1	1

IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
4	5	4	5	4	5	5	5	5	5	4	4	5	4	5
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4	4	5	4	5	4	4	5	4	4	4	5	4	4	5
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3	1	1	1	1	4	4	5	4	5	2	3	3	3	2
4	4	4	4	4	2	3	3	2	3	5	5	5	5	5
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4	4	4	4	5	4	5	4	4	4	5	4	4	4	5

IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
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4	4	5	4	4	5	4	4	4	4	4	4	4	4	4
3	1	3	3	4	2	2	1	2	3	5	5	5	5	5
3	3	1	1	3	3	3	3	3	3	4	4	4	5	5
4	4	5	5	5	5	4	5	4	5	4	5	4	5	5
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4	4	5	5	5	5	4	5	4	5	4	4	5	5	5
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5	5	4	4	4	5	4	5	5	5	5	5	4	4	4
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4	4	4	4	4	3	1	2	4	2	5	5	5	5	5
4	5	4	5	4	5	4	4	4	5	5	5	5	5	5
4	4	4	4	5	4	4	4	4	5	4	4	4	4	4
3	5	5	5	5	4	4	5	4	5	4	5	5	4	4

IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
3	3	3	3	3	4	4	5	4	4	5	5	5	5	5
5	4	4	5	5	4	4	5	4	5	4	4	5	5	5
4	5	5	5	5	5	5	5	5	4	5	5	5	4	4
3	3	2	3	3	5	5	5	5	5	4	4	4	4	5
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1	3	3	3	3	2	3	3	3	3	3	2	2	2	3
5	4	5	4	4	4	4	5	5	5	4	5	5	5	5
3	1	3	3	3	2	1	3	4	1	1	1	2	1	1
4	5	4	5	5	4	4	4	4	5	5	4	5	5	5
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3	3	3	3	2	4	4	4	4	4	4	5	5	4	4
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IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
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3	4	5	4	4	5	5	5	5	5	4	4	5	5	5
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5	5	4	4	5	4	4	5	5	4	5	3	4	4	5
4	5	5	4	4	4	4	5	5	5	4	4	5	4	5
5	4	5	5	5	2	3	4	3	3	5	5	4	5	4
5	4	4	4	4	5	5	5	5	5	4	5	5	5	4

IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
4	4	5	4	5	4	4	4	4	4	5	5	5	5	5
1	2	1	2	3	5	5	5	5	4	5	4	5	5	5
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1	1	3	2	1	1	2	1	2	2	3	2	2	2	3
1	1	2	2	2	1	3	2	2	4	1	1	1	2	1
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4	4	4	4	5	5	4	4	5	5	5	5	4	5	5
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IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
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IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
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IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
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IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
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IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
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IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
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IQ1	IQ2	IQ3	IQ4	IQ5	SQ1	SQ2	SQ3	SQ4	SQ5	SvQ1	SvQ2	SvQ3	SvQ4	SvQ5
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SAT1	SAT2	SAT3	SAT4	SAT5
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2	4	4	3	3
4	5	3	5	5

SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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3	4	5	4	5
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SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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4	3	4	5	3
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SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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SAT1	SAT2	SAT3	SAT4	SAT5
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