

# A Revolution in Mathematics? What Really Happened a Century Ago and Why It Matters Today

*Frank Quinn*

**T**he physical sciences all went through “revolutions”: wrenching transitions in which methods changed radically and became much more powerful. It is not widely realized, but there was a similar transition in mathematics between about 1890 and 1930. The first section briefly describes the changes that took place and why they qualify as a “revolution”, and the second describes turmoil and resistance to the changes at the time.

The mathematical event was different from those in science, however. In science, most of the older material was wrong and discarded, while old mathematics needed precision upgrades but was mostly correct. The sciences were completely transformed while mathematics split, with the core changing profoundly but many applied areas, and mathematical science outside the core, relatively unchanged. The strangest difference is that the scientific revolutions were highly visible, while the significance of the mathematical event is essentially unrecognized. The section “Obscurity” explores factors contributing to this situation and suggests historical turning points that might have changed it.

The main point of this article is not that a revolution occurred, but that there are penalties for not being aware of it. First, precollege mathematics education is still based on nineteenth-century methodology, and it seems to me that we will not get satisfactory outcomes until this changes [9]. Second, the mathematical community is adapted to the social and intellectual environment of the mid- and late twentieth century, and this environment is changing in ways likely to marginalize core mathematics. But core mathematics provides the skeleton that supports the muscles and sinews of science and technology; marginalization will lead to a scientific analogue of osteoporosis. Deliberate

management [2] might avoid this, but only if the disease is recognized.

## **The Revolution**

This section describes the changes that took place in 1890-1930, drawbacks, objections, and why the change remains almost invisible. In spite of the resistance, it was incredibly successful. Young mathematicians voted with their feet, and, over the strong objections of some of the old guard, most of the community switched within a few generations.

## **Contemporary Core Methodology**

To a first approximation the method of science is “find an explanation and test it thoroughly”, while modern core mathematics is “find an explanation without rule violations”. The criteria for validity are radically different: science depends on comparison with external reality, while mathematics is internal.

The conventional wisdom is that mathematics has always depended on error-free logical argument, but this is not completely true. It is quite easy to make mistakes with infinitesimals, infinite series, continuity, differentiability, and so forth, and even possible to get erroneous conclusions about triangles in Euclidean geometry. When intuitive formulations are used, there are no reliable rule-based ways to see these are wrong, so in practice ambiguity and mistakes used to be resolved with external criteria, including testing against accepted conclusions, feedback from authorities, and comparison with physical reality. In other words, before the transition mathematics was to some degree scientific.

The breakthrough was development of a system of rules and procedures that really worked, in the sense that, if they are followed very carefully, then arguments without rule violations give completely reliable conclusions. It became possible, for instance, to see that some intuitively outrageous things are nonetheless true. Weierstrass’s nowhere-differentiable function (1872) and Peano’s horrifying space-filling curve (1890) were early

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# Recent Revolution In Mathematics

**R Bogdan**



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