Managing Cognitive Load in Invertebrate Classification: CLT-Based Notecard Learning Media

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Abstract: Learning invertebrate classification requires intensive interactivity that often overloads students' working memory and leads to superficial understanding. From a Cognitive Load Theory (CLT) perspective, this issue is worsened by instructional media with complex, unfocused visuals that increase extraneous cognitive load. This study developed and evaluated a CLT-based notecard media to manage cognitive load and support meaningful schema construction. Using an R&D approach, the study included needs analysis, CLT-informed design, expert validation, and limited field testing with 39 senior high school students. Data was collected through expert validation instruments, analysis of students' classification records, Paas mental effort ratings, and qualitative responses. Results indicate that the CLT-based notecard media align with CLT principles and are feasible for instructional use, although refinements are needed to improve readability and visual signaling. Students' mental effort levels were generally low to moderate, suggesting that the media may provide manageable cognitive support during classification tasks. Overall, the findings suggest that CLT-based notecard learning media may support early observation and initial schema development in biological classification learning.

Keywords: Cognitive Load Theory, Invertebrate Classification, Notecard Learning Media, Schema Construction, Working Memory

INTRODUCTION

Biology education plays a crucial role in developing students' understanding of life and the diversity of living organisms (Sadava *et al.,* 2024). One essential topic at the secondary education level is the Animal Kingdom, which encompasses complex concepts such as morphology, anatomy, physiology, taxonomy, and the ecological roles of animals (Urry *et al.,* 2025). Traditionally, one of the most common instructional approaches used to support students' understanding of animal anatomy is dissection. Dissection activities are widely acknowledged as effective for providing direct experiences with internal structures and spatial relationships within animal bodies (Spernjak & Sorgo, 2017; Oakley, 2012).

However, the use of dissection in biology classrooms has increasingly been questioned due to concerns related to animal welfare, sustainability, and the use of preserved specimens (Fancovicova *et al.,* 2013). Dissection and animal-based observation activities may also evoke negative emotional responses such as fear, anxiety, or disgust, which can reduce participation, attention, motivation, and conceptual understanding (Andreoli *et al.,* 2023; Baptista, 2024; Graesser, 2020). Similar affective barriers are reported toward certain animal taxa, including insects, reptiles, amphibians, and annelids, potentially discouraging students from observing and classifying animal characteristics

during learning activities (Prokop & Tunnicliffe, 2008; Randler *et al.,* 2012, 2013; Balcombe, 2001; Oakley, 2013; Kiani *et al.,* 2022; Kaiser *et al.,* 2023).

In addition to affective challenges, learning about Animalia poses substantial cognitive demands. Learning animal diversity requires students to identify visual characteristics and connect them with abstract classification concepts. However, numerous studies have reported that students struggle to integrate visual and textual information, particularly when instructional media are not optimally designed (Bali et al., 2026; Wicaksana *et al.,* 2023). Unfocused or overly dense visual media may increase extraneous cognitive load. As a result, students' working memory can become overloaded, which may hinder understanding (Sweller *et al.,* 2011).

From a cognitive perspective, working memory has a highly limited capacity. Individuals can typically retain no more than about 7 elements of novel information and simultaneously process only 3–4 elements for approximately 20 seconds, with this capacity decreasing further when information is complex (Baddeley, 2012; Sweller, 2024). In the context of Animalia learning, cognitive overload may occur when illustrations are excessively detailed, photographs are unclear, or text and images are presented separately, forcing learners to engage in heavy mental integration. This condition is known as the split-attention effect (Guzman & Zambrano, 2024). Therefore, instructional media should be deliberately designed based on Cognitive Load Theory (CLT) to manage intrinsic and extraneous cognitive load effectively (Paas & Sweller, 2012; Candido & Cattaneo, 2025).

In modern education that emphasizes discovery learning, inquiry-based instruction, and visual observation, two-dimensional learning media such as cards, diagrams, charts, and illustrations offer considerable potential. These media are accessible, flexible, and capable of presenting simplified yet meaningful representations of complex biological concepts (Ainsworth, 2006; Schnotz & Bannert, 2003). However, traditional visual media often function in a one-way manner and provide limited opportunities for learners to actively process information or externalize their understanding (Tuovinen, 2000; Clark & Mayer, 2016).

An innovative alternative is the use of CLT-based notecard media. This type of media allows students to observe animal illustrations or photographs on one side while actively recording identification results, key characteristics, or reflections on the reverse side. Such dual-function media support generative learning, encourage active engagement, and facilitate meaningful interaction with content (Mayer & Moreno, 2003; Fiorella & Mayer, 2015; Mayer, 2024). The integration of professional scientific illustrations with authentic animal photographs can enhance visual accuracy and realism while accommodating diverse learning preferences.

From the perspective of Cognitive Load Theory (Sweller, 1988), well-designed CLT-based notecard media can help reduce extraneous cognitive load and support schema construction. By directing students' attention toward diagnostically important features, the media may also facilitate germane cognitive processing (Plass *et al.,* 2010; Sweller, 2023; de Jong, 2010). Optimizing intrinsic load and minimizing unnecessary complexity in high-element interactivity tasks can prevent cognitive overload and improve learning outcomes (Pyke *et al.,* 2024).

Furthermore, indirect visual exposure through illustrations and photographs has been shown to reduce fear and disgust responses, creating a psychologically safe learning

environment without the ethical and emotional risks associated with live animals or dissection (Tomažič, 2011; Zemanova & Knight, 2021; Zemanova *et al.,* 2021; Zemanova, 2022). Despite these advantages, empirical research focusing on CLT-based notecard media for Animalia learning remains limited, particularly in higher education and teacher-training contexts. Most existing studies emphasize digital multimedia or virtual simulations, leaving a research gap in low-cost, flexible, and cognitively optimized physical learning media.

Despite the growing body of research on multimedia learning and Cognitive Load Theory, studies examining low-cost physical learning media specifically designed to support invertebrate classification remain limited. Most previous studies have focused on digital multimedia or virtual simulations, whereas empirical evidence regarding CLT-based notecard learning media in biology education is still scarce, particularly in the context of observation-based classification tasks. Therefore, this study aimed to develop CLT-based notecard media for Animalia learning, validate its academic and design feasibility, and explore its potential to support cognitive load during classification learning. It is expected that this media will help students understand Animalia concepts in a more systematic, engaging, focused, and meaningful manner while addressing both cognitive limitations and affective barriers to learning.

METHODS

This study is a research and development (R&D) study aimed at producing notecard learning media based on Cognitive Load Theory (CLT) (Greer *et al.,* 2017; CESE, 2017a; CESE, 2017b) for invertebrate topics, as well as evaluate its feasibility and explore its potential to support cognitive load. This study employed a simplified Research and Development (R&D) approach adapted from common instructional development frameworks proposed by Borg & Gall (2003) and educational media development procedures described by Greer et al. (2017). Due to the exploratory nature of the study and the limited scope of implementation, the development process was simplified into four stages: (1) needs analysis and media design, (2) expert validation and revision, (3) limited field testing, and (4) analysis of cognitive load and student responses. The simplification was intended to focus on preliminary feasibility and usability evaluation prior to broader implementation.

The expert validation process involved three validators consisting of two biology education lecturers and one instructional media expert. The validators evaluated the media based on content accuracy, readability, technical quality, usability, and alignment with Cognitive Load Theory principles using a three-point Likert scale (1 = low, 2 = moderate, 3 = high). Validation scores from all validators were averaged to determine the overall feasibility category. Mean scores were interpreted using the following criteria: 1.00-1.66 = low, 1.67-2.33 = moderate, and 2.34-3.00 = high feasibility. The field testing phase involved 39 senior high school students who were studying the topic of Animalia, particularly invertebrate classification.

During the needs analysis stage, data were collected through interviews with biology teachers, and a student learning needs survey using a KWL chart (Rahmasari *et al.,* 2024). These data served as the basis for designing the CLT-based notecard media, which emphasized visual simplification and highlighted essential morphological

characteristics in accordance with CLT principles intended to help reduce extraneous cognitive load.

The expert validation stage was conducted to assess the feasibility of the content and media design. The evaluated aspects included the accuracy of biological concepts, readability, visual quality, and alignment with cognitive load principles. Feedback from the validators was used to revise the media before its implementation in learning activities.

The limited field-testing stage was conducted in one class. Students used CLT-based notecard media to observe images of invertebrates, identify morphological characteristics, and record their observations on the cards. After the learning activity, students were asked to complete a mental effort measurement instrument.

The final stage involved the analysis of cognitive load and student responses. Cognitive load was measured using the Paas Mental Effort Scale (1–9) (Paas, 1992), while student responses were collected through open-ended response questionnaires to identify perceived sources of mental effort during media use.

Data was analyzed using quantitative and qualitative descriptive approaches. Expert validation scores and students' mental effort scores were analyzed descriptively by calculating mean values based on the Paas Mental Effort Scale (1-9). For interpretation purposes, scores were grouped into low (1.00-3.00), moderate (3.01-6.00), and high (6.01-9.00) perceived mental effort levels. Qualitative responses were analyzed using a thematic analysis approach. Student responses were first coded based on recurring statements related to sources of mental effort. Similar codes were then grouped into broader themes representing cognitive load originating from the media, classification ability, or a combination of both. To improve consistency, the coding process was conducted collaboratively by the researchers through repeated review and discussion to improve consistency of interpretation.

RESULTS AND DISCUSSION

Needs Analysis

The results of interviews with Biology teachers indicate that learning the Animalia topic, particularly invertebrates, still faces challenges related to instructional media and students' cognitive and affective aspects. Teachers reported that the media used so far have not been able to direct students' attention to essential morphological characteristics, thereby increasing irrelevant cognitive load (extraneous cognitive load). To clarify the findings, the interview results are summarized in Table 1.

Table 1. Summary of the Biology Teacher Interview Results

Observed Aspect	Main Findings	Instructional Implications
Instructional media	Textbook images are too complex, labels are small, and do not focus on diagnostic characteristics.	Students have difficulty identifying key characteristics for classification.
Cognitive load	Visual information is dense and unstructured.	Increases extraneous cognitive load
Student understanding	Students tend to memorize phylum names without understanding the distinguishing characteristics.	Conceptual schema formation is not optimal.

Observed Aspect	Main Findings	Instructional Implications
Affective aspect	Some students feel fear or disgust toward certain animals.	Reduces learning interest and engagement
Media need	Simple media with clear visuals that allow students to record observation results	Supports active and focused learning

The interview findings reveal a chain of interrelated cognitive problems. This pattern can be described as follows:

Complex visual media
↓
Unfocused information
↓
Increased extraneous cognitive load
↓
Difficulties in observation and classification
↓
Superficial understanding (rote memorization)

The diagram indicates that the main problem lies not in the content itself but in the way information is visualized. As a result, students must allocate mental effort to interpreting the media display rather than to constructing conceptual schemas.

According to the teacher interviews summarized in Table 1, students often struggle to identify which body parts should be observed when studying specific invertebrate groups. This difficulty is associated with instructional media containing overly complex visuals, small labels, and insufficient emphasis on diagnostic features, making classification challenging. From a Cognitive Load Theory perspective, such dense and unstructured visual information can overload working memory and hinder meaningful learning (Sweller *et al.,* 2024; Mayer, 2024).

In addition, Table 1 reveals affective barriers, as some students experience fear or disgust toward certain invertebrates, reducing engagement. These negative emotions can further increase cognitive load by diverting attention from the learning task (Tzafilkou *et al.,* 2021). Recent research confirms that fear and disgust may heighten cognitive load and weaken learning effectiveness in biology, particularly in animal-related topics (Kaiser *et al.,* 2023).

The instructional implications in Table 1 highlight the need for media that emphasize essential morphological characteristics, minimize irrelevant details, and support active observation. These features align with cognitive load principles, particularly reducing extraneous load and fostering germane load for schema construction (Paas & Sweller, 2012). Accordingly, CLT-based notecard media grounded in Cognitive Load Theory are considered relevant and necessary to promote more focused and meaningful invertebrate learning. An analysis of students' learning needs was conducted using a KWL chart (Know–Want to Know–Learned) to map students' prior knowledge and information needs related to invertebrate topics. The focus of the analysis in this study was on the K (Know) and W (Want to Know) components as the basis for instructional media design.

Table 2. Results of the Analysis of Students' KWL Chart on Invertebrate Topics

KWL Aspect	Student Responses	Percentage (%)	Initial Interpretation
Know (K)	Invertebrates are animals without backbones.	100	Students possess basic conceptual knowledge.
Want to Know (W)	Types of invertebrates	54	Need for clear visual classification
	Other morphological characteristics	18	Need for emphasis on diagnostic features
	Reproductive methods	13	Need for conceptual enrichment
	Habitat	7.5	Contextual learning needs
	Body organs	2.5	Limited structural understanding
	Anatomy	2.5	Low awareness of internal details
	Locomotion	2.5	Minor interest

The KWL chart results show that 100% of students share the same prior knowledge, identifying invertebrates as animals without backbones. Although this indicates mastery of the general definition, the knowledge remains declarative and superficial, lacking a well-structured classification schema. In the Want to Know (W) component, most students (54%) expressed a need to learn about invertebrate types, followed by distinguishing morphological characteristics (18%).

The pattern in Table 2 suggests that students' main difficulties lie in identification and classification rather than basic concept recognition. This aligns with research indicating that learning Animalia requires strong visual–spatial and analytical skills, particularly for differentiating groups based on morphology (Mayer, 2024). Only 2.5% of students mentioned anatomy or body organs, reflecting limited awareness of structural features as the basis for classification and weakly organized schemas. From a Cognitive Load Theory perspective, insufficient prior schemas may increase intrinsic cognitive load in complex classification tasks (Sweller, 2023; Paas & Sweller, 2012).

Overall, the findings highlight the need for instructional media that structure visual information, emphasize key morphological traits, reduce extraneous load, and support active processing. Therefore, CLT-based notecard media grounded in Cognitive Load Theory are relevant and necessary to bridge declarative knowledge and practical classification skills.

Expert Validation Analysis

Expert validation was conducted to assess the feasibility of CLT-based notecard media based on Cognitive Load Theory (CLT) in terms of content, language, visual design, and usability. The evaluation was conducted using a Likert scale based instrument with a score range of 1-3, where higher scores indicate a higher level of feasibility.

Table 3. Results of Expert Validation of CLT-Based Notecard Media

Indicator	Score
Alignment with competency standards and learning objectives	3
Accuracy and current information	3
Language appropriateness for students' age	2

Indicator	Score
Attention and engagement levels	3
Ease of use (for teachers or students)	2
Technical quality	2
Absence of bias	3
Readability (font size and clarity)	2
Simplicity (clarity and design unity)	2
Appropriateness of color use	3
Total score	**25**
Category	**Moderate**

The feasibility category was determined based on the percentage of the total validation score. Scores between 81-100% were categorized as high feasibility, 61-80% as moderate feasibility, and 60% or below as low feasibility. The obtained score of 25 out of 30 (83.3%) indicates that the media were feasible for instructional use, although several revisions were still required. As presented in Table 3, CLT-based notecard media meet basic feasibility standards, particularly in content accuracy and alignment with learning objectives. Indicators related to competency alignment and the accuracy and currency of biological content received the maximum score (3), indicating conceptual soundness and the absence of misconceptions. Accurate content is essential in biology learning to prevent unproductive cognitive load and support schema formation (Mayer, 2020).

However, language appropriateness and ease of use received moderate scores (2), as some labels and instructions require simplification. Overly technical language may increase extraneous cognitive load by forcing learners to devote working memory to decoding rather than understanding key concepts (Sweller, 2024). Similarly, technical quality, readability, and design simplicity also scored 2, suggesting that improvements are needed in font size, image clarity, and visual consistency. Unclear or overly complex designs can overload working memory and reduce learning effectiveness (Krieglstein *et al.,* 2022).

In contrast, color use, engagement level, and absence of bias received high scores (3). Effective color functions as signaling to guide attention and reduce cognitive load (Fiorella & Mayer, 2015), whereas engagement supports germane cognitive load (Paas & Sweller, 2012; Sweller, 2024). Overall, the media are feasible but require revisions to simplify language, enhance readability and clarity, and improve design consistency to further reduce extraneous cognitive load and optimize learning effectiveness.

Data and Analysis of Students' Identification Results

The students' identification results were obtained from notes written on note cards after observing illustrations and photographs of invertebrates. This analysis aimed to determine the extent to which the CLT-based notecard media helped students observe morphological characteristics and perform animal classification. Students' identification records were assessed using three criteria: completeness of diagnostic morphological characteristics, accuracy of classification-related observations, and clarity of written descriptions. Responses were categorized as accurate when students correctly identified most key diagnostic characteristics, moderately accurate when only some essential characteristics were recorded, and inaccurate when observations were incomplete or conceptually incorrect. To improve scoring consistency, two raters independently

reviewed students' identification records and discussed discrepancies before final categorization.

Table 4. Results of Students' Identification of Morphological Characteristics (n = 39)

Identification accuracy category	Number of students	Percentage (%)	Criteria
Accurate	12	30.8	Main morphological characteristics were recorded completely and appropriately.
Moderately accurate	21	53.8	Some key characteristics were recorded, but not completely.
Inaccurate	6	15.4	Key characteristics are unclear or incorrectly identified.

The students' identification results show that 53.8% were in the moderately accurate category, 30.8% achieved accurate identification, and 15.4% still experienced difficulties. Error analysis also revealed recurring patterns in students' notes. As presented in Table 4, the CLT-based notecard media helped students recognize basic morphological characteristics; however, they did not consistently guide students to record complete and diagnostically relevant features. This is reflected in the dominance of the moderately accurate category compared to the smaller proportion achieving full accuracy.

The prevalence of moderately accurate responses suggests that most students understood what to observe but struggled to distinguish diagnostic traits from general features, connect visual observations to classification principles, and document findings systematically. These results suggest that the notecard media may function as initial instructional scaffolding that supports early observation and recognition, although the development of comprehensive classification schemas appears to remain limited.

Table 5. Identified Patterns of Identification Errors

Type of error	Example findings	Indicated problem
Failure to record diagnostic characteristics	Did not note the presence of segments or tentacles	Observation focuses not yet directed
Overly general characteristics	"Soft body," "lives in water."	Classification schema not yet formed
Misinterpretation of images	Interpreting pseudopods as jointed legs	Difficulty in visual interpretation
Labels not used	Ignoring labels on images	Visual readability is not yet optimal

Table 5 identifies four recurring error patterns in students' use of CLT-based notecard media. First, many students failed to record key diagnostic features, indicating limited attention to essential characteristics. Second, they frequently used overly general descriptions (e.g., "soft body," "lives in water"), suggesting weak classification schemas. Third, some image misinterpretations reflect difficulties in visual analysis. Fourth, labels were often ignored, implying that readability and visual signaling were not fully effective. Overall, although the media supported initial observation, elements of extraneous cognitive load remained, and stronger visual guidance is needed to support accurate schema formation.

Consistent with Tables 4 and 5, the most common errors involved general characteristics and the omission of diagnostic traits, such as segmentation or specialized appendages. From a Cognitive Load Theory perspective, this suggests that intrinsic cognitive load in invertebrate classification remains high, whereas extraneous load has been reduced but not optimally managed. Students could process basic features, yet working memory resources were not sufficiently directed toward germane cognitive load for constructing well-organized schemas (Paas & Sweller, 2012; Sweller, 2024). Thus, while the CLT-based notecard media reduced initial confusion and supported early observation, stronger signaling of diagnostic features and clearer instructional scaffolding are needed to promote fully accurate identification and schema development.

Student cognitive load data and analysis

Students' cognitive load was measured using the Paas Mental Effort Scale (1–9) after students completed tasks involving the identification of morphological characteristics and the classification of invertebrate animals using CLT-based notecard media. Higher scores indicate greater mental effort.

Table 6. Distribution of Students' Mental Effort Scores (n = 39)

Mental Effort Score Range	Cognitive Load Category	Number of Students	Percentage (%)
1-3	Low	16	41.0
4-6	Moderate	17	43.6
7-9	High	6	15.4
Total		**39**	**100**

Based on Table 6, most students (84.6%) experienced low to moderate cognitive load, while only 15.4% reported high cognitive load. The dominance of the moderate category, followed by the low category, indicates that CLT-based notecard media promoted active processing, such as observing visuals, selecting key morphological traits, and linking them to classification concepts without overloading working memory.

The smaller proportion of students in the high cognitive load category suggests individual differences in prior knowledge, visual strategies, and conceptual mastery. This variation is supported by the descriptive statistics in Table 7, where the standard deviation is within a moderate range, indicating differences in mental effort that are present but not extreme. From a Cognitive Load Theory perspective, low to moderate cognitive load may indicate that students were generally able to complete the learning tasks without excessive overload, as it enables learners to devote mental resources to germane cognitive load for schema construction and reinforcement (Paas & Sweller, 2012; Sweller, 2024).

Table 7. Descriptive Statistics of Mental Effort

Statistic	Value
Minimum score	2
Maximum score	8
Mean	3.875
Standard deviation	1.63

The mean mental effort score of 3.875 shown in Table 7 indicates a moderate level of cognitive load, suggesting that the task remained manageable for most students. The

findings may indicate that the notecard media helped reduce some unnecessary cognitive demands, although several students still reported difficulties related to readability and visual interpretation. However, the presence of high scores among some students indicates that elements such as label readability or limited emphasis on diagnostic features may still increase cognitive load, particularly for those with weaker classification skills (Mayer, 2020).

Based on Tables 6 and 7, CLT-based notecard media generally created a manageable cognitive load, enabling most students to complete tasks without excessive overload (David *et al.,* 2024). Nevertheless, further improvements in visual design and additional conceptual scaffolding are needed to better support students experiencing higher cognitive load (van Nooijen, 2024). Overall, the findings suggest that notecard media have the potential to support invertebrate learning.

Analysis of Student Responses

The analysis of student responses was conducted to identify the sources of cognitive load experienced by students during learning activities using CLT-based notecard media. The data were collected through an open-ended questionnaire in which students were asked to explain the main factors influencing their mental effort while identifying and classifying invertebrate animals. Student responses were analyzed qualitatively using thematic analysis. Based on recurring response patterns, student responses were grouped into three categories of cognitive load sources:

1. Cognitive load originating from the CLT-based notecard media,
2. Cognitive load originating from students' classification abilities, and
3. Cognitive load originating from a combination of media and classification abilities.

Table 8. Distribution of Student Responses Based on Sources of Cognitive Load (n = 39)

Source of Cognitive Load	Number of Students	Percentage (%)	Example of Student Response
CLT-based notecard media	24	61.5	"The text on the cards was unclear, so it took longer to think."
Classification ability	11	28.2	"I am still confused about distinguishing the characteristics of each animal group."
Combination of media and ability	4	10.3	"The images were helpful, but I still found it difficult to determine the main characteristics."
Total	**39**	**100**	

Based on Table 8, 61.5% of students identified the CLT-based notecard media as the primary source of their mental effort, particularly due to issues related to text readability, label clarity, and the need to interpret images before identifying morphological characteristics. These findings suggest that although the media may have supported observation activities and visualization processes, elements of extraneous cognitive load were still experienced by many students. Student responses further indicate that improvements are still needed in terms of font size, label clarity, image readability,

and visual signaling. Greater emphasis on diagnostic morphological features through clearer labeling, improved color contrast, and simplified visual layouts may help reduce unnecessary cognitive demands in future implementations.

Meanwhile, 28.2% of students reported that their mental effort was more strongly influenced by their own classification abilities, particularly in distinguishing diagnostic traits among invertebrate groups. This finding may indicate that the learning tasks required prior knowledge and conceptual understanding while remaining generally manageable for most students. In addition, 10.3% of students reported that their mental effort originated from both the media and their classification skills, suggesting that although the media supported visual observation, stronger conceptual scaffolding was still needed to support classification learning.

These response patterns are consistent with the Paas mental effort scale results, which showed a moderate average cognitive load. However, the predominance of responses attributing mental effort to the media suggests that extraneous cognitive load had not been fully minimized. Some working memory resources may still have been allocated to processing the media display rather than supporting classification schema construction (germane cognitive load). Therefore, the findings should be interpreted as preliminary indications that the media may support cognitive load, rather than conclusive evidence of effective extraneous load control.

CONCLUSION

This study concludes that the development of CLT-based notecard media grounded in Cognitive Load Theory (CLT) is theoretically and pedagogically justified for supporting invertebrate classification learning. Students' main difficulties stemmed from identifying and organizing diagnostic morphological characteristics rather than lacking basic knowledge, which increased intrinsic cognitive load. Expert validation confirmed that the media were scientifically accurate and aligned with learning objectives, although improvements in readability, language clarity, and visual design are needed to reduce extraneous cognitive load. The results indicate that the notecards may help students recognize important morphological features and manage mental effort effectively, as reflected by generally low to moderate cognitive load levels. Overall, the findings provide preliminary indications that CLT-based notecard learning media may help support the management of perceived mental effort during invertebrate classification learning.

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