

RESEARCH PROPOSAL

1. Title of the Proposed Study

Reducing Cognitive Overload in Virtual Learning Environments through User-Centred Design

2. Purpose of the Research Proposal

This research proposal outlines a study that investigates how the design of Virtual Learning Environments (VLEs), such as Moodle, contributes to cognitive overload among students including both neurotypical and neurodiverse learners at the University of Wales Trinity Saint David (UWTSD), across its campuses in Wales and England. The study focuses on learners who rely on digital platforms for accessing course materials, participating in learning activities, and completing assessments, where complex interface structures and high volumes of information may negatively impact learning efficiency and user experience.

The study will be conducted within the UWTSD higher education context, involving students and academic staff who actively use the institutional VLE system.

A combination of methods will be used to triangulate and validate the challenges experienced by learners when interacting with the VLE. This will include gathering students' perspectives on cognitive load through surveys, exploring their experiences in more depth through interviews, and observing how they interact with the platform during usability testing.

The research will begin with a review of existing work in this area, alongside an initial look at how the current Moodle system is structured at UWTSD. Data will then be collected from selected campuses in Wales and England to understand the challenges students face when using the platform. Based on these findings, practical design changes will be proposed and later tested to see whether they help reduce cognitive overload and improve usability. The aim is to develop realistic, evidence-based recommendations that can enhance the digital learning experience for students within UWTSD.

3. Problem Statement

Virtual Learning Environments (VLEs) such as Moodle have become essential tools in higher education, enabling flexible and accessible learning. However, the increasing complexity of these systems has introduced significant usability challenges. Learners are often required to process large volumes of information, navigate poorly structured interfaces, and manage multiple interactive elements simultaneously. These challenges reflect underlying sub-problems related to interface design complexity, information organisation, and navigation inefficiencies within VLE platforms (Bhalalusesa et al., 2023; Conley, Earnshaw and McWatters, 2020).

This leads to cognitive overload, a condition in which the learner's working memory is overwhelmed, negatively affecting comprehension, engagement, and academic performance (Sweller, 2011). Recent research indicates that unnecessary complexity in information presentation and interface design can increase extraneous cognitive load when learners are required to multitask or process excessive information (Skulmowski and Xu, 2022).

Furthermore, learners do not experience digital learning environments in the same way. Research suggests that students with different cognitive profiles, including neurodiverse learners, may experience different levels and sources of cognitive load when engaging with online learning environments (Le Cunff et al., 2024).

The consequences of cognitive overload include reduced system usability, learner frustration, decreased motivation, and ineffective learning experiences. There is therefore a need to investigate how VLE interfaces can be redesigned using user-centred approaches to minimise unnecessary cognitive demands and enhance learning efficiency.

This study aims to address this gap by identifying the sources of cognitive overload in VLEs and proposing evidence-based design improvements that support diverse learners while improving overall system usability. In doing so, the research will contribute to the development of practical design guidelines for digital learning environments and extend existing knowledge in Human-Computer Interaction by applying cognitive load principles to the design and evaluation of VLE systems.

4. Research Questions, Objectives, and Hypotheses

4.1 Research Questions

The research questions listed below are intended to explore how students engage with Virtual Learning Environments in practice, the challenges they encounter, and how these experiences can inform improvements in design to better support learning.

RQ1: How do the design features of Virtual Learning Environments (VLEs), such as Moodle, contribute to cognitive overload among students at UWTSD?

RQ2: What specific usability challenges do students including both neurotypical and neurodiverse experience when interacting with the VLE across different campuses in Wales and England?

RQ3: In what ways can user-centred design approaches be applied to reduce cognitive overload and improve the overall learning experience?

4.2 Research Objectives

To answer the above research questions, the study sets out few practical objectives that focus on understanding how students interact with the VLE and to identify the challenges while learning. The aim is not only to identify the issues, but also to explore how the design of the system can be improved in a way that better supports different types of learners.

RO1: Examine how key design features of the VLE influence cognitive load among students at UWTSD

RO2: Identify the main usability challenges students face when using the platform, including both neurotypical and neurodiverse learners

RO3: Explore how these challenges are experienced across different campuses and learning contexts

RO4: Assess how effectively the current VLE design supports students in managing information and completing tasks

RO5: Develop user-centred design recommendations aimed at reducing cognitive overload

RO6: Evaluate whether these design improvements make a meaningful difference to usability and the overall learning experience

4.3 Hypothesis

H1: There is a significant relationship between the complexity of VLE design features and the level of cognitive load experienced by students.

H2: Higher levels of cognitive load are associated with lower perceived usability and reduced satisfaction when interacting with the VLE.

H3: There will be a significant difference in cognitive load and usability outcomes between the existing VLE design and a user-centred redesigned interface.

5. Literature Review

5.1 Cognitive Overload in Learning

The purpose of this literature review section is to examine key concepts related to cognitive overload, usability, and Virtual Learning Environments (VLEs) in practice. It is useful to see how these concepts are interlinked. Hence this review is useful for its relevance to this research's focus cognitive overload and its impact on learners experience.

Cognitive Load Theory suggests that when too much information is presented at once, or when tasks are unnecessarily complex, learners can struggle to make sense of what they are seeing (Sweller, 2011). More recent work has shown that this issue is particularly relevant in digital learning environments, where students may need to process information presented through multiple sources, interfaces, and activities. Poorly designed digital environments can increase unnecessary cognitive demands by requiring learners to spend mental effort managing the learning environment rather than focusing on learning tasks (Paas and van Merriënboer, 2020; Skulmowski and Xu, 2022).

Researches and experiments carried out in online learning contexts indicate that poorly organised content, unclear instructions, and excessive on-screen elements can all increase what is often described as “extraneous” cognitive load which is a mental effort that does not directly support learning (Skulmowski and Xu (2022). This

is important in relation to RQ1 and RO1, as it highlights how specific VLE design features may influence learners cognitive load.

The impact of cognitive load is not determined only by the amount of information presented but also by how effectively the learning environment supports information processing. Therefore, examining interface design from a user-centred perspective is important to understand how different learners interact with VLE systems and how design decisions may influence usability experiences. This supports the focus of RQ2 and RO2, which look at variation across learner groups.

5.2 Usability and User Experience in VLEs

While general usability principles (Nielsen, Shneiderman) emphasise simplicity and consistency, studies suggest that many institutional VLEs still fall short in practice. A few recent studies highlight the challenges like difficulty locating course materials, inconsistent layout across modules, overwhelming amounts of content and unclear task structures that are linked to increased cognitive effort and reduced efficiency when using the system (Bhalalusesa et al., 2023; Conley, Earnshaw and McWatters, 2020). In some cases, students report spending more time figuring out how to use the platform than engaging with the learning itself.

This directly supports RQ1, RQ2, RO1, and RO4 by examining how current VLE design practices influence usability and learning experiences.

5.3 Multimedia Learning and Interface Design

The way information is presented plays a crucial role in shaping how easily it can be understood. Mayer's Cognitive Theory of Multimedia Learning explains that learners process information through separate visual and auditory channels, but both channels have limited capacity. When multimedia content is carefully designed, it can support learning by helping students organise and integrate new information.

However, excessive or poorly structured multimedia elements can increase cognitive demands (Mayer, 2021). When information is cluttered, repetitive, or poorly structured, it becomes harder for learners to focus and make connections. More recent studies in digital education have found that breaking content into smaller sections, using clear visual hierarchy and avoiding unnecessary duplication can significantly reduce cognitive load and improve comprehension (Liu, 2024).

5.4 Attention, Distraction, and Cognitive Overload

Digital learning environments do not operate in isolation. They compete for students' attention. Notifications, multiple tabs, embedded media, and interactive elements can all divide attention and increase mental effort. Research in cognitive psychology and digital learning suggests that when learners are required to manage too many inputs at once, their ability to concentrate and retain information may be reduced (Suryani et al., 2024).

This issue is particularly important in VLEs, where students often move between different sections, tools, and resources. Poorly designed interfaces can amplify this effect, making it harder for learners to stay focused on the task at hand.

Understanding cognitive load requires reliable ways of measuring it. Many studies use subjective rating scales, such as the NASA-TLX, which asks participants to reflect on the mental effort required to complete a task (Hart, 2006). In addition to subjective measures, usability research often includes task completion time, error rates, and usability questionnaires such as the System Usability Scale (SUS) (Brooke, 1996). Using multiple methods provides a more complete understanding of how users experience digital systems.

Research Gap and Contribution

Although there is a strong body of work on cognitive load and usability, much of the existing work has focused on general learning contexts or controlled experimental settings. There is still limited research that looks closely at how these issues play out within specific institutional contexts, particularly across different campuses and learner groups (Skulmowski and Xu, 2022; Conley, Earnshaw and McWatters, 2020).

In addition, while many studies identify usability problems, fewer go on to test practical design improvements within real systems such as Moodle. This creates a gap between theory and application (Ali et al., 2025).

This study addresses that gap by:

- focusing on a real-world VLE used at UWTSD
- considering both neurotypical and neurodiverse learners
- linking design features directly to cognitive load and usability
- testing design improvements in practice

6. Importance, Value, and Benefits of the Study

The increasing reliance on Virtual Learning Environments in higher education means that the quality of these systems has a direct impact on how students learn. As institutions continue to expand digital provision, concerns around usability and cognitive overload are becoming more visible, particularly as students are expected to engage with complex platforms on a daily basis. Addressing these issues is timely, as universities such as UWTSD continue to develop and rely on VLEs like Moodle to support teaching across multiple campuses in Wales and England.

This study is important because it focuses on how the design of these systems affects students in practice, rather than treating technology as neutral. By examining how cognitive overload emerges during real use, the research aims to provide a clearer understanding of the challenges students face, including both neurotypical and neurodiverse learners.

The findings are expected to offer practical value by identifying areas where VLE design can be improved to better support learning. This includes developing realistic, user-centred design recommendations that can help simplify navigation, improve information structure, and reduce unnecessary cognitive effort. These outcomes will be useful for academic staff who design course content, as well as for developers and institutional decision-makers responsible for maintaining and improving digital learning platforms.

In addition to practical benefits, the study will contribute to academic knowledge within Human-Computer Interaction (HCI) and educational technology by applying cognitive load theory to the design and evaluation of VLEs within a real institutional setting. The research also brings attention to the importance of considering diverse learner needs when designing digital systems, which remains an area that is still developing.

Finally, the study will provide a foundation for future research by offering both methodological insights and design guidelines that can be adapted and evaluated in other higher education contexts. It will support further exploration on inclusive design, system usability, and the long-term impact of cognitive load on student engagement and performance.

7. Research Design

This study adopts a mixed-methods research design, combining both exploratory and evaluative approaches. The exploratory aspect is used to understand how students experience Virtual Learning Environments (VLEs) in practice, particularly in relation to cognitive overload and usability challenges. The evaluative component focuses on assessing whether user-centred design improvements can reduce cognitive load and improve the overall learning experience.

7.1 Types and Sources of Data

The study will make use of both primary and secondary data.

Primary data will be collected directly from students and academic staff at the University of Wales Trinity Saint David (UWTSD), focusing on their experiences with the Moodle-based VLE. This will include students from different campuses in Wales and England, ensuring a range of perspectives.

Secondary data will include existing research on cognitive load, usability, and digital learning environments. Institutional documentation and guidance relating to the use and structure of the VLE will also be considered where appropriate.

7.2 Data Collection Methods

Data will be collected using a combination of qualitative and quantitative methods to build a more complete understanding of the problem.

- Surveys will be used to gather quantitative data on perceived cognitive load, usability, and satisfaction.
- Interviews will provide more detailed insights into how students and staff experience the VLE in practice.
- Usability testing will involve observing how students interact with the platform while completing typical learning tasks, helping to identify specific areas where difficulties arise.

Using these methods together allows the study to triangulate findings, making it possible to compare patterns across different types of data.

7.3 Sampling Strategy

The study will use a non-probability sampling approach, specifically purposive sampling. Participants will be selected based on their active use of the institutional VLE and their ability to provide relevant insights into learner interaction and usability experiences.

The sample will include:

- Students from UWTSD across campuses in Wales and England
- A range of learners including both neurotypical and neurodiverse students
- Academic staff involved in designing, managing, or delivering learning content

The study will follow an iterative user-centred design approach consisting of two main evaluation phases.

The first phase will examine students' experiences with the existing VLE design. Findings from this phase will inform the development of user-centred design improvements.

The second phase will evaluate the redesigned interface or proposed improvements to determine whether changes have improved cognitive load, usability, and overall user experience.

Participants in both phases will be drawn from the same target population to allow meaningful comparison between the existing and improved design conditions.

7.4 Data Collection Process

Data collection will be conducted directly by the researcher.

- Surveys will be distributed online to students across selected campuses
- Interviews will be conducted either in person or online, depending on availability
- Usability testing sessions will involve students completing set tasks within the VLE while their interactions are observed

The study will follow an iterative design and evaluation process involving two separate phases of data collection: an initial phase capturing students' experiences

with the existing VLE design, and a second phase, conducted after the implementation of user-centred design revisions. This approach allows comparison of cognitive load and usability outcomes across the two design conditions.

7.5 Data Analysis

Both qualitative and quantitative data will be analysed.

- Qualitative data collected through interviews and usability observations will be analysed using thematic analysis. This will involve identifying recurring themes, patterns, and usability issues relating to users experiences of interacting with the VLE.
- Quantitative data collected from surveys will be analysed using descriptive statistics (averages, frequency distributions) and inferential tests (correlation or comparison tests) to examine relationships between VLE design, cognitive load, and usability.

Statistical analysis will be carried out using software such as SPSS, standard statistical software package, while qualitative data will be organised and analysed using structured coding techniques.

Combining quantitative and qualitative analysis will provide a more complete understanding of both measurable outcomes and user experiences.

7.6 Measurement Instruments

To assess cognitive load, usability, and overall interaction with the VLE, a combination of established measurement tools will be used. These instruments are selected to capture both subjective experiences and observable performance during system use.

Cognitive load will be measured using a structured rating scale such as the NASA Task Load Index (NASA-TLX). This tool allows participants to reflect on the mental effort required when completing tasks within the VLE, including aspects such as mental demand, effort, and frustration. It is widely used in usability and human-computer interaction research and provides a reliable way to quantify perceived cognitive load.

Usability will be evaluated using standard usability measures, such as adapted versions of the System Usability Scale (SUS) or similar rating-based instruments. These measures capture users' perceptions of how easy the system is to use, how intuitive the interface feels, and how efficiently tasks can be completed.

In addition to self-reported measures, task performance data will be collected during usability testing. This will include indicators such as task completion time, error rates, and the number of steps taken to complete specific activities within the VLE. These measures provide a more objective view of how users interact with the system and help to identify areas where design improvements may be needed.

By combining these different instruments, the study will be able to triangulate findings and develop a more complete understanding of how cognitive load and usability are experienced in practice.

8. Scheduling

The proposed study will be conducted over a period of approximately four years, allowing sufficient time for literature review, iterative data collection, in-depth analysis, and the development and evaluation of design interventions.

Year 1 (Months 1–12) will focus on building a strong foundation for the study. This will involve an in-depth review of the literature, alongside a preliminary evaluation of the existing Moodle-based VLE used at UWTSD. During this stage, the research design will be refined, measurement instruments will be developed and piloted, and ethical approval will be secured.

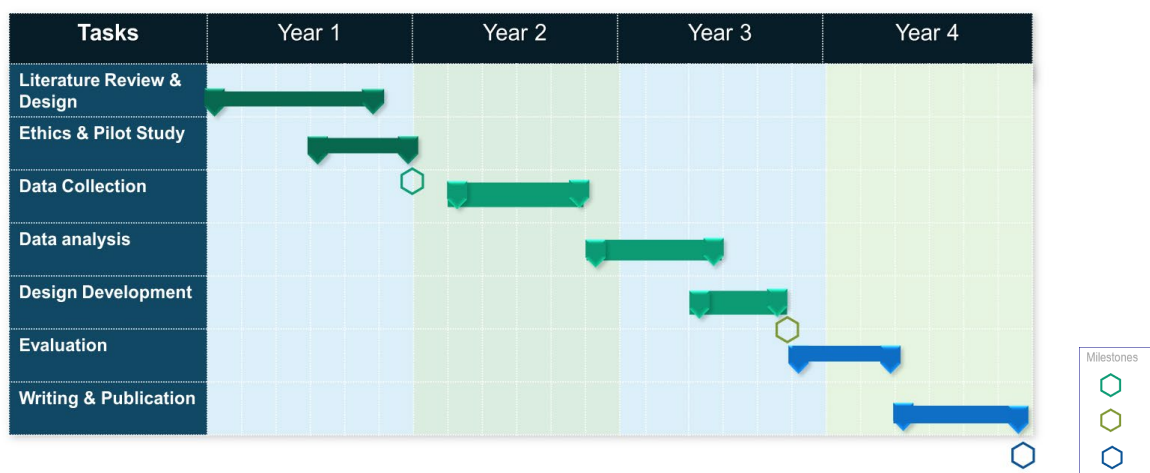
Year 2 (Months 13–24) will concentrate on empirical data collection. Data will be gathered from students and academic staff across selected campuses in Wales and England. This will include the distribution of surveys, conducting semi-structured interviews, and carrying out usability testing sessions. Data collection may be carried out in phases, allowing early findings to inform subsequent stages where necessary.

Year 3 (Months 25–36) will focus on detailed data analysis and the development of design interventions. Both quantitative and qualitative data will be analysed to examine relationships between cognitive load, usability, and interface complexity. Based on these findings, user-centred design improvements will be developed and

implemented in a prototype or modified VLE interface. These design changes will then be evaluated through further usability testing.

Year 4 (Months 37–48) will involve consolidating findings and finalising the research. This stage will include refining the analysis, validating the results, and completing the writing of the thesis. The final phase will also focus on articulating the study's contribution to both theory and practice, and preparing outputs for dissemination such as conference papers or journal publications.

PhD Research Timeline



9. Ethical Considerations

The study will adhere to university research ethics policies, including:

- Informed consent
- Confidentiality of participants
- Voluntary participation
- Data protection and secure storage

10. List of Sources (Preliminary)

Reference List

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