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Integrating Teachers' Educative Functions with Science Education in High School Biology under Quality-oriented Education

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Abstract: Quality-oriented education calls for a transformation in basic education subject teaching–from knowledge transmission to competency cultivation. The teaching of biology in junior and senior high schools needs to balance the dual functions of scientific cognition and life value guidance. How to achieve the organic integration of the two in biology classes has become a practical issue that must be addressed in the reform of subject teaching. This article reviews the relevant educational policy documents and curriculum standards that have been established in recent years regarding the core competencies framework, and analyzes the current challenges faced by the educative functions of biology classes in junior and senior high schools and the integration of science education. These challenges include the separation of the sequence of knowledge imparting and value guidance, the lack of thinking participation and value reflection in inquiry activities, and the lack of smooth connection between the educational goals of junior and senior high school stages. Based on this, it proposes integration paths from three dimensions: curriculum content integration, improvement of inquiry-based teaching, and transformation of teacher roles. The study holds that the integration of educative functions and scientific education is not a simple addition of the two, but organic integration of knowledge construction and value formation in the same teaching process, achieving mutual support among the four qualities of life concepts, scientific thinking, inquiry-based practice, and social responsibility.

Keywords: Quality-oriented education, Biology teaching in junior and senior high schools, Educative function, Science education, Integration strategies.

1. Introduction

Since the late 1990s, Quality-oriented education has been established as the direction of China's educational reform, and its connotation has continuously deepened with the advancement of policies. In 2001, the "Outline for the Reform of Basic Education Curriculum (Trial)" clearly stated that "change the tendency of the curriculum to overly focus on knowledge transmission, emphasize the formation of an active and proactive learning attitude, and make the process of acquiring basic knowledge and skills also become a process of learning how to learn and forming correct values." In 2019, "China's Education Modernization 2035" proposed "pay more attention to well-rounded development", "enhance comprehensive qualities", "improve the education quality standard system, and clarify the requirements for core student development competencies". In 2026, the "15th Five-Year Plan for Education Development" required "cultivate socialist builders and successors with well-rounded development in morality, intelligence, physical fitness, aesthetics, and labor", and "promote the alignment of ideological and political courses and curriculum-based ideological and political education". These documents constitute the institutional basis for the integration of the educative function of biology classrooms and scientific education.

The biology subjects in junior and senior high schools have their own unique features. They mainly rely on experimental observation and undertake the task of cultivating students' scientific literacy and competency; their teaching content revolves around life phenomena–from cell structure to ecosystems, from genetic variation to biological evolution–carrying the functions of life education and value guidance. "The Senior High School Biology Curriculum Standards (2017 Edition 2020 Revised)" established four core competencies of life concepts, scientific thinking, scientific inquiry, and social responsibility, promoting the transformation towards core competency cultivation.

The integration of educative function and scientific education still faces constraints. The separation of knowledge transmission and value guidance, the lack of thinking participation and value reflection in inquiry activities, and the lack of smooth connection of educational goals in the junior and senior high school stages all restrict the depth of integration [1]. How to achieve the integration of the two in the biology classroom is the core issue of the reform. This article explores the basis and paths of integration from three dimensions: curriculum content integration, improvement of inquiry-based teaching, and transformation of teacher roles.

2. The Intrinsic Logic of Integrating the Educative Function with Scientific Education

How can the educative function and scientific education be integrated in the field of biology? We need to start from two aspects: one is how much of the quality education has defined the role of teachers in education; the other is what role scientific education plays in today's educational system. Once these two lines are clarified, the point where they intersect in the biology classroom will naturally emerge.

In the past, when it came to teachers' educative function, what usually came to people's minds were class advisors' talks, ideological and moral education classes, and theme class meetings, which seemed to be completely different from the teaching of cell division and genetic laws in biology classes. What truly broke through this barrier in quality education was clearly stating to everyone: Education is not the exclusive domain of moral education classes; every subject has its share. The four points presented in “The Senior High School Biology Curriculum Standards (2017 Edition 2020 Revised)” –life concepts, scientific thinking, scientific inquiry, and social responsibility –ultimately, which one can do without value guidance? Which one can be accomplished merely by imparting knowledge? This means that if biology teachers still consider education as "extracurricular activities", then the most essential element in the classroom will be missing. For each lesson prepared, knowledge, ability, and values should all be presented together. Missing any one of them is like having a meal with a missing dish [2].

On the side of scientific education, it's also different. In the past, teaching science meant teaching formulas and operations, memorizing the experimental steps and accurately recording the data. Now, the "Opinions on Strengthening science and technology education in primary and secondary schools" clearly states that by 2035, science education should achieve a comprehensive ecosystem construction, and "project-based, inquiry-based, and interdisciplinary teaching methods will be widely applied". In essence, biology classes cannot just deal with those few reagents in the laboratory; they need to be brought into life and into real problems [3].

In summary, biology itself is a good platform that can connect these two aspects. It is a science about life and also a form of education about life. Through inquiry, students understand what life is like. This is not only a cognitive gain– when they really approach life and understand it, a sense of awe, responsibility, and attitude towards nature are all quietly formed in that process. Both aspects belong to different sides of the same process, and artificial separation will weaken the overall educative function of the biology discipline.

3. Structural Challenges in the Integration Practice

The integration of the educative function and scientific education has no major disagreement in terms of concepts. The real difficulty lies in bridging the "last mile". The problem is not just that a certain lesson was not taught well, but that it is tied to more fundamental aspects such as how exams are conducted, how teachers understand their roles, and how junior and senior high schools are connected.

Let's first look at the mismatch between knowledge teaching and the educational goals. The pressure for academic success is there, and teachers spend a lot of class time on the organization and memorization of knowledge points. This is an objective reality. What about education? It is often relegated to the last two or three minutes of the class, where the teacher hastily throws in a few words about emotional elevation, and it is considered a success. First teaching knowledge, then attaching labels, education becomes an additional component at the end rather than something that runs through the entire class. As a result, knowledge teaching and education take separate paths, and students, after learning a chapter, have memorized the concepts but have not truly internalized the emotional aspects.

The same is true for inquiry activities. Biology is a discipline that relies on experiments to speak. If the inquiry-based teaching design is appropriate, it should connect scientific education and value guidance. But in many current classrooms, the inquiry is more like following a process–the experimental steps are printed on the lesson plan, students follow them, record data, and verify conclusions. During this entire process, students rarely ask questions actively, let alone ponder the meaning behind the experiments [4]. After the experiments are completed and the conclusions are reached, questions such as "What does this have to do with me?" and "What does this discovery mean?" are rarely asked. Scientific inquiry has become merely a training in operation, and the educative function has naturally become suspended.

The connection between junior high school and senior high school also exposes another issue. In junior high school, the focus is on "what is life", establishing basic concepts; in senior high school, it suddenly moves to the molecular level and mechanism level. As knowledge progresses upwards, logically, the content of education should continuously enrich as cognition deepens. However, discussions on stage transitions mostly remain at the level of "whether there are repetitions or omissions of knowledge", whether the educational goals are coherent and progressive, and few people inquire about them [5]. The life consciousness and ecological concepts established in the junior high school stage cannot be found to continue in the senior high school stage; the scientific ethics and social responsibilities to be discussed in senior high school are lacking the necessary emotional groundwork in junior high school. What was done in the earlier stage is wasted, and the later goals cannot be reached.

The distance between the concept and its implementation is formed by these three challenges. Only by recognizing them can we talk about targeted solutions.

4. Curriculum Content Integration: The Organic Unification of Educational Resources and Scientific Knowledge

Curriculum content serves as the carrier of teaching activities. In the face of the aforementioned three challenges, the integration at the curriculum content level is the most fundamental focus. The biology textbooks for junior and senior high schools contain many educational resources, but most of these resources are not directly prominent. They are hidden behind the expression of knowledge points, the selection of cases, and the design of experiments. Teachers should view the textbooks with an educational perspective and extend the teaching value of scientific knowledge from the cognitive level to the emotional, attitude, and value levels.

The integration at the junior high school stage can be carried out around themes such as ”biodiversity”, “ecosystem”, and “healthy life”. For example, when teaching “ecosystem”, not only should students memorize the food chain and food web, but also they should be guided to think about the relationship between humans and nature, as well as the connection between protecting the environment and themselves [6]. When teaching “human physiology”, the choice of healthy lifestyle should be included to help students establish a scientific concept of health. These contents are not only basic biological knowledge but also a handle for life education. The “Biology Curriculum Standards for Compulsory Education (2022 Edition)” requires that the curriculum content “present the corresponding conceptual framework in the form of big ideas, key concepts, and sub-concepts”.

At the senior high school stage, the direction of integration is different. It should pay more attention to scientific frontiers and social issues. When teaching “genetic engineering” and "biotechnology", not only should the technical principles be explained, but also students should be asked to think about the ethical boundaries of gene editing, the controversy of genetically modified technology, and the impacts of the application of biotechnology in society. This can help students understand the social attributes of scientific knowledge and also cultivate their judgment and responsibility [7]. When teaching "ecology", issues such as "carbon neutrality" and "biodiversity protection" can be brought into the classroom. There is a teaching design with "carbon neutrality" as the topic, integrating perspectives from multiple disciplines such as biology, chemistry, and geography, guiding students to extend from the microscopic mechanism of photosynthesis to the macroscopic action of carbon neutrality, and connecting knowledge construction, ability development, and ecological responsibility awareness in this process.

The integration of curriculum content also needs to pay attention to the connection between junior and senior high school levels. At the junior high school stage, emphasis should be placed on awakening life consciousness and cultivating scientific interest, allowing students to establish the basic understanding that '"life is magical and precious". At the senior high school stage, this should be followed by moving towards the reflection on scientific ethics and the assumption of social responsibility. The educational themes of the two stages should be coherent, and the depth of education should be progressive. Each should not have its own set of approaches.

5. Improvements in Inquiry-Based Teaching: From Practical Training to Value Cultivation

Content integration is the foundation, but merely having content is not enough; the teaching methods also need to be adjusted accordingly. Inquiry-based teaching is centered on students, and teachers cannot neglect the value dimension in the teaching design. The prominent problem with current inquiry-based teaching is that it overly emphasizes whether the operational procedures are standardized, while neglecting the students' thinking activities and emotional experiences during the inquiry process.

The design of inquiry questions should balance scientificity and humanism. An inquiry question should have both clear scientific orientation and the ability to stimulate students' in-depth thinking about life, nature, and society. Take "Exploring the Way Yeast Cells Breathe" as an example. Teachers should not only have students follow the steps for operation, record data, and draw conclusions, but also guide them to think: How can the principle of yeast cell respiration be used in food fermentation? What value does it have in agricultural production? By pulling the experiment from the laboratory to real-life scenarios, scientific inquiry can become a process of value experience [8].

Let's look at the inquiry process. We should value students' active participation and thinking development. The reason why verification experiments cannot carry much educative function is that students are merely following the process, rather than exploring the questions [9]. Teachers should create opportunities for students to fully experience the series of steps: "Formulate questions–Make hypotheses–Design experiments–Conduct inquiries–Reach conclusions–Communicate and discuss". They can truly understand the essence of scientific research. During this process, students not only gain knowledge but also experience the rigor and hardship of scientific exploration, and recognize the significance of cooperation and sharing.

Inquiry-based teaching also needs to be combined with scenario creation and large-unit teaching design. Some educational research practices have proposed a "Scenario–Big Concept–Large Unit" integration model. It starts with a real scenario, leads with a big concept, and integrates knowledge construction and value formation in the same process, avoiding the separation of the two. The teaching case "Guarding Life's Respiration" is an example of this. It guides students to explore the principle around respiratory health, while also permeating the concepts of cherishing life, scientific protection, and healthy living. These practices repeatedly confirm a principle: When the inquiry activities are placed in a real context, knowledge learning and value formation can fully support each other within the same process.

6. Transformation of Teacher Roles: Professional Reorientation of Educative Scientific Educators

Whether inquiry-based teaching can truly fulfill the educative function ultimately depends on how the teacher designs and guides. This means that the role of the teacher needs to change–they should not only be someone who imparts knowledge, but also a scientific educator capable of nurturing students. This change is not as simple as just changing the title; it involves three aspects: how to think in the mind, what skills are available in hand, and what support is provided by the school.

Let's start with the conceptual level. Biology teachers must first figure out: Education is not an "add-on task" beyond knowledge teaching; it is inherent in the teaching process. When preparing a lesson, one should have three questions in mind: What knowledge will this lesson impart to students? What abilities can be developed? Which emotional strings can be touched? These three questions cannot be prioritized; omitting any one will leave a gap in the lesson. Some scholars have called this concept "Towards Discipline-based Education"–Education cannot be separated from knowledge teaching; it must be embedded in the process of knowledge teaching.

Then, let's look at the ability level. Just having scientific knowledge and being able to lecture is far from being a "educative scientific educator". You must be able to transform scientific knowledge into educational resources, guide students to reflect on their value orientations, and maintain composure and provide directions in the face of controversial scientific issues. For example, in the case of gene editing and cloning technology, teachers cannot just explain the principles clearly; they also need to guide students to think and judge on their own. This puts higher demands on the teacher's knowledge perspective and judgment ability [10]. Additionally, teachers need to consider how to connect the educational goals between junior and senior high school levels. For instance, in the junior high school stage, it focuses on awakening the sense of life, while in the senior high school stage, it needs to consider how to extend from the existing foundation to scientific ethics, and how to fill the missing gradient and what teaching strategies to use to fill it–all of these require anticipation in the design. The cognitive levels of students at different ages are different, and the pace and depth of education also need to be adjusted accordingly.

Finally, let's talk about institutional support. Relying solely on the efforts of the teachers is not enough; training, research and development, and evaluation must also keep up [11]. The "Southern Teaching Seminar Hall" organized by the Guangdong Provincial Institute of Education Research is guiding teachers to optimize teaching methods and develop students' core competencies through lesson demonstrations, class evaluations, and teaching seminars. Schools also need to establish evaluation mechanisms, and the way teachers implement the integration of education and scientific education in the classroom should be recognized and included in the evaluation system. Otherwise, even if the call is repeated, it will still be in vain if it does not fall into the assessment.

7. Conclusion

This paper starts from the internal logic of integration, clarifying how the educative function and scientific education can be possible and necessary in the field of biology, and then analyzes the threefold structural dilemmas existing in current practice. It proposes integration paths from three dimensions: curriculum content, teaching methods, and teacher roles. The establishment of this analytical framework is helpful for subsequent research to find more specific focuses at the operational level.

It should be acknowledged that this study mainly stays at the theoretical analysis and path exploration level and has not yet entered the systematic empirical verification stage. Whether the integration paths in the three dimensions can be implemented in actual classrooms, what the implementation effects are, and the differences in the applicability of the paths under different school conditions and teacher qualities, all these issues need to be further tested through case studies, classroom observations, and empirical investigations in the future. Moreover, the discussion on the connection between junior and senior high school stages in this paper is still relatively macroscopic. The gradient design and progressive strategies of the educational goals in the two stages need to be clarified in more detailed comparative studies of the stages.

The integration of educative function and scientific education does not lie in how the two are superimposed in form, but in whether knowledge construction and value formation can be organically unified in the same teaching process. When students can naturally associate the understanding of the mechanism of photosynthesis with the practical significance of carbon neutrality; when students can actively inquire about the ethical implications behind fermentation technology when conducting yeast respiration experiments–this state of "natural integration" is the sign of the true occurrence of integration. With the implementation of requirements such as "cultivating well-rounded development socialist builders and successors" and "promoting the alignment of ideological and political courses and course ideological education" proposed in the 15th Five-Year Plan for Education Development, there is still a broad exploration space for junior and senior high school biology classrooms.

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