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Application of Cognitive Load Theory in Instructional Design of Online Courses at Pre-Service Teachers' Training Programs: A Qualitative Cross-Case Evaluation

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Abstract

This study evaluated the application of Cognitive Load Theory (CLT) in the instructional design of tertiary-level online courses. The primary aim was to examine whether and to what extent CLT principles are incorporated into selected online courses. Specifically, the study analyzed the alignment between CLT-based theoretical guidelines and their practical implementation in course design. A qualitative evaluative research design was employed, using a purposive sample of three online courses from the B.Ed. (4-year) programs offered by virtual universities in Pakistan. Three courses, 'Educational Psychology', 'Curriculum Development', and 'Comparative Education', were assessed through a researcher-developed checklist grounded in established CLT principles. The findings revealed a low to moderate level of alignment between the instructional design of the selected courses and CLT principles. This suggests that current online courses do not adequately implement CLT-informed strategies, potentially leading to increased cognitive overload among learners.
Based on these findings, the study offers evidence-based recommendations for improving instructional design. These include effective integration of multimedia, scaffolding with gradual fading of guidance, provision of adaptive learning pathways, incorporation of reflective activities, and enhancement of platform usability.

Keywords: Cognitive Load Theory, Instructional Design, Online Learning, Tertiary Education, Evaluative Research

Introduction

Multiple factors influence students' everyday learning, among which instructional design is one of the most influential. In the teaching-learning process, the design of a course significantly affects students' understanding of the subject matter. Therefore, teachers need to emphasize the development of students' conceptual understanding through meaningful practice by designing instructional materials that specifically address cognitive needs (Rind & Ahmed, 2026). In recent years, there has been a growing interest among educationists in the intersection of education and cognition. Evidence from cognitive science suggests that traditional approaches to instructional design are no longer sufficient for addressing the complexities of learning (Asma & Dallel, 2020).

Consequently, instructional strategies based on Cognitive Load Theory (CLT) are increasingly regarded as more effective and appropriate for reducing students' cognitive load (Asma & Dallel, 2020). Furthermore, studies have reported no significant differences in performance between male and female students regarding cognitive load management (Khanam & Jamil, 2025).

The major contextual gap in this research is that, although some studies have explored the application of Cognitive Load Theory in instructional design, most of them are conducted in developed countries (Caskurlu et al., 2021; Chen et al., 2017; Dönmez, 2022; Skulmowski & Xu, 2022; Van Merriënboer & Ayres, 2005). Limited research has examined the implementation of Cognitive Load Theory principles in online courses within tertiary education in developing countries, particularly in Pakistan (Gunbatar, 2023). Therefore, it is necessary to explore how these principles can be applied to evaluate and improve the instructional design of online courses at the tertiary level within the local educational context.

Statement of the Problem

The reason for conducting this research is that, in Pakistan and worldwide, many institutions have shifted their focus towards online learning. These institutions have developed online courses for students, but unfortunately, the instructional designs used to develop these online courses are not up to standard due to their high content load (Mushtaq et al., 2023). These designs often do not adhere to the principles of cognitive load theory, which increases the load on students' working memory (Noor, Ali, & Husnine, 2020). As the load on working memory increases, less material is retained in long-term memory, leading to weaker retention (Ali, Ullah & Raees, 2023). Online learning and face-to-face learning are now moving in parallel. Many universities in Pakistan have succeeded in developing online courses for their students, but they are still not achieving the desired level of success (Sarwar et al, 2020; Ullah et al, 2021). This study evaluated the "application of Cognitive Load Theory (CLT) in the instructional design of online courses at the tertiary level."

Literature Review

Many studies provide empirical evidence for the appropriate use of Cognitive Load Theory (CLT) to make content digestible, relevant, and long-lasting in the memory of learners. For example, Evans et al. (2024) conducted survey research to investigate the impact of instructional design on students' cognitive load, achievement, engagement, and motivation. They analyzed that the instructional load-reducing strategies successfully reduced the cognitive load of the students and also improved the motivation, engagement, and achievement of the students. The motivating styles of the teachers also helped in reducing the intrinsic and extraneous loads through embodied cognition, such as gestures, object manipulation, physical actions, and whole-body movements, which enhanced students' motivation and engagement (Ouwehand et al., 2025; Zou et al., 2025).

Similarly, Hazan-Liran and Miller (2024) investigated the impact of extraneous cognitive load on basic learning processes. They noticed the presence of irrelevant information in working memory, which imposes an extraneous cognitive load, thereby reducing learners' efficiency in processing task-relevant information. The authors emphasized that instructional materials should minimize unnecessary content and transform potentially irrelevant information into meaningful and relevant representations to facilitate learners' attention and comprehension.

Furthermore, this overload negatively affects learning efficiency and overall academic performance. Studies further support this perspective, highlighting that effective instructional design should prioritize cognitive clarity, coherence, and relevance to optimize learning outcomes (Ekin et al., 2025; Sortwell et al., 2026; Zhang et al., 2025).

With reference to improving instructional design, the role of Cognitive Load Theory (CLT) has been widely examined in contemporary research. Castro-Alonso et al. (2021) highlighted that instructional strategies designed to manage cognitive load can be implemented by both instructors and learners; however, their effectiveness depends on the learner's level of expertise. In particular, the expertise reversal effect suggests that novice learners benefit more from structured, instructor-guided environments, whereas advanced learners perform better in learner-controlled settings.

Recent studies further extend this understanding by emphasizing adaptive and technology-enhanced learning environments. For instance, integrating artificial intelligence with CLT principles has been shown to support dynamic cognitive load management by tailoring instructional content to learners' needs, thereby enhancing schema construction and learning efficiency (Twabu, 2025). Similarly, research in multimedia learning demonstrates that visual and linguistic load must be carefully balanced, as excessive load can hinder comprehension, particularly for learners with varying language proficiency levels, as highlighted by Bali et al. (2024). CLT continues to serve as a foundational framework for optimizing instructional design (Zou et al., 2025; Martella et al., 2024).

Chen et al. (2018) examined the spacing effect by extending Cognitive Load Theory to include the concept of working memory resource depletion. Their research, based on two experiments in mathematics with primary school students, compared spaced learning (with time intervals between learning sessions) and massed learning (continuous learning without breaks). The findings showed that students who engaged in massed learning experienced higher cognitive load and performed worse on working memory capacity tests compared to those who followed spaced learning. The study also demonstrated that students in the massed learning condition showed greater working memory depletion, particularly when assessed immediately before the content test (Chen et al., 2018).

Previous research continues to support these findings, emphasizing that spaced learning reduces cognitive overload and enhances long-term retention by allowing sufficient recovery of cognitive resources between learning sessions (Kang, 2016).

Objectives

The study followed the given objectives:

1. To analyze the application of CLT in instructional designs of three online courses: Educational Psychology, Curriculum Development, and Comparative Education, at the B.Ed. level.
2. To assess the degree of alignment between theoretical CLT principles and their practical application comparatively in the three courses.
3. To provide effective strategies for enhancing instructional design in online courses.

Research Questions

1. How are the principles of Cognitive Load Theory applied in the instructional design of selected online courses at B.Ed. level?
2. What is the comparative degree of alignment between theoretical Cognitive Load Theory (CLT) principles and their practical application in the three courses?
3. What strategies can effectively enhance the instructional design of online courses in higher education?

Research Methodology

This study adopted a cross-case qualitative methodology influenced by the Constructivist

Paradigm. A multiple case study approach was used to evaluate the application of Cognitive Load Theory (CLT) principles in the instructional design of online courses at the tertiary level. Three online courses were selected through purposive, criterion-based sampling based on their full online delivery, structured multimedia-based instructional content, and relevance to a pre-service teacher education program (B.Ed. 4 years). Data were collected through systematic document analysis and non-participant observation of course design components, including course outlines, recorded lectures, instructional materials, learning activities, and assessment tasks. A researcher-developed checklist grounded in Cognitive Load Theory was employed to evaluate the presence and application of intrinsic, extraneous, and germane cognitive load principles, operationalized through indicators such as segmenting, modality, coherence, redundancy, signaling, scaffolding, and worked examples.

Population & Sampling

The population of the study comprised all 30 tertiary-level online courses offered by higher education institutions for B.Ed. (4 years) programs that are designed for fully online delivery and incorporate multimedia instructional materials. There were 2 major universities in Pakistan offering online B.Ed. (4 years) program, i.e., Virtual University and Allama Iqbal Open University.

The sample consisted of three purposefully selected B.Ed. online courses: Educational Psychology, Curriculum Development, and Comparative Education.

Instrumentation

The primary instrument used in this study was a researcher-developed checklist based on Cognitive Load Theory (CLT) to evaluate the alignment of instructional design elements in online tertiary-level courses. The checklist was developed through an extensive review of CLT literature, incorporating key principles such as modality, segmentation, coherence, redundancy, signaling, scaffolding, worked examples, and transient information (Sweller, 1994, 2005, 2011, 2020; Sweller & Chandler, 1991; Paas et al., 2010). The items were structured under CLT dimensions, with each item assessing the presence and alignment of these principles within course design.

Scoring was based on a five-point Likert scale:

1. No alignment (no evidence of the CLT principle is present in the instructional design; the course design contradicts or ignores the principle 1-10%)
2. Low alignment (minimal or isolated evidence of the principle is present, but it is inconsistent, unclear, or ineffective, 11-30%)
3. Partial alignment (the principle is moderately evident but applied inconsistently across modules or lacks depth and integration, 31-60%)
4. Moderate alignment (the principle is clearly applied in most parts of the course with reasonable consistency, though minor gaps exist, 61-80%)
5. Full alignment (the principle is systematically, consistently, and effectively integrated throughout the course design, 81-100%)

To establish validity, a multi-stage expert review process was conducted. Initially, six instructional design experts evaluated the checklist for relevance, clarity, and theoretical alignment with CLT (Sweller, 1994, 2005, 2011, 2020; Sweller & Chandler, 1991; Paas et al., 2010). Subsequently, subject specialists experienced in online tertiary teaching reviewed the instrument to ensure contextual appropriateness and applicability in e-learning environments, leading to further refinement. Especially, the checklist was also reviewed by John Sweller, the originator of Cognitive Load Theory, which strengthened its theoretical grounding (Sweller, 1994, 2011).

For quantitative validation, the Content Validity Index (CVI) was computed using expert ratings on a five-point relevance scale. Item-level CVI (I-CVI) was calculated to assess agreement on item relevance, and items not meeting acceptable thresholds were revised accordingly. Inter-rater agreement was also examined during this process. This combined quantitative and qualitative validation approach ensured strong content and theoretical validity, consistent with established CLT-based instructional design research (Paas et al., 2010; Sweller, 2005, 2020). The finalized checklist was then applied uniformly across all selected online courses to ensure consistency in data collection.

On this scale, the higher scores indicated greater relevance to Cognitive Load Theory principles and lower scores indicated smaller/no relevance to Cognitive Load Theory. For CVI calculation, ratings of 4 and 5 were considered indicative of content validity. Item-level Content Validity Index (I-CVI) values were calculated by dividing the number of experts rating an item as relevant (4 or 5) by the total number of experts. There was a total of 6 experts.

$$\mathrm{I-CVI} = \frac{\text{Number of experts rating 4 or 5}}{\text{total number of experts}}$$

Table 1

Item-wise Content Validity Index (I-CVI)

No.	Checklist Indicator (CLT Principle)	No. of Experts	Agree (4-5)	I-CVI
1	Split Attention, integration of visuals, and sequencing	6	5	0.8
2	Reduction of Redundant Information	6	6	1.0
3	Expertise Reversal and novice information	6	6	1.0
4	Element Interactivity, Segmenting of instructional content	6	6	1.0
5	Modality principal application	6	6	1.0
6	Worked Example	6	5	0.8
7	Guidance Fading and Scaffolding	6	5	0.8
8	Use of Signaling cues	6	6	1.0
9	Self-Explanation & Reflection	6	5	0.8
10	Online Learning Design Appropriateness	6	4	0.6

The Scale-level Content Validity Index (S-CVI) was calculated by using the average method (S-CVI/Ave) across all checklist items. The values of I-CVI ranged from 0.6 to 1.0, while the overall S-CVI/Ave was 0.89, which indicated an acceptable content validity of the checklist items. The items having lower ratings were revised based on expert qualitative feedback before finalizing the checklist.

Table 2

Scale-Level Content Validity Index (S-CVI)

CVI Method	Value
S-CVI	0.89

Inter-Rater Reliability

To enhance the reliability of the evaluation process, an independent second rater, an expert from the Faculty of Education at a women's university in Lahore, with expertise in education and instructional design, was invited to evaluate the selected online course materials using the developed CLT-based checklist.

Table No. 3

The Education Psychology Course was evaluated by the second rater.

No.	Checklist Indicator (CLT Principle)	Researcher rating	Second rater rating	Agreement/ Disagreement
1	Split Attention, integration of visuals, and sequencing	Partially aligned	Partially aligned	Agreement
2	Reduction of Redundant Information	Partially aligned	Partially aligned	Agreement
3	Expertise Reversal and novice information	Low aligned	Not aligned	Disagreement
4	Element Interactivity, Segmenting of instructional content	Low aligned	Low aligned	Agreement
5	Modality principal application	Low aligned	Low aligned	Agreement
6	Worked Example	Low aligned	Low aligned	Agreement
7	Guidance Fading and Scaffolding	Low aligned	Low aligned	Agreement
8	Use of Signaling cues	Partially aligned	Low aligned	Disagreement
9	Self-Explanation & Reflection	Not aligned	Not aligned	Agreement
10	Online Learning Design Appropriateness	Moderately aligned	Moderately aligned	Agreement

Percentage Agreement = (8/10) x 100

Percentage Agreement = 80%

The comparison of ratings across 10 checklist indicators showed that 8 items were rated consistently by both raters, while 2 items showed disagreement. The overall percentage agreement was calculated as 80%, indicating an acceptable level of consistency.

Data Analysis

A qualitative, evaluative, and cross-case analytical approach guided by Cognitive Load Theory (CLT) was used. The researcher developed a checklist that was applied to the selected three online courses. The courses were analyzed as individual independent cases. A cross-case comparative analysis was conducted to recognize the similarities and differences in the instructional design.

Results

RQ$_1$: How are the principles of Cognitive Load Theory applied in the instructional design of selected online courses at B.Ed. level?

Annexure (A)

Education Psychology Course Alignment with CLT Principles.

Annexure (B)

Curriculum Development Course Alignment with CLT Principles.

Annexure (C)

Comparative Education Course Alignment with CLT Principles.

The overall evaluation of the three courses showed low to partial alignment with the principles of Cognitive Load Theory. Although certain instructional design elements demonstrated partial adherence to CLT-informed practices, the application of these principles was largely inconsistent and lacked systematic integration throughout the course.

RQ2: What is the comparative degree of alignment between theoretical Cognitive Load Theory (CLT) principles and their practical application in the three courses?

Table No.7

Similarities and differences across courses: A comparative analysis of the application of CLT

No.	Checklist Indicator (CLT Principle)	Educational Psychology Course	Comparative Education Course	Curriculum Development Course
1	Split Attention, integration of visuals, and sequencing	Partially aligned	Partially aligned	Partially aligned
2	Reduction of Redundant Information	Partially aligned	Moderately aligned	Moderately aligned
3	Expertise Reversal and novice information	Low aligned	Low aligned	Low aligned
4	Element Interactivity, Segmenting of instructional content	Low aligned	Low aligned	Low aligned
5	Modality principal application	Low aligned	Partially aligned	Partially aligned
6	Worked Example	Low aligned	Not aligned	Not aligned
7	Guidance Fading and Scaffolding	Low aligned	Not aligned	Not aligned
8	Use of Signaling cues	Partially aligned	Partially aligned	Partially aligned
9	Self-Explanation & Reflection	Not aligned	Not aligned	Not aligned
10	Online Learning Design Appropriateness	Moderately aligned	Moderately aligned	Moderately aligned

RQ3: What strategies can effectively enhance the instructional design of online courses in higher education?

The cross-case evaluation of the three courses suggests the following model for instructional design of online courses.

Annexure (D)

A five-point model is suggested for incorporating CLT in the instructional design of online courses at virtual universities.

Findings

The following are the precise findings against the application of each CLT principle used in the evaluated online courses:

1. Split-Attention Principle

The split-attention principle was examined through seven indicators assessing the integration and synchronization of instructional elements. The findings revealed a 'low-to-moderate level of alignment, indicating that learners were frequently required to divide their attention across multiple sources. This is particularly concerning given Sweller's (2011) evidence that split-attention imposes one of the most direct negative effects on working-memory efficiency during multimedia learning.

2. Redundancy Principle

The redundancy principle was evaluated using six indicators examining unnecessary repetition across verbal, visual, and textual formats. The findings showed 'low-to-moderate' alignment, with redundant presentation of identical information occurring frequently. Although some modules attempted to reduce redundancy, the overall pattern suggests inconsistent application of this principle across courses.

3. Expertise Reversal Principle

The expertise reversal principle was assessed through six indicators. The findings showed consistently 'low alignment', as none of the courses differentiated instructional pathways based on learners' prior knowledge. Instruction was uniformly designed for a single type of learner, limiting adaptive learning opportunities.

4. Element Interactivity

Six indicators examined how complex instructional content was organized and integrated. The findings revealed 'low alignment', with limited instructional support for managing interacting elements. The courses that performed moderately well on redundancy reduction (e.g., Curriculum Development) performed poorly on element-interactivity management, demonstrating an inconsistent and ad hoc application of CLT principles.

5. Modality Principle

The modality principle was evaluated through six indicators assessing the balance of auditory and visual information. The findings showed 'low alignment', with limited use of dual-channel processing. Text-heavy explanations and minimal integration of narration with visuals restricted opportunities to optimize cognitive load.

6. Worked Examples

Five indicators assessed the availability and scaffolding of worked examples. The findings revealed a 'very low' level of alignment, with worked examples that were largely absent across all three courses. This represents a missed opportunity for cognitive apprenticeship, a pedagogical approach shown to be particularly effective in teacher-education contexts (Van Merriënboer & Sweller, 2005).

7. Guidance Fading

Four indicators examined the gradual withdrawal of instructional support. The findings showed 'very low alignment', as instructional scaffolding was either absent or remained constant throughout the courses.

8. Signaling Principle

Five indicators assessed the use of visual and verbal cues to direct learners' attention. The findings showed 'low alignment', with inconsistent use of signaling features. While some headings and color cues were present, they were not applied systematically.

9. Self-Explanation and Reflection

Five indicators evaluated opportunities for metacognitive engagement. The findings also revealed 'very low alignment', as self-explanation prompts, reflective questions, and metacognitive activities were almost absent. This confirms that deeper cognitive-processing principles were among the most neglected.

10. Online Learning Design

Six indicators examined usability, navigation, and technical functionality. The findings showed 'moderate alignment', although several design features still contributed to extraneous cognitive load. Navigation inconsistencies and technical delays were common across courses. This pattern aligns with the "seductive details" phenomenon (Sundararajan & Adesope, 2020), where superficial design features receive attention while cognitively essential principles are overlooked.

Discussion and Conclusion

The present study aimed to evaluate the alignment of Cognitive Load Theory (CLT) principles in the instructional design of B.Ed. level online courses. This study systematically assessed multiple dimensions of cognitive load management, including split-attention, redundancy, modality, expertise reversal, element interactivity, signaling, worked examples, guidance fading, self-explanation and reflection, and overall online learning design. Analysis of the selected online courses revealed low to moderate adherence to CLT principles, indicating substantial opportunities for improving instructional design to enhance cognitive efficiency and learning outcomes.

The findings suggest that learners were frequently required to integrate information from multiple sources without sufficient guidance, as well as encounter redundant presentations of content. The results matched with Sweller's (2011) statement that poorly managed extraneous load negatively influences working memory and learning efficiency. The study showed that there was extremely limited use of the modality principle for instructional videos and animations. Whereas there was a lack of corrective examples, which reserved the potential of learners to identify and resolve misconceptions consistent with cognitive load research, highlighting the importance of demonstrating correct reasoning in complex learning (Van Merriënboer & Sweller, 2005). Similarly, the integration of reflection, self-explanation, and metacognitive prompts was mainly absent. Such content provided very limited opportunities for learners to actively process content in their brains, monitor understanding, and develop deeper cognitive schemas (Van Merriënboer & Sweller, 2005). It was revealed that some principles of CLT were partially integrated, some were integrated at a very low level, and some were absent. These results align with previous research (e.g., Taylor, 2024; Waxman, 2025), indicating that online courses often focus on content delivery rather than cognitive efficiency. They do not consider the importance of incorporating dual-channel processing, segmentation, scaffolding, and adaptive supports to optimize learning outcomes. In conclusion, aligning instructional design with CLT principles is not only theoretically justified but practically essential for optimizing online learning at the tertiary level. This study provides both empirical evidence and practical guidance for improving instructional design so that there can be advancement in the online education system.

Recommendations

1. The study suggests integration of visuals, text, and audio in a cohesive way to reduce split attention and redundancy.
2. Worked examples and scaffolding should be thoroughly but gradually faded, and reflective activities should be embedded in the course to promote self-explanation.
3. Adaptive pathways accommodating varying levels of prior knowledge should be incorporated to adhere to the expertise reversal principle.
4. Regular signaling, simplified navigation, and platform usability improvements are essential to minimize extraneous cognitive load that arises from the online learning environment itself.
5. The study presents a five-point model to ensure the effectiveness of an online course prepared with CLT-based instructional design to reduce the cognitive load of university students.

Limitations

1. The study was limited to the evaluation of only three B.Ed. online courses offered through selected virtual universities in Pakistan.
2. Purposive sampling was used to select the courses, which may limit the generalizability of the findings beyond the sampled courses and institutional context.
3. The study evaluated course design based on CLT principles but did not directly measure

learners' cognitive load, academic performance, or learning outcomes.

Ethical Consideration

The three online courses analyzed in this study were part of the B.Ed. programs offered by Virtual Universities in Pakistan. The researcher accessed the video lectures from YouTube as they were open to the public. The notes and supplementary materials were obtained from instructors and shared via WhatsApp. The study involved only the evaluation of existing instructional materials available.

References

Ali, N., Ullah, S., & Raees, M. (2023). The effect of task-specific aids on students' performance and minimization of cognitive load in a virtual reality chemistry laboratory. Computer Animation and Virtual Worlds, 34(6), e2194. https://doi.org/10.1002/cav.2194

Asma, H., & Dallel, S. (2020). Cognitive Load Theory and Its Relation to Instructional Design: Perspectives of Some Algerian University Teachers of English. Arab World English Journal, 11(4), 110-127. https://doi.org/10.24093/awej/vol11no4.8

Bali, S., Chen, T.-C., & Liu, M.-C. (2024). Behavioral Intentions of Low-Achieving Students to Use Mobile English Learning. International Journal of Human-Computer Interaction, 1–11. https://doi.org/10.1080/10447318.2024.2364142

Caskurlu, S., Richardson, J. C., Alamri, H. A., Chartier, K., Farmer, T., Janakiraman, S., ... & Yang, M. (2021). Cognitive load and online course quality: Insights from instructional designers in a higher education context. British Journal of Educational Technology, 52(2), 584-605.

Castro-Alonso, J. C., de Koning, B. B., Fiorella, L., & Paas, F. (2021). Five Strategies for Optimizing Instructional Materials: Instructor- and Learner-Managed Cognitive Load. Educational Psychology Review, 33(4). https://doi.org/10.1007/s10648-021-09606-9

Chen, O., Castro-Alonso, J. C., Paas, F., & Sweller, J. (2018). Extending cognitive load theory to incorporate working memory resource depletion: Evidence from the spacing effect. Educational Psychology Review, 30(2), 483-501. https://doi.org/10.1007/s10648-017-9426-2

Chen, O., Woolcott, G., & Sweller, J. (2017). Using cognitive load theory to structure computer-based learning, including MOOCs. Journal of Computer Assisted Learning, 33(4), 293-305.

Dönmez, O. (2022). A Cognitive Load Perspective to Instructional Design for Online Learning. In Handbook of Research on Managing and Designing Online Courses in Synchronous and Asynchronous Environments (pp. 380-403). IGI Global Scientific Publishing.

Ekin, M., Krejtz, K., Duarte, C., Duchowski, A. T., & Krejtz, I. (2025). Prediction of intrinsic and extraneous cognitive load with oculometric and biometric indicators. Scientific Reports, 15(1), 5213. https://doi.org/10.1038/s41598-025-89336-y

Evans, P., Vansteenkiste, M., Parker, P. D., Kingsford-Smith, A., & Zhou, S. (2024). Cognitive Load Theory and Its Relationships with Motivation: A Self-Determination Theory Perspective. Educational Psychology Review, 36(1). https://doi.org/10.1007/s10648-023-09841-2

Gunbatar, M. S. (2023). Online Flipped Classroom in the Context of Transactional Distance and Cognitive Load: A Mixed-Methods Study. Pakistan Journal of Distance and Online Learning, 9(1), 1-28.

Hazan-Liran, B., & Miller, P. (2024). The Influence of Manipulating and Accentuating Task-Irrelevant Information on Learning Efficiency: Insights for Cognitive Load Theory. Journal of Cognition, 7(1), 36–36. https://doi.org/10.5334/joc.361

Kang, S. H. (2016). Spaced repetition promotes efficient and effective learning: Policy implications for instruction. Policy insights from the behavioral and brain sciences, 3(1), 12-19. https://doi.org/10.1177/2372732215624708

Khanam, A., & Jamil, M. A. (2025). Effect of Cognitive Load Management on Physics Achievement at the Secondary Level. Sir Syed Journal of Education & Social Research (SJESR), 8(1), 11–19. https://doi.org/10.36902/sjesr-vol8-iss1-2025(11-19)

Martella, A. M., Lawson, A. P., & Robinson, D. H. (2024). How scientific is Cognitive Load Theory research compared to the rest of educational psychology? Education Sciences, 14(8), 920. DOI:10.3390/educsci14080920

Mayer, R. E. (2009). Multimedia learning (2nd ed.). New York: Cambridge University Press.

Mushtaq, S., Yasin, G., & Lak, T. A. (2023). Impediments of online learning and teaching during the COVID-19 pandemic: A Case of University Students in Punjab, Pakistan. Annals of Social Sciences and Perspective, 4(1), 103-120. DOI:10.52700/assap. v4i1.247

Noor, S., Ali, M. N., & Husnine, S. M. (2020). Performance of online classes in Lahore, Pakistan, during COVID-19. Performance Improvement, 59(9), 33-42. https://doi.org/10.1002/pfi.21938

Ouwehand, K., Lespiau, F., Tricot, A., & Paas, F. (2025). Cognitive load theory: emerging trends and innovations. Education Sciences, 15(4), 458. https://doi.org/10.3390/educsci15040458

Paas, F., Renkl, A., & Sweller, J. (2010). Cognitive load theory and instructional design: Recent developments. Educational Psychologist, 38(1), 1-4. DOI:10.1207/S15326985EP3801_1

Rind, I. A. (2026). "Conceptualizing the Impact of AI on Teacher Knowledge and Expertise: A Cognitive Load Perspective." Education Sciences 16(1), 57. https://doi.org/10.3390/educsci16010057

Sarwar, H., Akhtar, H., Naeem, M. M., Khan, J. A., Waraich, K., Shabbir, S., & Khurshid, Z. (2020). Self-reported effectiveness of e-Learning classes during the COVID-19 pandemic: A nation-wide survey of Pakistani undergraduate dentistry students. European journal of dentistry, 14(S 01), S34-S43. doi: 10.1055/s-0040-1717000

Skulmowski, A., & Xu, K. M. (2022). Understanding cognitive load in digital and online learning: A new perspective on extraneous cognitive load. Educational psychology review, 34(1), 171-196.

Sortwell, A., Gkintoni, E., Díaz-García, J., Ellerton, P., Ferraz, R., & Hine, G. (2026). Beyond cognitive load theory: Why learning needs more than memory management. Brain Sciences, 16(1), 109. https://doi.org/10.3390/brainsci16010109

Sundararajan, N., & Adesope, O. (2020). Keep it coherent: A meta-analysis of the seductive details effect. Educational Psychology Review, 32(3), 707-734.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive science, 12(2), 257-285. https://doi.org/10.1207/s15516709cog1202_4

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. Learning and Instruction, 4(4), 295-312. https://doi.org/10.1016/0959-4752(94)90003-5

Sweller, J. (2005). Implications of cognitive load theory for multimedia learning. The Cambridge handbook of multimedia learning, 3(2), 19-30. https://doi.org/10.1017/CBO9780511816819.003

Sweller, J. (2011). Cognitive load theory. In Psychology of learning and motivation (Vol. 55, pp. 37-76). Academic Press. https://doi.org/10.1016/B978-0-12-387691-1.00002-8

Sweller, J. (2011). Cognitive Load Theory: Recent Theoretical Advances. Cognitive Load Theory, 29–47. https://doi.org/10.1017/cbo9780511844744.004

Sweller, J. (2020). Cognitive load theory and educational technology. Educational technology research and development, 68(1), 1-16. https://doi.org/10.1007/s11423-019-09701-3

Sweller, J., & Chandler, P. (1991). Evidence for cognitive load theory. Cognition and instruction, 8(4), 351-362. https://doi.org/10.1207/s1532690xci0804_5

Taylor, S. (2024). Chapter 03: Message Design for Instructional Designers –Audio and Video Best Practices. ODU Digital Commons. https://digitalcommons.odu.edu/instructional_message_design_vol3/8/

Twabu, K. (2025). Enhancing the cognitive load theory and multimedia learning framework with AI insight. Discover Education, 4(1), 160. https://doi.org/10.1007/s44217-025-00592-6

Ullah, A., Ashraf, M., Ashraf, S., & Ahmed, S. (2021). Challenges of online learning during the COVID-19 pandemic encountered by students in Pakistan. Journal of Pedagogical Sociology and Psychology, 3(1), 36-44. https://doi.org/10.33902/JPSP.2021167264

Van Merriënboer, J. J., & Ayres, P. (2005). Research on cognitive load theory and its design implications for e-learning. Educational Technology Research and Development, 53(3), 5-13.

Van Merriënboer, J. J., & Sweller, J. (2005). Cognitive load theory and complex learning: Recent developments and future directions. Educational Psychology Review, 17(2), 147- 177. DOI:10.1007/s10648-005-3951-0

Waxman, J., Sue, A., & Goldie, J. (2025). Perspectives from the CHDS Media Hub Cognitive Theory of Multimedia Learning. Centre for Health Decision Science, Harvard T.H Chan School of Public Health

Zhang, S., Liu, L., Ding, S., Peng, T., Wang, J., & Wu, Y. (2025). Mediator effects of cognitive load on the relationship between task complexity and guideline adherence among clinical nurses: a cross-sectional survey of nurses in China. Journal of Research in Nursing, 30(5-6), 479-490. doi: 10.1177/17449871251329197

Zou, L., Zhang, Z., Mavilidi, M., Chen, Y., Herold, F., Ouwehand, K., & Paas, F. (2025). The synergy of embodied cognition and cognitive load theory for optimized learning. Nature Human Behaviour, 9(5), 877-885. https://doi.org/10.1038/s41562-025-02152-2

Annexure (A)

Table No.4

No.	Checklist Indicator (CLT Principle)	Educational Psychology Course	Qualitative Remarks
1	Split Attention, integration of visuals, and sequencing	Partially aligned	Visuals were generally relevant to the instructional content; however, explanations were often provided separately from the visuals. Although most videos presented coherent material, learners frequently needed to toggle between videos, slides, and notes to fully understand the concepts.
2	Reduction of Redundant Information	Partially aligned	Many times, the instructor read aloud text that was also displayed on the slides, resulting in unnecessary duplication of information.
3	Expertise Reversal and novice information	Low aligned	Foundational concepts were generally explained in detail; however, the courses provided limited opportunities for advanced learners to engage with more complex or extended content.
4	Element Interactivity, Segmenting of instructional content	Low aligned	In some modules, concepts were introduced sequentially; however, explicit connections among interacting elements were not consistently reinforced.
5	Modality principal application	Low aligned	Narration was occasionally used to explain visual representations, and written explanations frequently accompanied or replaced audio. Several multimedia segments relied heavily on a single modality, most commonly text-based explanations.
6	Worked Example	Low aligned	The evaluated courses primarily relied on theoretical explanations without providing explicit demonstrations of how concepts could be applied in authentic online teaching or learning contexts. Learners were occasionally given tasks.
7	Guidance Fading and Scaffolding	Low aligned	Some guided activities were present in early stages, without clear progression toward increased learner autonomy in subsequent modules.
8	Use of Signaling cues	Partially aligned	Key points were typically embedded within dense textual content without explicit emphasis, making it difficult for learners to identify essential information. Visual cues were often decorative rather than instructional.
9	Self-Explanation & Reflection	Not aligned	Some reflective prompts were present; they were optional and not systematically embedded within instructional modules.
10	Online Learning Design Appropriateness	Moderately aligned	Delays in content loading and inconsistent multimedia performance were observed, which may disrupt learners' cognitive flow.

Annexure (B)

Table No.5

No.	Checklist Indicator (CLT Principle)	Curriculum Development Course	Qualitative Remarks
1	Split Attention, integration of visuals, and sequencing	Partially aligned	There was very little written explanation with visuals; however, visuals were relevant to the instructional content.
2	Reduction of Redundant Information	Moderately aligned	The instructor explained the text instead of just reading it from the screen. The explanation of the content was to the point and very limited. There was no repetition of material. Every concept was split into small parts, so there was no summarization before starting any new concept.
3	Expertise Reversal and novice information	Low aligned	Foundational concepts were generally explained in detail. There was a limited opportunity for advanced learners to engage with more complex or extended content. The absence of differentiated

			instructional pathways constrained the potential for adaptive learning experiences.
4	Element Interactivity, Segmenting of instructional content	Low aligned	The topics were broken into chunks, but they were not combined after the completion of the explanation. Practical implementation was not guided. The interactive tools were recall-based; they did not support the breakdown or recombination of interacting elements.
5	Modality principal application	Partially aligned	Narration was used to explain visual representations, and written explanations were frequently accompanied or replaced with audio. Several multimedia segments relied heavily on a single modality, most commonly text-based explanations.
6	Worked Example	Not aligned	There were only theoretical explanations without telling the application of concepts in learning contexts. Examples illustrating high-quality responses were largely absent.
7	Guidance Fading and Scaffolding	Not aligned	There were no guided activities present. Instructional support remained largely uniform throughout the course. Instructional scaffolding was not present due to very small chunks of video lectures.
8	Use of Signaling cues	Partially aligned	Key points were typically embedded in less textual content, which made it easy for learners to understand information. Visual cues were instructional; however, verbal signaling during lectures was minimal.
9	Self-Explanation & Reflection	Not aligned	There were no reflective questions for the learner. Reflection was not consistently taken from the students. The courses primarily emphasized only content delivery, and assessment of recall was also absent.
10	Online Learning Design Appropriateness	Moderately aligned	Delays in content loading and inconsistent multimedia performance were observed, which may disrupt learners' cognitive flow.

Annexure (C)

Table No.6

No.	Checklist Indicator (CLT Principle)	Comparative Education Course	Qualitative Remarks
1	Split Attention, integration of visuals, and sequencing	Partially aligned	The duration of the video was very short. The single concept was split into two videos. Students have to toggle between videos to understand the same topic.
2	Reduction of Redundant Information	Moderately aligned	The instructor explained the text instead of just reading it from the screen. The explanation of the content was to the point and very limited. There was no repetition of material. Every concept was split into small parts, so there was no summarization.
3	Expertise Reversal and novice information	Low aligned	Foundational concepts were generally explained in detail. There were very limited opportunities for advanced learners to engage with more complex or extended content.
4	Element Interactivity, Segmenting of instructional content	Low aligned	A single concept was explained in 2-3 short videos, and they were not combined after the completion of the explanation. Practical implementation was not guided; some real-life examples were given. Learners were rarely shown step-by-step demonstrations.
5	Modality principal application	Partially aligned	Narration was used to explain visual representations, and written explanations frequently accompanied or replaced audio. Several multimedia segments relied heavily on a single modality, most commonly text-based explanations.
6	Worked Example	Not aligned	There were only theoretical explanations without telling the application of concepts in learning contexts. Examples illustrating high-quality responses were largely absent.
7	Guidance Fading and Scaffolding	Not aligned	There were no guided activities present. Instructional support remained largely uniform throughout the course. Instructional scaffolding was not present due to very small chunks of video lectures.

8	Use of Signaling cues	Partially aligned	Key points were typically embedded in less textual content, which made it easy for learners to understand information. Visual cues were instructional; however, verbal signaling during lectures was minimal.
9	Self-Explanation & Reflection	Not aligned	There were no reflective questions for the learner. Reflection was not taken from the students. The courses primarily emphasized only content delivery, and assessment of recall was also absent.
10	Online Learning Design Appropriateness	Moderately aligned	Delays in content loading and inconsistent multimedia performance were observed, which may disrupt learners' cognitive flow. Learners were not provided with visual cues to monitor their progression through course content, potentially increasing planning-related cognitive demands.

Annexure (D)

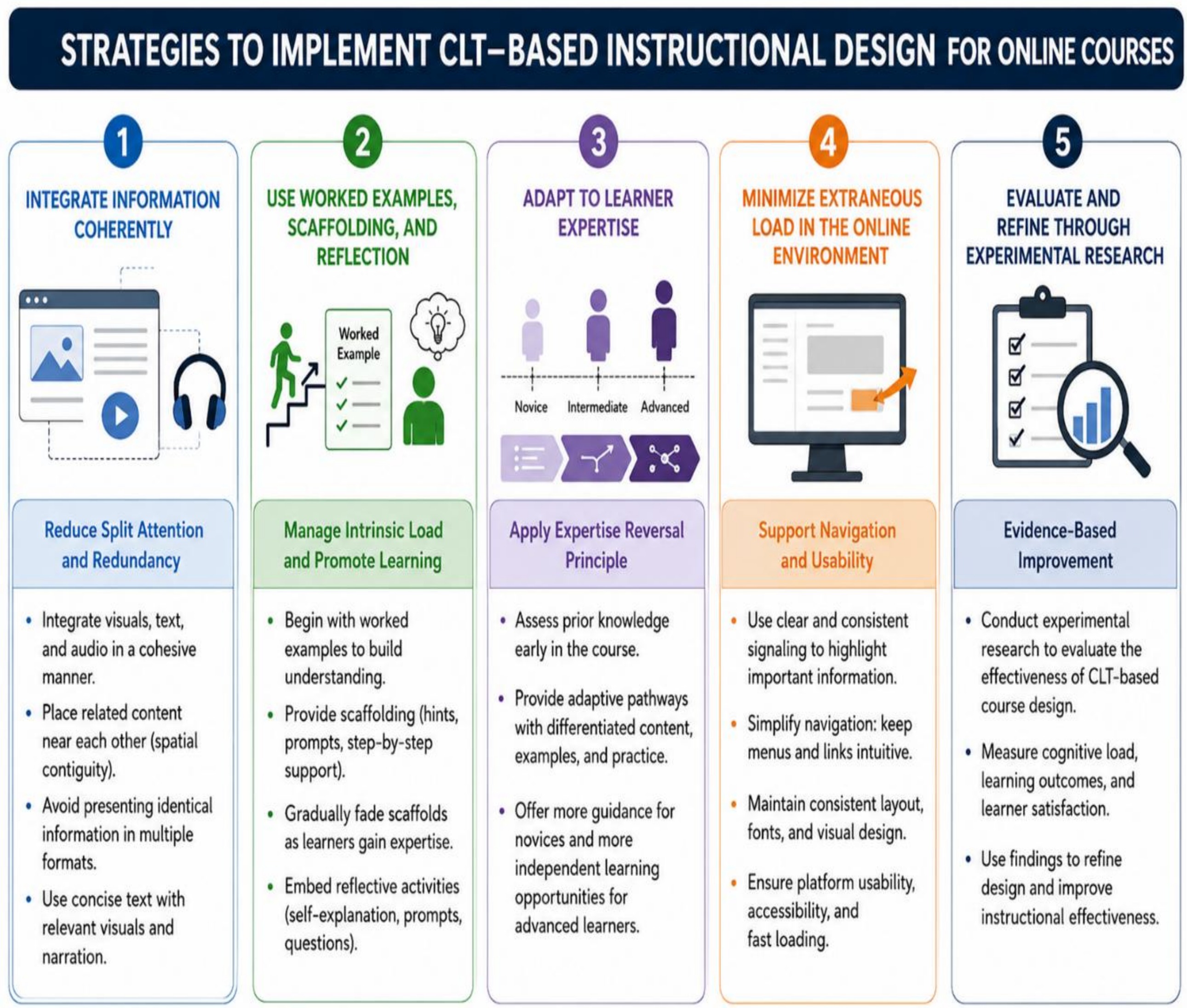

Figure No. 1: Strategies to implement CLT-based instructional design for online courses