

# Research on the Construction of Content Parameters for Analyzing Contextualized Biology Examination Questions in Senior High School

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## Abstract

At present, the reform of the college entrance examination is continuously developing in the direction of contextualized examination questions. High school contextualized biology examination questions are the focus of the test center researchers and biology teachers. However, there is still no systematic analysis theory on how to effectively analyze the internal characteristics of high school contextualized biology examination questions. The content parameters in Roegier's situation typology can reflect the internal characteristics of the situation. Therefore, based on the content parameters of Roegier situation typology, this study determined the content parameters of the high school biology contextualized examination questions by conducting an expert questionnaire survey, in order to provide an analytical theory for the research of high school biology contextualized examination questions.

## Keywords

High school biology; Contextualized examination questions; Content parameters.

## 1. Research Background

"Contextualization " is the carrier of college entrance examination, bearing the content and requirements of examination. Deepening the analysis and research of high school biology contextualized test questions is of great significance to promoting the college entrance examination to play the functions of morality and talent cultivation, service selection and teaching guidance. When reviewing relevant literature on the study of biological contextualized examination questions, the author found that most of the researchers' analysis of the contextualized examination questions started from the context type, context material and examination content, and there was a lack of systematic theory on the analysis of biological contextualized examination questions. How to effectively analyze high school biology contextualized examination questions is worth further study.

## 2. Theoretical Basis and Definition of Related Concepts

### 2.1. Theoretical Basis

#### 2.1.1. Situation Typology

Belgian scholar Xavier Roegier, based on the principle of integrating academic acquisitions, quantitatively analyzed teaching contextualization, and proposed a theory and tool "situation typology" for analyzing problem contextualization. According to Roegier, problem situation refers to a group of background information to be connected by a certain person or group of people in order to complete a certain task [1]. Roegier emphasizes the integration of academic acquisition into complex situation and the ultimate goal of developing students' abilities, which coincides with the goal of cultivating students' core qualities in China.

Situation typology provides context designers with reference points to construct context and helps context users to reposition context. Therefore, this study takes situation typology as the theoretical basis. The first-level dimensions of situation typology proposed by Roegier include: identification parameters, content parameters, and dressing parameters. The content parameter refers to the internal characteristics of the situation when students solve the problem context, mainly including the knowledge, ability, attitude and so on. The specific dimension division and description of content parameters are shown in Table 1.

**Table 1.** Dimensional division of content parameters in Roegier situation typology

First dimension	Secondary dimension	Description of secondary dimension
Situation typology	The goal pursued	From the knowledge acquired in the context, the learning goals pursued and the ability to refer, the situational goals can be divided into: divergent or explicit, implicit or explicit, intermediate or final.
	The knowledge, skills, and attitudes used	The same or different knowledge, skills and attitudes mobilized in different situations.
	Usage instructions	Methods for solving problem situations are divided into: known methods; known but yet to be specified methods; and yet to be created methods.
	Independence of the problem	To prevent students from making mistakes on the same problem or the steps to solve the problem, the problems are divided into: problems that are completely independent of each other, problems that are partially interdependent, and problems that are completely interdependent.

## 2.2. Definition of Related Concepts

### 2.2.1. Situation

In the field of college entrance examination evaluation, context refers to the true problem background and the field of activity centered on the problem or task[2]. In the field of curriculum and assessment, because of the particularity of teaching activities and assessment activities, context can be divided into teaching context and examination questions context[3]. The context of this study refers to the examination questions context, which includes not only the background material of the examination questions but also the task context of the examination questions.

### 2.2.2. Contextualized Biology Examination Questions

Du Mingrong believes that the contextualization of examination questions means the integration of examination questions with real problem situations, combining knowledge examination with practical problem solving[4]. According to Wu Yangshuo, contextualized examination questions refer to examination questions compiled on the basis of situations, which are based on materials from real life, and have operational characteristics such as active material presentation and strong openness[5]. From the perspective of discipline, different disciplines have different definitions of contextualized examination questions. The biological contextualization examination questions in this study refer to the objective life phenomena in nature or life, and the life activities in nature or social production as the background, and examine the students' use of biological knowledge and key abilities to solve contextualized tasks.

## 3. Research Contents

Content parameters can reflect the internal characteristics of the contextualized examination questions, including the necessary knowledge, task types and test requirements. Based on

Roegier 's situation typology, this study reconstructed the dimensions of content parameters according to the characteristics of biology discipline, the level of academic quality in curriculum standards and the examination requirements of the college entrance examination evaluation system. Conduct empirical research on the initially constructed content parameters through expert questionnaires to ensure the rationality, scientificity and accuracy of the division of dimensions and indicators. The reconstruction of content parameters suitable for high school biology contextualized examination questions is conducive to the comprehensive research and analysis of the internal characteristics of examination questions.

### **3.1. Construction of Content Parameter of High School Biology Contextualized Examination Questions**

In the situation typology, some dimensions of content parameters are blurred, and some dimensions are subjective, so it is necessary to reconstruct the dimensions of content parameters in order to apply them to the analysis of examination questions. According to the curriculum standards and the evaluation system of the college entrance examination, this study re-integrated the two dimensions of the goal pursued and the knowledge, skills, and attitudes used attitude to form the dimensions of module of knowledge and examination requirements. The usage instructions dimension is difficult to control in the analysis of examination questions and is not suitable for this study, so this dimension is deleted. The dimension of question independence is too general. In order to highlight the specificity of this dimension, this dimension is modified into the degree of combination of question and situation. Therefore, the dimensions of analyzing the content parameters of high school biology contextualized examination questions include module of knowledge, the task type of the context, the degree of integration between the question and the context, contextual task openness, and the examination requirements.

#### **3.1.1. The Index Composition of the Dimension of Module of Knowledge**

The curriculum standards stipulate that compulsory modules include "Molecules and Cells" and "Genetics and Evolution"; optional compulsory modules include "Homeostasis and Regulation", "Biology and Environment" and "Biotechnology and Engineering"[6]. Among them, the knowledge test scope of the college entrance examination biology questions involves compulsory modules and optional compulsory modules. Therefore, this study divides the dimension of module of knowledge into single module and multiple modules. Single module means: when solving problem contexts, the biological knowledge that needs to be applied involves only one module of compulsory and optional compulsory courses. Multi-module means: when solving problem contexts, the biological knowledge that needs to be applied involves multiple modules in compulsory and optional compulsory courses.

#### **3.1.2. The Index Composition of the Dimension of the Task Type of the Context**

Contextualized examination questions are composed of three elements: question idea, background material and situational task. The contextualized task is to provide students with a problem to be solved. By designing specific tasks, a problem space or barrier between known conditions and a target state is constructed [5]. When setting the task of contextualized examination questions, the proposer mainly selects the appropriate command words to make the students clear the test intention of the test questions and the direction of answering. This study summarizes the instruction words of the 2021 Chinese college entrance examination biology contextualized examination questions, classifies and summarizes them according to the task category, and summarizes the contextual task types as: biological phenomenon identification, diagram analysis and generalization, and exploring biological mechanisms, predicting the results. Biological phenomenon identification refers to: using the necessary knowledge of biology to identify and judge the biological phenomena or laws presented in the examination question context. Graphical analysis and generalization means: based on the

physical diagrams, change graphs and statistical tables presented in the examination question, summarize the key information from them, and apply the knowledge of biology learned to answer the questions by combining the known conditions given in the examination question context. Exploring biological mechanisms means: after acquiring ideas or methods of inquiry or steps from an inquiry-type question context, being able to clarify the reasons for the experimental results or refine the process of inquiry. Predicting the results means: predicting or inferring the results of an experiment based on the biological phenomena, experimental protocols, and investigations described in the examination question context.

### **3.1.3. The Index Composition of Questioning and Contextual Integration Dimension**

According to the degree of integration of questioning and context, it was divided into three indicators: separation, relevance, and integration. Separation means that the questions are context-independent, and students can use their existing knowledge to answer directly in the absence of context. Relevance means: the context presents the background information of the question, and students need to get the relevant information from the context to solve the problem with their biological knowledge. Combination means that students must learn and internalize the information provided by the context if they are to solve the problem, and reorganize what they have learned about biology with the new information obtained in the context.

### **3.1.4. The Index Composition of Contextual Task Openness Dimension**

The division of the contextual task openness dimension focuses on the solution of the contextual task; therefore, this study classifies the task context of biology test questions into closed and open contexts. Open contexts allow students to use different ideas and methods to solve problems with their own perspectives and attitudes according to the range of answers deployed in the contextual task; closed contexts have a unique final solution answer and are more restrictive for students to solve problems.

### **3.1.5. The Index Composition of the Dimension of the Examination Requirements**

The basic indicators constructed by the examination requirements in the college entrance examination evaluation system can evaluate the level of students' literacy, and also effectively evaluate the quality of college entrance examination questions. The assessment function of the examination requirements lies in the rational selection or creation of contexts based on basic, comprehensiveness, applicability and innovation, and triggering students' academic performance in the corresponding contexts. Therefore, the examination requirements in the college entrance examination evaluation system can be used as one of the content parameters to analyze the biology contextualized examination questions. Basic means creating the most basic and simple problem context-as a vehicle to test the basic knowledge, principles and methods of biology. Comprehensiveness refers to the complexity of the problem situation, which requires students to apply basic biological knowledge and methods to explain life phenomena and solve experimental investigation problems. Applicability means that the context is close to daily life and social development, and students can comprehensively apply their knowledge of biology to solve practical problems; in the experimental context, they can apply the research ideas and methods of scientists and propose experimental solutions. Innovation means that the context is exploratory or open, the contextual material is novel or unfamiliar, the way the test task is presented or the way the questions are asked is novel, and students can combine their knowledge of biology to make new explanations of life phenomena and propose new ideas or new methods in experimental investigations.

### 3.2. An Agreement Survey on the Content Parameter of High School Biology Contextualized Examination Questions

The content parameters of the high school biology contextualized examination questions initially constructed in this study are inevitably unreasonable in the construction process due to subjective judgment, such as the division of individual secondary dimensional indicators. In order to avoid the above situation and to ensure that each indicator in the content parameters has clear directionality, reasonableness of division and accuracy of indicator description, etc., this study uses expert questionnaires for empirical research.

In this study, the expert questionnaire was designed using the tabulation principle of the Likert 5-point scale, and the theoretical basis of the construct content parameters and the indicators and indicator descriptions of each dimension were presented in the questionnaire to facilitate the respondents' understanding. For each group of dimensional indicators, five levels of agreement were set: "completely disagree", "relatively disagree", "average", "relatively agree", and "completely agree", corresponding to scores of 1, 2, 3, 4, and 5 respectively. After drawing up the questionnaire questions, the final expert questionnaire was formed after repeated revisions and refinements.

In order to enhance the credibility of the questionnaire, the survey was mainly directed to front-line teachers of high school biology, teachers of examination proposing institutions, and teachers of universities. A total of 30 questionnaires were distributed, 29 were collected, 29 were valid, and the recovery rate was 96.7%. Among the 29 experts who participated in this survey, 23 were front-line teachers of high school biology, 2 were teachers of examination proposing institutions engaged in proposing questions for college entrance examinations, and 4 were university teachers involved in biology education and teaching research. The basic information of the experts, such as their teaching years (working years) and titles, is shown in Tables 2 and 3 below.

**Table 2.** Teaching experience of experts

Teaching experience	Under 5 years	5 to 10 years	11-15 years	Over 15 years
Experts (number)	2	1	2	24

**Table 3.** Expert titles

Title	Senior Teacher (Secondary school)	Associate professor	Professor	Lecturer
Experts(number)	24	2	1	2

## 4. Research Results

### 4.1. Analysis of Questionnaire Results

This study used SPSS23.0 software to analyze the data from the questionnaire results, and the results are shown in Table 4. Reliability refers to the stability of the data measured by the questionnaire survey. The value of Cronbach's alpha coefficient of this questionnaire survey is 0.811, which is greater than 0.8, indicating that the results of this questionnaire survey have high reliability, and the results have reliability and validity. Validity is the degree of respondents' agreement measured by the questionnaire. KMO (Kaiser-Meyer-Olkin) is the number of sampling fitness measures, and the KMO value of this questionnaire is 0.619, which is greater than 0.6, indicating that there are common factors among the variables and each variable is suitable for factor analysis. The Bartlett's sphericity test value of 104.583 (with 45 degrees of freedom) reached a significant level of 0.05, allowing the rejection of the null hypothesis between the variables. The significance probability value of 0, which is less than



0.05, indicates that the variables in the questionnaire are significantly correlated and suitable for factor analysis.

**Table 4.** Reliability and validity of the questionnaire results

Cronbach's alpha	KMO		0.619
	Bartlett's sphericity test value	Approximate cardinality	104.583
Degree of freedom		45	
Significance		0	
0.811			

Statistical analysis of the scores of each dimensional indicator of the content parameters (Table 5) revealed that the score of each dimension was above 4, which indicated that the experts agreed more on the division of each dimensional indicator; secondly, the coefficient of variation of each dimension was less than 15%, which indicated that the experts disputed less on each dimensional indicator.

**Table 5.** Survey of indicators for each dimension of content parameters

Dimensionality	Average value	Standard deviation	Coefficient of variation
Module of knowledge	4.52	0.509	11.3%
Task type of the context	4.45	0.506	11.4%
Questioning and contextual integration	4.48	0.509	11.4%
Contextual task openness	4.31	0.471	10.9%
Examination requirements	4.59	0.501	10.9%

#### 4.2. Content Parameters for Analyzing Contextualized Biology Examination Questions in Senior High School

Based on the results of the questionnaire, the content parameters for analyzing contextualized biology examination questions in senior high school were finally determined, as shown in Table 6.

**Table 6.** The content parameters for analyzing contextualized biology examination questions in senior high school

Content parameters	Dimensionality	Indicators
	Module of knowledge	Single module Multiple modules
Task type of the context	Biological phenomenon identification	
	Diagram analysis and generalization	
	Exploring biological mechanisms	
Questioning and contextual integration	Predicting the results	
	Separation	
	Relevance	
Contextual task openness	Integration	
	Open contexts Closed contexts	
Examination requirements	Basic	
	Comprehensiveness	
	Applicability	
	Innovation	

## 5. Conclusion

This study takes Roegier situation typology as the theoretical basis, takes the content parameters in the theory as the research base, and reconstructs the dimensions and indicators in the content parameters according to the characteristics of the biology subject, the academic quality level of the curriculum standards and the examination requirements of the college entrance examination evaluation system. The final content parameters constructed for analyzing contextualized biology examination questions in senior high school include 5 dimensions and 15 indicators through the empirical study conducted with expert questionnaires. In order to provide a systematic analysis theory for analyzing contextualized biology examination questions in senior high school.

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