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DESIGNING EXERCISES ACCORDING TO THE AMERICAN COLLEGE TESTING (ACT) APPROACH TO ASSESS STUDENTS' SCIENTIFIC THINKING COMPETENCE IN TEACHING THE TOPIC "ECOLOGY AND ENVIRONMENT" IN BIOLOGY GRADE 12

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Abstract. In the context of the ongoing shift from content-based to competence-based education, the development of assessment tools that validly and reliably measure student competencies has become an essential priority. This study addresses this need by proposing and operationalizing a framework for assessing scientific thinking competence, drawing on the structure of the American College Testing (ACT) approach. The framework encompasses three core components: (1) Interpretation of Data (IOD); (2) Scientific Investigation (SIN); and (3) Evaluation of Models, Inferences, and Experimental Results (EMI). The study's principal contribution lies in translating this conceptual structure into a systematic process for designing ACT-oriented assessment instruments that extend beyond factual recall to capture higher-order cognitive processes. Applying this process to the Grade 12 Biology topic "Ecology and Environment" resulted in the development of 22 item clusters, comprising 160 questions in four formats: choice, short answer, true/false, and drag-and-drop, illustrating a practical pathway for embedding competence-based assessment into science education to more effectively evaluate and promote advanced levels of student thinking.

Keywords: scientific thinking competence, American College Testing, exercises, Ecology and Environment

1. Introduction

The transition from a content-based to a competence-based teaching approach, along with objectives concretely defined based on the guiding perspectives of the Party and the State, has oriented the current education program toward helping students "master general knowledge" and "effectively apply acquired knowledge and skills in real life" [1]. In the context of rapid scientific and technological development, the ability to think scientifically has become an essential competence for students to participate effectively in evidence-based decision-making and to address real-world problems [2], [3]. Scientific thinking encompasses skills such as formulating testable questions, designing and controlling experiments, interpreting data, and constructing arguments grounded in evidence [4], [5]. These abilities not only support success in science learning but also foster transferable reasoning skills applicable across disciplines and in everyday life.

International assessments such as PISA have demonstrated that scientific thinking is a multidimensional construct involving knowledge, procedural skills, and epistemic understanding [2].

However, in many educational settings, assessments still focus predominantly on factual recall, which does not adequately capture students' capacity for scientific reasoning and problem-solving. This gap highlights the need to develop valid and reliable tools to assess students' scientific thinking abilities [6]-[8]. Moreover, one of the pressing realities that reflects the actual effectiveness of the current curriculum implementation at school and classroom levels is the limited assessment literacy of teachers, which falls short of the competence and quality development outcomes set forth [9]. Both domestic and international studies have pointed to the urgency of innovating teachers' assessment literacy, as well as their ability to access and establish philosophies and concepts regarding competence-based assessment [10]-[12]. Therefore, Vietnamese educators must update and equip themselves with appropriate knowledge and skills in assessing learners' competencies, particularly with a focus on higher-order thinking competencies.

Numerous academic studies have been conducted on students' higher-order thinking competencies. One of the earliest global approaches can be found in *Thinking about Scientific Content,* described in Max Wertheimer's *Productive Thinking* (1945) [13]. Besides, Bruner (1956) and Wason (1968) conducted several studies about the second type of scientific thinking, "collections of general-purpose processes operating on complex, abstract, components of scientific thought" [14]. Lehrer and Schauble (2006) linked scientific thinking to scientific literacy and proposed three main approaches: (1) *Science-as-logical reasoning*, focusing on universal reasoning methods such as formal logic, heuristics, and applied strategies; (2) *Science-as-theory change*, highlighting the dynamic and evolving nature of science; and (3) *Science-as-practice*, viewing scientific knowledge and reasoning as part of a broader system that includes participation rules, empirical skills, and epistemological understanding [15]. These approaches provide an important foundation for defining and developing the theoretical framework of scientific thinking competence in contemporary research.

However, research specifically on scientific thinking competence reveals that approaches, competence frameworks, and assessment tools in Vietnam remain limited [8]. In general, scientific thinking competence in Vietnam can be approached in two ways: (1) indirectly, through related higher-order thinking competencies; and (2) directly, through focused research on scientific thinking competence itself. For the first approach, several representative studies on critical thinking by Pham Thi Phuong Anh et al. (2024), Nguyen Hai Thanh et al. (2021), and Nguyen Thi Bich (2025) have demonstrated that fostering students' critical thinking in the process of assessing real-world problems serves as a foundation for developing aspects of scientific thinking competence. This involves operations such as information seeking, evidence gathering, and reasoning [16]-[18]. In terms of direct approaches, Nguyen Nhu Tho (2002) highlighted the relationship between philosophy and the development of students' scientific thinking in the early 2000s [19]. Furthermore, the research group led by Vu Thi Thu Thuy et al. (2022) argued that developing students' scientific thinking competence requires immersing them in authentic contexts where they experience the operations of real scientists [20]. Notably, the research by Nguyen Thi Lam Quynh et al. (2024) is one of the few studies that delves deeply into the assessment of students' scientific thinking [8]. Based on theoretical grounds for levels of cognitive operations, and standardized international exams (e.g., ACT), the research team proposed a process for designing items (questions) to assess scientific thinking competence and criteria for evaluating such items. This illustrates the emerging research efforts on assessing scientific thinking; However, clarification of the competence framework, component competences, and especially indicators for concretizing and quantifying scientific thinking competence through item clusters has not yet been deeply and thoroughly investigated.

The American College Testing (ACT) is a standardized test designed to evaluate students' readiness for college-level education. The ACT comprises four sections: English, Mathematics, Reading, and Science. In the Science section, test-takers are presented with real-world problems in the role of actual scientists and are required to demonstrate scientific thinking competencies, such as analyzing data trends/graphs, interpreting experiments/models, reasoning, and evaluating conclusions based on experimental evidence [21], [22].

However, the ACT is composed entirely of multiple-choice items. Therefore, the item sets designed in our study include additional formats such as true/false, short answer, and drag-and-drop items. To optimize the assessment of scientific thinking skills according to the ACT, it is necessary to integrate various item formats to meet the core objectives. Specifically, True/False questions allow for a direct assessment of conceptual understanding and reasoning ability; Short-answer questions activate the process of active recall [23], while Drag-and-drop questions help measure the ability to classify, organize, and establish relationships between scientific information [24]. This combination not only enhances content validity and reduces format bias but also provides more authentic evidence of a student's scientific thinking competence.

Ecology and Environment is one of the topics inherited, revised, and expanded in the 2018 General Education Curriculum. The topic provides a particularly appropriate context for fostering students' scientific thinking competence because it inherently involves the collection, analysis, and evaluation of empirical data related to interactions within ecosystems. Moreover, integrating socio-scientific issues (SSI) such as climate change, biodiversity loss, and pollution into ecology instruction has been found to not only increase student engagement but also improve evidence-based reasoning and environmental citizenship [25]. These characteristics make Ecology and Environment an ideal foundation for designing ACT-style assessment tasks that authentically measure and develop scientific thinking competence.

Based on the above analysis, our study seeks to analyze the theoretical foundation for the scientific thinking competence framework aligned with the ACT. From that foundation, a procedure for designing item clusters was proposed to assess this type of competence; thereby, a set of such item clusters and test matrices with specific indicators was developed.

2. Content

2.1. Research subject and method

**** Research subject***

The research subjects include the following components: ACT-oriented exercises for assessing the scientific thinking competence; the scientific thinking competence framework according to the ACT approach; the process of designing the ACT-oriented exercises for assessing the scientific thinking competence; and the relationship between the designed items and scientific thinking competence indicators in the ACT framework.

**** Research method***

This study employs a theoretical research approach by searching for scientific literature to systematize and concretize the theoretical foundations related to the concept and structural framework of scientific thinking competence, the structure and characteristics of ACT-oriented exercises, and the process of designing ACT-oriented exercises to assess scientific thinking competence aligned with the ACT framework.

2.2. Scientific thinking competence according to the ACT approach

2.2.1. Concept of scientific thinking competence

**** Competence***

Eraut, M. (1998) argues that competence is "the ability to perform the tasks and roles required to the expected standard" [26]. According to Dang Thanh Hung (2012), competence is "a personal attribute that allows individuals to successfully perform certain activities, achieve desired results under specific conditions" [27].

The 2018 General Education Curriculum defines competence as follows: "Competence is an individual attribute that is formed and developed through available qualities and the process of learning and training, allowing people to mobilize and synthesize knowledge, skills and other personal attributes such as interest, beliefs, willpower, etc., successfully carry out a certain type of activity, achieve the desired results under specific conditions" [28].

* ***Scientific thinking competence***

Kuhn (2010) highlighted the systematic nature of the conceptual approach to scientific thinking, asserting that scientific thinking is not merely a collection of discrete skills employed by an individual to solve a problem. Rather, it is a systematic process of knowledge-seeking through cognitive strategies aimed at analyzing, comparing, and adjusting one's own understanding in light of empirical evidence [5]. According to Vázquez-Parra et al. (2022), scientific thinking is a constituent competence within the macro-competence of complex thinking. This complex thinking emphasizes the importance of other higher-order thinking competencies such as critical thinking, innovation, and systems thinking [29].

Based on these orientations, the ACT exam assesses scientific thinking competence by measuring the ability to reason, analyze data, and solve problems in scientific contexts, rather than by requiring the reproduction of knowledge. The content of the test does not require in-depth knowledge of science subjects; however, background knowledge in high school science subjects may be necessary to answer some questions. Therefore, the test emphasizes scientific reasoning skills rather than recalling scientific content, math skills, or reading comprehension skills [22].

2.2.2. Scientific thinking competence framework according to the ACT approach

In studying the ACT scientific thinking competence framework, we referred to and reorganized the structure of scientific thinking competence based on the indicator system published by ACT [30]. This framework includes the following core competences: (1) Interpretation of Data - IOD; (2) Scientific Investigation - SIN; and (3) Evaluation of Models, Inferences, and Experimental Results - EMI. Additionally, each core competence is further broken down into specific component competencies. A schematic representation of the scientific thinking competence framework as guided by the ACT is presented as follows:

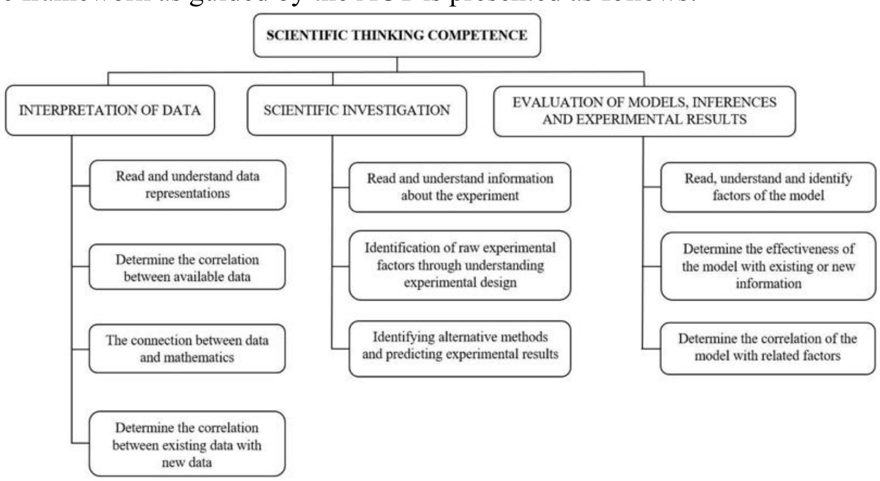


Figure 1. Component competence framework of ACT-oriented scientific thinking competence

The component tests within the ACT examination are assessed based on different levels of cognitive complexity using Depth of Knowledge (DOK) levels, including DOK 1, DOK 2, and DOK 3. These levels are described in Table 1.

Table 1. Descriptions of depth of knowledge (DOK) according to the ACT approach

DOK	Level Description
DOK 1	Defining location, recall, and/or reproduction of information.
DOK 2	Processing presented information and applying skills and knowledge. Students usually have to process one or two cognitive steps.
DOK 3	Applying higher-order thinking, such as analysis and evaluation, and using evidence to prove reasoning. Students often have to deal with multiple cognitive steps, and overall tasks tend to be complex and abstract.

2.3. Designing the ACT-oriented exercises to assess students' scientific thinking competence in teaching the topic of Ecology and Environment in Biology grade 12

2.3.1. Structure and features of the ACT scientific thinking assessment exercises

The structure of the tests in the ACT examination is designed according to a strictly regulated format. Each test includes: (1) an *information section*, comprising the test title, time allotted, number of questions, and test instructions; (2) an *item (question) section*, which consists of several item clusters or a combination of independent items and item clusters.

An analysis of the test, which was an official release, coded as Form A09, was conducted [31]. The Science test is structured into item clusters called *Passages*, numbered by Roman numerals. Each Passage is organized into two parts: (1) *scientific information*; (2) *a set of items*.

(1) The scientific information section is designed in one of three distinct formats: Data Representation, Research Summary; and Conflicting Viewpoints.

(2) The Science test does not specify a fixed number of passages and items within each Passage. Each item is designed to assess one of three specific scientific reasoning skills: Interpretation of Data (IOD); Scientific Investigation (SIN); Evaluation of Models, Inferences, and Experimental Results (EMI).

For the item section, the multiple-choice item is designed to include the following components: item number, stem, and options. The stem presents the main context that students need to process; it often includes a scenario, assumption, or specific task. The options consist of several answer choices, typically four (A, B, C, D), of which only one is correct. Each item also targets a specific scientific thinking competence. For example, in Item 11 illustrated below, the assessed competence is Interpretation of Data (IOD).

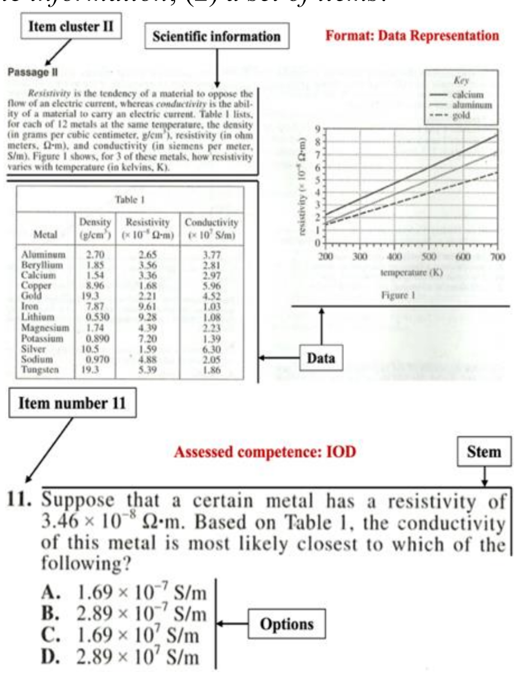


Figure 2. Description of the scientific information and item

From the analysis of the structure of the ACT Science Test (Form A09), it can be seen that ACT-oriented exercises are characterized by three main features:

(1) Higher-order thinking: The test not merely requires learners to recall or name scientific terms/events, but also demands that learners apply their scientific knowledge in combination with cognitive processes such as analysis, comparison, etc.

(2) Practical context: The competence-based assessment exercises require the person designing the exercise to put students in a real-life situation, and learners are required to mobilize all skills and knowledge to solve or propose the optimal solution to the problem.

(3) Data-based reasoning: The ACT Science Test presents learners with various forms of scientific information, such as graphs, tables, or experimental results, ensuring that students not only understand scientific content but also develop essential skills in reasoning with evidence.

2.3.2. The process of designing the ACT-oriented exercises to assess students' scientific thinking competence

Based on the process of designing the exercises for assessing scientific thinking competence proposed by Nguyen Thi Lam Quynh et al. (2024) [8], and in alignment with key principles for designing competence-based assessment exercises according to the ACT approach, which include: (1) Structurally: Thematically linking item clusters; (2) Ensuring the accuracy of scientific information; (3) Exploiting the ability of scientific analysis and reasoning; (4) Balancing between types of scientific competence assessment items; (5) Minimizing the requirement for complex calculations, the following process of designing ACT-oriented exercises for assessing scientific thinking competence according to the ACT approach has been developed.

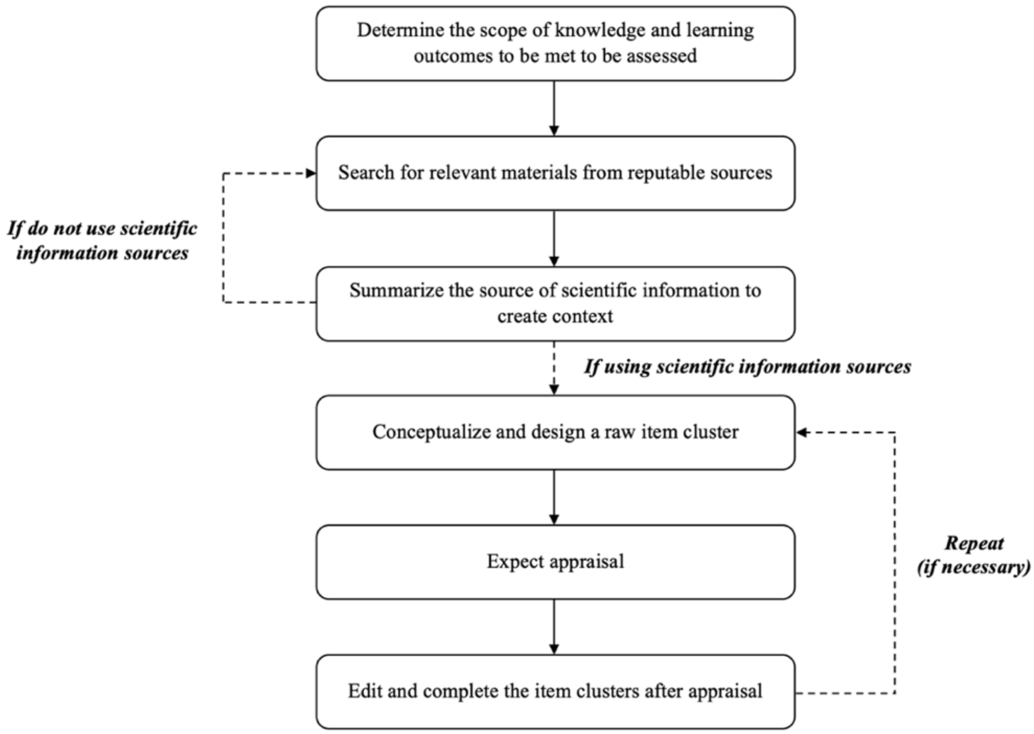


Figure 3. The process of designing items/exercises to assess scientific thinking competence

Step 1. *Determine the scope of knowledge and learning outcomes to be met for assessment.*

Educators need to determine the learning outcomes to be achieved based on the 2018 General Education Curriculum (Ministry of Education and Training). The determination of knowledge and learning outcomes aims to limit the content used to design the system of items and exercises.

Step 2. *Search for relevant materials from reputable sources*

The designer needs to look for relevant materials from reputable scientific sources (e.g., Google Scholar, National Geographic, Science Direct) or some reputable scholarly books (e.g., Elements of Ecology, 9th Edition, Global Edition by Robert Leo Smith and Thomas M.

Smith; Ecology: Concepts and Applications, 8th Edition, by Manuel C. Molles Jr.), ensuring the accuracy and objectivity of the exercises. The selection of relevant documents needs to ensure that the scientific information from the documents is associated with the content of knowledge and meets the learning outcomes that have been determined in *step 1*.

Step 3. *Summarize the source of scientific information to create context*

After collecting the documents, the designer needs to summarize the scientific sources to create a context for designing the items. This stage helps to select important information from experiments or from paper data and conclusions. If the designer does not use the summarized scientific information source, they need to repeat *step 2* until a suitable source for the learning outcomes and pedagogical purpose of the designer is found. On the contrary, if they have chosen the right source, they need to store and summarize it in a clear and accurate format, ensuring that they do not distort hypotheses or conclusions. The choice of scientific text format also contributes to assessing students' scientific thinking competence, because each format requires different thinking skills. There are 3 main formats: Data Representation (reading tables, charts), Research Summary (reviewing and drawing conclusions from experiments), and Conflicting Viewpoints (analyzing and comparing different hypotheses).

Step 4. *Conceptualize and design a raw item cluster*

After the designer has chosen the scientific text format, the designer needs to build an idea and design a raw item cluster. First of all, the scientific information needs to be processed by the designer for assessment purposes in accordance with the scope of knowledge and learning outcomes to be achieved. Next, the design of the raw item cluster is considered an important step in transforming scientific information into applicable items, suitable for the format of multiple-choice questions, including: (1) Multiple choice; (2) Short answer; (3) True/False; and (4) Drag-and-drop.

Step 5. *Expert appraisal*

After designing the raw item clusters, the designer needs to send the system of items and exercises to experts in the field of Education and Basic Sciences corresponding to the selected scope of knowledge in order to evaluate the accuracy of the content. Moreover, to evaluate the quality of the exercise system, a consultation questionnaire for experts was proposed by Nguyen Thi Lam Quynh and Nguyen Van Bien (2024) [8]. The set of criteria consists of two types: one for evaluating the scientific information and another for evaluating the item clusters.

Step 6. *Edit and complete the item clusters after appraisal*

After evaluation, if the raw item cluster fully meets the criteria of item format, pedagogical purposes, and professional accuracy, the designer needs to revise and finalize the item cluster. If the item cluster after evaluation does not meet the above criteria, the designer needs to repeat *steps 4* to *6* until the items and exercises are completed in both form and content.

2.3.3. Illustrative example for the process of designing the ACT-oriented exercises in the topic "Ecology and Environment" in Biology Grade 12

To clarify the steps in the process of designing the ACT-oriented exercises for assessing students' scientific thinking competence, we analyze the following example:

Step 1. *Determine the scope of knowledge and learning outcomes to be met for assessment*

- Scope of knowledge: Ecological niches and the role of competitive relationships in the formation of ecological niches.

- Learning outcomes: (1) Present the concept and distinguish the relationships between species in the community in the biological community; (2) Present the concept of ecological niche and the role of competition in forming ecological niche; (3) State hypothesis and conclusion, controlled variables of the experiment; (4) Analyze and evaluate the survival strategies of competing populations.

Step 2. *Search for relevant materials from reputable sources*

Search for relevant documents that meet the knowledge scope in *step 1*, including: competitive relationships between populations in the community; the correlation between the relationship of competition and the formation of ecological niches. In the analyzed example, the source of the article on the topic was found on the Science Direct website.

Step 3. *Summarize the source of scientific information to create context*

The scientific information section was based on Ghoul and Mitri's article (2016), which was analyzed by reviewing the title, abstract, and major findings. Key results describing distinct survival strategies of microbial populations were synthesized with representative experimental evidence. Relevant figures and datasets were adapted to fit the intended ACT-oriented assessment format. All extracted information was systematically organized to ensure coherence between the scientific information section and the cognitive objectives of the designed exercises.

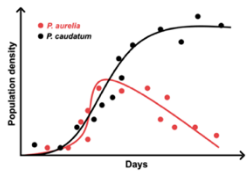
Step 4. *Conceptualize and design a raw item cluster*

A part of the exercise after design, appraisal, and revision is illustrated below:

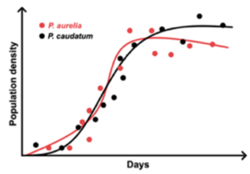
Table 2. Example of the design process of item cluster IX

CLUSTER IX: DIFFERENT FORMS OF COMPETITION BETWEEN MICROBIAL POPULATIONS
Microorganisms interact with each other in a variety of ways in their habitat. Inevitably, over time, this specialization reduces direct competition between microbial populations. The three experiments below describe the different forms of competition among microorganisms. - *Experiment 1:* In Gause's classic experiment, two species of *Paramecium* bacteria (*P. aurelia* and *P. caudatum*) were kept together in a test tube with a limited food source. Over time, *P. Aurelia* has dominated and extincted *P. caudatum*. When kept separately, both species have good growth capacity. - *Experiment 2:* In the microbial community in tree hollows, competing bacterial species have begun to use organic compounds or competitor waste products as their primary resource. Some species specialize in decomposing rotten leaves, while others use metabolites produced by rivals. - *Experiment 3:* In a study of populations of *Pseudomonas fluorescens* cultured in test tubes, the researchers observed that some bacteria formed biofilms in both liquid and air environments, while others lived in a liquid environment or gathered at the bottom of the test tube. The results of competition over time between microbial populations are described on two main scales: diversity and stability. Overall, competition is predicted to lead to a decrease in diversity at the local scale and an increase in ecological stability. Three widely accepted ecological stability outcomes are as follows: - *Result 1:* Strains coexist by occupying different niches, each specializing in a type of resource. - *Result 2:* Less competitive strains became extinct, while other strains dominated the community. - *Result 3:* Strains separate into different spatial niches or areas. *(Source: Ghoul M, Mitri S. The Ecology and Evolution of Microbial Competition. Trends in Microbiology. 2016 Oct; 24(10):833-845)*
Item 1 *– SIN (DOK 1):* Based on the information of experiment 1, fill in the appropriate words/phrases in the blanks below to represent the independent variable and the dependent variable in the experiment. Independent variables: [1]; Dependent variables: [2]. ***Item 2*** *– IOD (DOK 3):* Which of the following charts is suitable to describe the competition in the conditions of limited life resources of two species of bacteria when co-cultured in experiment 1?

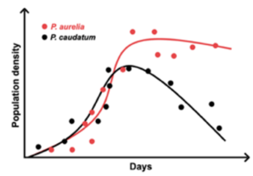
A.



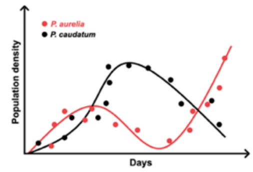
B.



C.



D.



***Item 3** – EMI (DOK 2):* In experiment 2, the main survival strategy of bacteria is

A. Using competitors' waste products as their main food source, making these bacteria no longer able to grow independently.

B. Coexisting by occupying different sources of life, each specializing in a type of resource.

C. Using the organic compounds of the surrounding environment to produce energy on its own, without the involvement of other species.

D. Relentlessly competing for access to rival metabolic products, causing the decline of most species in the community.

***Item 4** – EMI (DOK 1):* Based on the information from experiment 3, which of the following is likely to be the factor that bacterial populations have evolved to survive together?

A. Dividing food sources. B. Formation of biofilms.

C. Monopolizing space. D. Distinguishing the physical properties.

***Item 5** – EMI (DOK 2):* Fill in the numbers 1, 2, and 3 corresponding to the results 1, 2, and 3 to match the survival strategy used by the microorganisms in experiments 1, 2, and 3.

Experiment 1: [...]; Experiment 2: [...]; Experiment 3: [...].

***Item 6** – EMI (DOK 2):* Figure 4 describes the competition of microbial populations at the start of a hypothetical community. Suppose this microbiome exists according to the survival strategy of dividing and monopolizing a living space. Over time, which of the following diagrams is appropriate to describe the distribution of the above microbiomes?

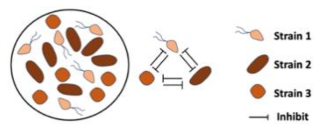
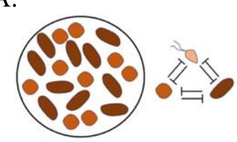
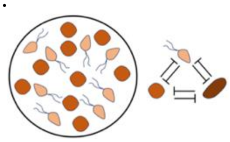


Figure 4. Microbial populations at the beginning of the biome

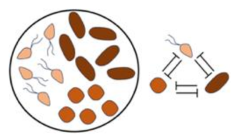
A.



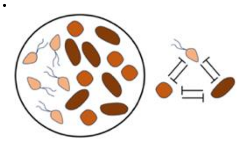
B.



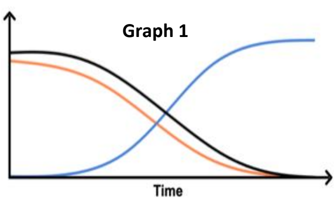
C.

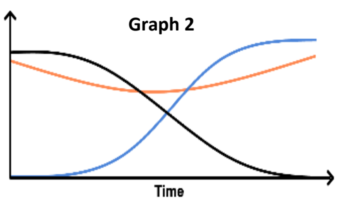


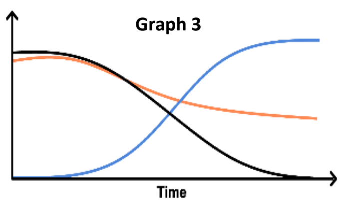
D.



***Item** 7 – EMI (DOK 3):* Suppose there are three existing microbial biomes corresponding to the three strategic types described in results 1, 2, and 3. A scientist wants to represent three factors: (1) diversity (orange line); (2) ecological stability (blue line); and (3) competitiveness (black line) over time on the same graph. Fill in the number of the graph (1, 2, or 3) in the blank space corresponding to each of the strategy types 1, 2, and 3 (corresponding to results 1, 2, and 3) described.







Type 1: [...]; Type 2: [...]; Type 3: [...].

Based on the process, the ACT-oriented exercise system was designed, including 22 item clusters and totaling 160 items: 104 multiple-choice items, 20 true/false items, 29 short-answer items, and 7 drag-and-drop items. The exercise system is accessible via the QR code provided. Each cluster is titled as follows:

Figure 5. Titles of designed item clusters

No.	Title	No.	Title
1	Self-thinning in plants	12	Elaiosomes and the mechanism of particle dispersion by ants
2	G. F. Gause's research on competitive relations	13	Some biological and ecological characteristics of *Luthrodes pandava* pests on Wantue trees planted in Vinh city, Nghe An province
3	Competition for Caterpillars: Parasitic Flies and Bees	14	Ecological Succession - Opposing Theories
4	Effect of *Trichoderma spp.* on the absorption capacity of N, P, K and the quality of pineapple grown on alum soil in Hau Giang province	15	Leaf Area Index (LAI) and the correlation between LAI and ecosystem
5	Effect of day and night pollination on the successful reproduction of yellow flowers	16	The relationship between the identity of predators and their prey
6	General Pollination System and Protection of Local Species from *Solidago Canadensis* Invasion	17	The Effect of Water Temperature on the Relative Competitiveness of Three Fish Species Exhibiting Vertical Substitution in Rocky Mountain Streams
7	Effect of pepper extract (*Capsicum frutescens*) on red spider mites (*Tetranychus urticae*) plant damage	18	Ecological relationship between *Callinectes sapidus* and *Zostera marina*
8	Feeding behavior of wood rats	19	Correlation between beak size and particle size for Finch species
9	Different Forms of Competition Between Microbial Populations	20	Fundamental ecological niche and actual ecological niche
10	Effect of planting density on growth, yield and economic efficiency of two sweet potato varieties (VD1 and KLR3)	21	Theory and empirical results of the predator-prey relationship model
11	Diversity of insect composition in Can Gio mangrove forest, Ho Chi Minh City	22	Flow of matter in the community ecosystem

2.3.4. The expression of competence in the item system

To clarify the scientific thinking competence assessed through the item system, each item in item cluster IX was analyzed to determine its type of competence and the expression of competence within the competence framework as guided by ACT. Below is a detailed description:

Table 3. The expression of competence in item cluster IX

Item	Competence	Expression of competence
I.1	SIN	Understand a simple experimental design
I.2	IOD	Translate information into a table, graph, or diagram
I.3	EMI	Identify implications in a model
I.4	EMI	Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text.
I.5	EMI	Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with two or more data presentations, models, and/or pieces of information in text.
I.6	IOD	Determine which models imply certain information
I.7	EMI	Determine whether the presented information, or new information, supports or contradicts a complex hypothesis or conclusion, and why

3. Conclusions

Scientific thinking competence has been widely studied and developed by education systems around the world, particularly through standardized exams such as the ACT. This paper proposes a scientific thinking competence framework aligned with the ACT orientation; outlines a six-step process for constructing an exercise system; provides an analysis of the designing process and competence expression through item cluster IX. Based on that, a set of 160 items was developed across four different formats (multiple choice, short answer, true/false, and drag-and-drop).

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