

The Concept of “Zero” and Its Redefinition — A Proposal for a Unified Framework Across Disciplines

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1. Background

The concept of “zero” is employed in various disciplines—mathematics, physics, logic, biology, and more. However, its interpretation differs across fields, leading to inconsistencies. In mathematics, “0” is treated as one of the numbers; yet, depending on the context it may transform from a numerical value to a conceptual entity and even exhibits unique properties in basic arithmetic operations. In physics, 0 appears as a “reference point” (for instance, absolute zero) that carries a meaning different from the mathematical idea of “nothingness.” In logic, it is taken as “false” in propositions, and thus does not directly correspond to the mathematical 0. In biology, “0” is frequently used in the form of “zero population” or “zero growth rate,” serving as a measure or indicator. In this way, the concept of 0 varies from one discipline to another, and these differing interpretations hinder a coherent inter-disciplinary understanding.

This study aims to clarify the concept of “zero” and propose a unified framework that makes it easier to share a common understanding across academic fields.

2. Problem Statement

2.1 Problems of Zero in Mathematics

In mathematics, 0 is considered one of the basic numbers; however, there are several issues:

- Multiple interpretations exist, such as “the zero of nothingness,” “the reference zero,” and “the vacant zero.”
- Although operations like multiplication with 0 are defined (e.g., $0 \times 0 = 0$), division (e.g., $0 \div 0$) is “undefined,” indicating a lack of consistency.
- Since the mathematical concept of 0 is confined within an axiomatic framework, it does not necessarily align with its interpretations in other disciplines.

2.2 Differences in the Treatment of Zero in Other Disciplines

In fields other than mathematics, zero is used in different ways:

- **Physics:** Zero is used as a “reference value.”
 - Example: Absolute temperature 0 K (absolute reference) and 0 m/s (a state of rest).

- **Logic:** Zero is employed to represent the “false” value in truth tables.
 - Example: In truth tables, “False” is equated with 0.
- **Biology:** Zero appears as “zero population” or “zero growth rate,” and is used primarily as an indicator.
 - Example: The number of individuals of a certain species in a region being 0.

3. A New Definition of Zero

In this study, the existing concept of 0 is organized into three distinct notions to establish a unified framework that harmonizes understanding across disciplines. Through this classification, the meaning of 0 in each field can be clarified and a cohesive framework created.

4. Applications and Practicality

4.1 Utilization in Education

- By classifying the concept of 0, students can achieve a more intuitive understanding.
- For instance, one can clearly explain the difference between “0 in mathematics (N0)” and “0 in physics (B0).”
 - A sample explanation for elementary students might be: “Zero might seem like nothing, but its meaning varies depending on the subject. For example, even if a bag appears empty, it still contains air. In math, we think of 0 as ‘nothing,’ but in science (physics and biology), we consider that something exists. Remember, there’s a kind of 0 that is about whether something is visible or not, which you’ll learn about later.”
- This classification makes it easier to understand the differences in the concept of 0 among mathematics, physics, and biology:
 - In physics, the “zero of motion” refers to a state of rest (a reference point).
 - In biology, the “zero of development” refers to a state where nothing has emerged (a reference point).
 - Since both are used as “reference zeros,” they can be intuitively grouped together as “B0.”

4.2 Bridging the Gap Between Disciplines

- Adjusting for the discrepancies in the meaning of 0 among areas such as mathematics, physics, logic, and biology will facilitate integrated research.

5. Philosophical Significance and an Evolutionary Perspective

Numbers are treated as “universal truths” in various fields; yet, while the numeral 0 remains the same, its conceptual interpretation exists independently in each discipline, leading to inconsistencies. Furthermore, the concept of “0” can be considered one of the tools that humanity has developed through the process of intellectual adaptation.

Relation to the Baldwin Effect

The Baldwin Effect is an evolutionary theory suggesting that the behaviors individuals adopt in response to environmental challenges can influence genetic changes over generations.

- **Example:** Monkeys may recognize “0” as signifying “nothing” or the state of “having or not having,” while chimpanzees can count basic numbers.
- Humans have developed a broader array of concepts, and throughout that development process the concept of “0” has diversified.
- Thus, by organizing and clarifying the concept of 0, we may enhance the coherence of our knowledge system.

6. Conclusion

This study has organized the concept of “0” and proposed a unified framework across disciplines.

- By classifying 0 into four categories—“number,” “numerical value,” “reference (B0),” and “comparison (C0)” —the discrepancies in interpretation between disciplines can be resolved.
- The differences between mathematics and physics are clarified, aiming for application in both educational and research settings.
- Zero is a product of evolution and can also be considered from the perspective of the Baldwin Effect.

7. Future Prospects

- Further examine how 0 is utilized in each discipline and explore possibilities for further subdivision.
- Test its practical utility in educational settings and consider its integration into teaching materials.
- Recognize that 0 is both a part of the logical system created by humans and a reflection of the universal properties derived from the cognitive abilities of primates.

This understanding should be carefully considered when aligning future conceptual frameworks.

- In future endeavors to create new concepts, naming them with “(English + 0)” may enhance clarity and contribute to further academic development.

8. In Conclusion

This paper is an attempt to organize the discrepancies in the concept of “0” among disciplines such as mathematics, physics, biology, and philosophy and to propose a unified framework.

I am a high school graduate and have not formally specialized in these fields; however, I have independently explored this topic by consulting various papers and specialized websites.

Many sources were referenced, but those that did not align sufficiently with the central theme of this paper were omitted, which is why the list of references is relatively short.

Thus, while my perspective may differ from that of experts, I hope you will consider it as a “bridging organization among disciplines.”

Furthermore, I welcome any suggestions or criticisms for further improvement as I continue to develop this work.

9. References

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