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REDUCING COGNITIVE LOAD IN FOREIGN LANGUAGE LEARNING AS A CONDITION FOR EFFECTIVE LANGUAGE ACQUISITION

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A language learner sitting through a listening comprehension task in a second language is doing several things at once: decoding phonology, retrieving vocabulary, parsing grammar, holding earlier parts of the sentence in working memory while processing the current word, and trying to construct meaning from the whole. None of these operations is automatic at an intermediate level of proficiency, and they all compete for the same limited cognitive resource. When the total demand exceeds what working memory can handle, something gives: the learner stops tracking the grammar, or the vocabulary retrieval fails, or the meaning of the whole sentence is lost because the parts consumed all available capacity. This is not a failure of intelligence or effort. It is a predictable consequence of overloading a system with a fixed ceiling.

Cognitive load theory, developed by John Sweller and colleagues over several decades, provides the most precise available account of why this happens and what can be done about it. The theory distinguishes three types of load that accumulate simultaneously in working memory. Intrinsic load is generated by the material itself - its inherent complexity and the number of elements that must be held in mind simultaneously. In language learning, intrinsic load is high by definition: grammar, vocabulary, phonology and discourse structure all interact, and none can be fully processed without the others. Germane load is the cognitive work involved in constructing new schemas - the productive effort of actually learning, building long-term representations that will reduce intrinsic load in future encounters with similar material. Extraneous load is the cognitive cost imposed not by the material but by the way it is presented: poor formatting, redundant information, split attention between a text and a diagram that should be integrated, unnecessary switching between sources. The central practical implication of the theory is that extraneous load is the only type that can be reduced without reducing learning - and reducing it frees capacity for germane load, the type that actually produces acquisition.

Bahari's systematic review of cognitive load management in technology-assisted language learning documents the range of extraneous load sources that digital environments introduce alongside their affordances [1, p. 89]. Navigation demands,

notification interruptions, interface complexity and the cognitive cost of switching between platform functions all consume working memory capacity that would otherwise be available for language processing. The review identifies a consistent pattern across studies: learners using well-designed technology-assisted environments outperform those using poorly designed ones not because the technology itself produces learning, but because good design removes barriers that worse design creates. The implication for language teachers and course designers is direct: the first question about any digital tool is not what it offers but what it costs - how much working memory capacity the learner must dedicate to operating the tool rather than learning the language.

The split-attention effect is among the most robustly documented sources of extraneous load in language instruction. When a learner must simultaneously consult two sources of information that cannot be understood independently - a grammar explanation and the example sentence it explains, a diagram and its verbal description, a written transcript and the audio it accompanies - working memory must hold and mentally integrate them. If those sources are physically or temporally separated, the integration itself becomes a cognitive task that competes with comprehension. Roussel, Tricot and Sweller examined this problem specifically in the context of academic listening in a second language, and their findings complicate a widely accepted pedagogical assumption [4, p. 631]. Listening to academic content in L2, they found, places such high simultaneous demands on working memory - phonological decoding, vocabulary retrieval, syntactic parsing, and discourse-level integration all at once - that the processing disadvantages can outweigh the assumed benefits of exposure to authentic academic input. The advantage of authentic material over simplified material depends critically on the learner's proficiency level: for learners whose L2 processing is not yet sufficiently automated, authentic academic listening may produce cognitive overload rather than acquisition, and the pedagogical value of the exposure is lost.

This finding has direct consequences for how listening tasks are sequenced and scaffolded in language courses. A task that would be productively challenging for a B2 learner may be simply overwhelming for a B1 learner - not because the B1 learner is less capable of acquiring the target language, but because the total cognitive demand of the task at that proficiency level exceeds working memory capacity, leaving no room for the schema construction that constitutes actual learning. Reducing cognitive load in this context does not mean making the task easier in content; it means controlling the load at each stage of the task so that working memory is never fully consumed by decoding operations alone. Pre-teaching vocabulary before a listening task, providing a structural outline before extended reading, breaking a complex grammar explanation into sequenced steps rather than presenting all elements simultaneously - each of these is a load-management intervention that preserves capacity for germane load.

The relationship between cognitive load and anxiety in language production tasks is examined by Xiao and Sun-Lin in a structural equation modelling study on story continuation writing in a foreign language [5, p. 4]. Their results establish a bidirectional interaction: high cognitive load increases writing anxiety, and writing anxiety in turn increases cognitive load, because anxiety consumes working memory

resources through ruminative and self-monitoring processes. The learner who is anxious about making grammatical errors in writing devotes part of working memory to monitoring for errors while simultaneously trying to plan content, retrieve vocabulary and manage discourse structure. The anxiety is not a separate problem that can be addressed independently of cognitive load; it is partly generated by cognitive overload and partly generates additional cognitive load in return. Xiao and Sun-Lin found that reducing task complexity - by providing structural scaffolding or vocabulary support - decreased both cognitive load and anxiety simultaneously, and that the improvement in writing performance followed from both reductions together rather than from either alone [5, p. 8].

The practical implication is that scaffolding is not a concession to weak learners; it is a cognitive load management tool. A learner who is given a genre template for an essay, a set of linking expressions and pre-taught topical vocabulary is not being given the answer; they are being given the conditions under which their working memory can engage with the genuinely generative aspects of the task - argument construction, evidence selection, voice - rather than being fully consumed by lower-level production decisions. As proficiency develops and lower-level processes become more automated, scaffolding can be progressively withdrawn. The endpoint is the same; the path through it is calibrated to the learner's current working memory capacity.

Li, Yu, Zhang and Liu set up a direct test between two competing accounts of what happens when language learners encounter new vocabulary alongside images [3, p. 6]. Dual coding theory predicts that the visual channel always helps, because it gives the learner a second representational route to the same meaning. Cognitive load theory predicts the opposite under certain conditions: if the image and the text carry the same information, the learner must process both, reconcile them, and confirm they agree - a cognitive operation that costs working memory capacity and returns nothing. The study found that both predictions are correct, depending on what the image actually does. A picture of an unfamiliar concrete object genuinely extends the meaning the text provides; the learner gets information from the image that the words alone do not deliver, and retention improves. A picture that simply depicts what the sentence already says clearly adds nothing to meaning and subtracts something from available cognitive capacity. The consequence for materials design is not that visuals should be avoided or preferred as a general rule. It is that a picture earns its place only when it carries information the text does not - and when it does not, removing it is the better pedagogical decision.

Collaborative writing tasks introduce a different cognitive load dynamic. Jiang and Kalyuga examined EFL writing skill development in collaborative settings through a cognitive load lens and found that collaboration can reduce individual intrinsic load by distributing cognitive demands across participants - but only under specific conditions [2, p. 7]. When a collaborative task is poorly structured, the social coordination required - negotiating decisions, managing disagreement, tracking shared understanding - itself generates extraneous load that may exceed the reduction in intrinsic load. Well-structured collaborative tasks, with clear role distribution and explicit shared planning phases, freed individual working memory capacity and

produced better writing outcomes than either poorly structured collaboration or individual writing under equivalent conditions. The beneficial effect of collaboration on cognitive load is not automatic; it is a product of task design.

Bahari's review notes that adaptive technologies offer one of the most promising routes to systematic cognitive load management in language learning, precisely because they can calibrate task difficulty to individual proficiency in real time [1, p. 97]. A task that is within the optimal challenge range for one learner may be trivially easy or overwhelmingly difficult for another at a different proficiency level, and a fixed curriculum necessarily misses the target for most of the students in any heterogeneous group. Adaptive systems can adjust input complexity, scaffolding level and task sequencing to keep each learner in the zone where intrinsic and germane load are productive and extraneous load is minimised. The limitation Bahari identifies is implementation quality: many adaptive platforms adapt on superficial metrics - response speed, error rate on multiple-choice items - rather than on genuine measures of cognitive load or schema development, which means their adaptations may not track what matters for acquisition.

What the studies reviewed here share is not a single finding but a single variable. The same learner, the same material, the same lesson - different cognitive load, different outcome. Roussel, Tricot and Sweller showed that academic listening in L2 can produce nothing at all if proficiency is not high enough to automate the decoding operations, because working memory is fully consumed before comprehension can begin [4, p. 635]. Xiao and Sun-Lin showed that writing anxiety does not sit alongside cognitive load as a separate problem - it feeds into it, occupying the same working memory that the writing task itself requires, and the two together push total demand past what the learner can manage [5, p. 8]. Jiang and Kalyuga showed that collaboration reduces individual load only when the task is structured well enough that coordination does not itself become a load source [2, p. 9]. In each case, the material was not the problem. The design was. A lesson that ignores this - that treats cognitive load as a background condition rather than a designable variable - is not simply less efficient. It can be the difference between a task that teaches and a task that exhausts without teaching anything.

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ПРИКЛАДНІ ЗАДАЧІ ЯК ЗАСІБ ФОРМУВАННЯ ПРОФЕСІЙНИХ КОМПЕТЕНТНОСТЕЙ У КУРСІ ВИЩОЇ МАТЕМАТИКИ

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У сучасних умовах розвитку вищої освіти особливої актуальності набуває проблема формування професійних компетентностей здобувачів освіти у процесі вивчення курсу вищої математики. Компетентнісний підхід передбачає не лише засвоєння теоретичних знань, а й здатність застосовувати їх у реальних професійних ситуаціях. У цьому контексті прикладні задачі виступають ефективним педагогічним засобом інтеграції теоретичних знань і практичної діяльності [2].

Однією з ключових проблем традиційного викладання вищої математики є її надмірна абстрактність, що знижує мотивацію здобувачів освіти і не сприяє формуванню професійного мислення. Використання прикладних задач дозволяє подолати цей розрив, оскільки такі задачі відтворюють реальні виробничі, інженерні та економічні процеси та забезпечують зв’язок між навчанням і майбутньою професійною діяльністю. Прикладна задача розглядається як завдання, що виникає поза межами математики, але розв’язується її засобами, що підкреслює її практичну спрямованість і міждисциплінарний характер [3].

Прикладні задачі виконують важливі функції у навчальному процесі. Вони підвищують мотивацію здобувачів освіти, оскільки демонструють практичну значущість математичних знань, а також сприяють формуванню ключових