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Relation Between Cognitive Load and Achievement Level in Some Theoretical Subjects For Third Stage Students in Department of Physical Education and Sport Sciences at College of Basic Education

[1]Ahmed Hisham Ahmed Al-Hilaly[*]

[1]College of Basic education / university of Mosul, Iraq

*Corresponding Author: **Ahmed Hisham Ahmed Al-Hilaly**, e-mail: **Ahmed_hisham@uomosul.edu.iq**

Abstract

Objectives. This study aimed to examine the relationships between intrinsic (inner) and extraneous (external) cognitive load and academic achievement in selected theoretical courses—*Rehabilitation of Athletic Trauma* and *Principles of Scientific Research*—among third-year students in the Department of Physical Education and Sport Sciences, College of Basic Education, University of Mosul.

Materials and Methods. A descriptive correlational design was used. The sample consisted of 52 third-year students (22 females and 30 males) drawn from a population of 76 students (72%) using total sampling. Data were collected using a cognitive load questionnaire adapted from Al-Badawi (2014), containing 30 items: 15 items measuring intrinsic cognitive load and 15 items measuring extraneous cognitive load. Responses were recorded on a three-option format (Yes, Relatively, No) with graded scoring. Academic achievement was represented by students' course attainment in the two specified theoretical subjects. Data were analyzed using descriptive statistics (mean and standard deviation) and correlation analysis to determine relationships between cognitive load dimensions and academic achievement.

Results. The findings indicated a **positive relationship** between intrinsic (inner) cognitive load and academic achievement among the sampled students. In contrast, extraneous (external) cognitive load showed a **negative relationship** with academic achievement in the same sample.

Conclusions. Intrinsic cognitive load appears to be associated with better academic attainment, whereas higher extraneous cognitive load is linked to lower attainment in theoretical coursework. These results suggest that instructional strategies should minimize extraneous cognitive load (e.g., reducing irrelevant information and improving clarity of materials) while appropriately managing intrinsic cognitive load through structured sequencing and learning support.

Keywords: Cognitive load; Academic achievement; Theoretical courses; Physical education students

Introduction

The contemporary educational process is undergoing major transformations. Teaching is no longer limited to transmitting information; it increasingly emphasizes how learners receive, organize, and process information in real time. Within this perspective, Cognitive Load Theory (CLT) has become a key framework for understanding learning effectiveness

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because it explains how the limited capacity of working memory can be overloaded when instructional content is complex or poorly organized, leading to reduced comprehension and weaker academic performance (Hassan, 2018).

In today's context—marked by rapid change, the expansion of knowledge, and the growth of information technology—students are exposed to large volumes of information that can create cognitive pressure and confusion if learning demands exceed their mental capacity (Assawi, 2019). This situation is especially critical in university settings where theoretical courses may contain abstract concepts, unfamiliar terminology, and dense explanations. When these materials are presented through traditional methods that do not support gradual processing, students may struggle to encode information effectively and transfer it into long-term memory, resulting in lower attainment (Hassan, 2018).

Cognitive load can be understood as the total mental effort required while learning or solving problems. It includes intrinsic (inner) cognitive load, which is related to the inherent complexity of the learning material and the number of interacting elements, and extraneous (external) cognitive load, which arises from the way information is presented or the design of the learning environment (Badawi, 2014). In other words, even well-prepared students may experience reduced achievement when content is inherently difficult (high intrinsic load) or when presentation is unclear and demanding (high extraneous load).

In the Department of Physical Education and Sport Sciences, cognitive load may be particularly noticeable because students study diverse courses that combine theoretical knowledge, scientific concepts, and practical sport-related content. Although physical education students often show stronger engagement with practical learning, many theoretical subjects require higher-level cognitive processing, including analysis, conceptual understanding, and scientific reasoning. Therefore, investigating cognitive load in this department is important for improving how theoretical content is structured and taught, and for enhancing student achievement outcomes.

Based on this rationale, the present study focuses on third-year students and examines how intrinsic and extraneous cognitive load relate to academic achievement in two selected theoretical courses: Rehabilitation of Athletic Trauma and Principles of Scientific Research. The findings are expected to provide evidence that can guide instructors in reducing unnecessary learning burdens and improving the design of theoretical instruction in physical education programs.

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Materials and Methods

Study Participants.

The study participants were third-year students enrolled in the Department of Physical Education and Sport Sciences, College of Basic Education, University of Mosul. The total population consisted of 76 students. Using total sampling, 52 students (72% of the population) participated in the study, including 22 females and 30 males. All participants were registered in the targeted theoretical courses—Rehabilitation of Athletic Trauma and Principles of Scientific Research—during the study period (15/12/2024–18/4/2025).

Study Organization

The study followed a descriptive correlational design. Data collection was conducted during regular class attendance in the department. The researcher administered the Cognitive Load Scale developed by Badawi (2014), consisting of 30 items (15 items measuring intrinsic/inner cognitive load and 15 items measuring extraneous/external cognitive load) with three response options (Yes, Relatively, No) and graded scoring. The questionnaire was distributed on 13/12/2024 and completed on the same day. Academic achievement data were obtained from the official first-semester grades in the two selected theoretical subjects, after coordination with the examination committee. Prior to the main administration, the instrument's reliability was verified using a test–retest procedure on a pilot group of 20 students with a 21-day interval, yielding acceptable stability ($r = 0.81$) and self-validity (0.90). Content validity was supported through expert review, confirming the suitability of the scale for the study purpose.

Statistical analysis.

Data were analyzed using descriptive and correlational statistics. Descriptive statistics included arithmetic means and standard deviations to summarize intrinsic cognitive load, extraneous cognitive load, and academic achievement scores. To examine the relationships between cognitive load dimensions and achievement, the Pearson correlation coefficient (simple correlation factor) was used for male and female groups separately. Statistical significance was evaluated at an alpha level of $p < 0.05$. All statistical procedures followed the methods described by Attikriti and Al-Obaidi (1999).

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Results

Table 2. Descriptive Statistics of Study Variables (Total Sample, n = 52)

Variable	Mean	SD
Intrinsic (Inner) Cognitive Load	12.00	2.87
Extraneous (External) Cognitive Load	11.23	3.31
Academic Achievement (selected theoretical subjects)	16.33	4.84

Table 3. Descriptive Statistics of Study Variables (Female Students, n = 22)

Variable	Mean	SD
Intrinsic (Inner) Cognitive Load	14.00	2.41
Extraneous (External) Cognitive Load	12.19	3.11
Academic Achievement (selected theoretical subjects)	18.07	5.14

Table 4. Pearson Correlation Between Cognitive Load and Academic Achievement

Group	Intrinsic (Inner) Cognitive Load vs Achievement (r, p)	Extraneous (External) Cognitive Load vs Achievement (r, p)
Male students	**−0.47**, p = 0.03*	0.23, p = 0.12
Female students	**−0.51**, p = 0.03*	0.15, p = 0.12

(by Gender)

Discussion

This study examined how intrinsic (inner) and extraneous (external) cognitive load relate to academic achievement in two theoretical courses (*Rehabilitation of Athletic Trauma* and *Principles of Scientific Research*) among third-year physical education students. The main finding was a significant negative correlation between intrinsic cognitive load and achievement for both males ($r = -0.47$, $p = 0.03$) and females ($r = -0.51$, $p = 0.03$). In contrast, extraneous cognitive load showed no significant relationship with achievement in either group (males: $r = 0.23$, $p = 0.12$; females: $r = 0.15$, $p = 0.12$).

The negative association between intrinsic cognitive load and achievement indicates that, as students perceive the *inherent complexity* of the learning content to be higher, their

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attainment tends to decrease. From a Cognitive Load Theory perspective, intrinsic load is driven by the difficulty of the material, the number of interacting elements, and how well students' prior knowledge supports processing those elements. In this context, both targeted courses likely require substantial conceptual understanding (e.g., injury mechanisms, rehabilitation principles, research concepts, terminology, and analytic reasoning). When the content complexity exceeds students' current schemas or prerequisite knowledge, working memory resources may be consumed by understanding basic relationships, leaving fewer resources available for deep learning, integration, and retrieval during assessment (Badawi, 2014; Hassan, 2018). This helps explain why students who reported higher intrinsic load achieved lower grades.

Importantly, the pattern appeared consistent across genders, suggesting that the intrinsic load–achievement relationship is not limited to one subgroup but reflects a broader learning challenge in these theoretical subjects. While the female descriptive means show relatively higher average intrinsic load alongside a relatively higher average achievement, the correlation analysis clarifies that within the female group, students who experienced higher intrinsic load still tended to perform worse. This implies that achievement differences are not determined by one factor alone; other variables (e.g., study time, motivation, prior preparation, or learning strategies) may contribute to mean achievement levels, while intrinsic load remains a meaningful predictor of performance variation within each gender group.

On the other hand, the lack of a significant relationship between extraneous cognitive load and achievement suggests that the way learning materials were presented—or the learning environment factors captured by the scale—may not have been the primary driver of performance in this setting (Badawi, 2014). One interpretation is that students were exposed to relatively similar instructional conditions (same department, similar lecture formats, comparable assessments), reducing variability in extraneous load and limiting its statistical relationship with grades. Another explanation is methodological: extraneous load is often sensitive to specific instructional design features (e.g., split attention, redundant explanations, unclear visuals), and a general self-report measure may not fully capture moment-to-moment design burdens that influence learning outcomes. Additionally, with a modest sample size, smaller effects may not reach significance even if they exist.

Overall, the findings highlight that the critical challenge in these courses may be managing intrinsic load by improving how complex content is structured and sequenced rather than focusing only on presentation quality. Practical teaching implications include: (1)

strengthening prerequisite knowledge through brief "pre-training" of key terms and concepts, (2) breaking complex content into smaller segments with clear progression, (3) using worked examples and guided practice before independent problem-solving, and (4) integrating concept maps, case-based scenarios, and applied examples that connect abstract theory to familiar sport and coaching contexts. Such strategies can make essential element interactions more learnable without reducing academic rigor, thereby supporting higher achievement (Assawi, 2019; Hassan, 2018).

Finally, this study should be interpreted in light of limitations. The design was correlational, so causality cannot be concluded. Cognitive load was measured by self-report, which may be influenced by perception and test anxiety. The study also focused on one department, one university, and two subjects, which may limit generalizability. Future research could include larger samples, multiple universities, objective learning analytics, and experimental instructional interventions designed to reduce cognitive load and test whether achievement improves as expected.

Conclusions

The findings of this study indicate that intrinsic (inner) cognitive load has a significant negative relationship with academic achievement in the examined theoretical subjects. This means that the higher the intrinsic cognitive load experienced by students, the more likely their academic achievement scores are to decrease. In contrast, extraneous (external) cognitive load showed no significant relationship with academic achievement for either male or female students. Overall, these results suggest that differences in learning outcomes in theoretical courses are more strongly influenced by the inherent complexity and difficulty of the material (intrinsic load) than by presentation- or environment-related factors (extraneous load).

Conflict of interest

The author declares no conflict of interest.

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