Andrew Marzo

Professor Little

Math Across Time

14 December 2010

Consequences of Non-Euclidian Geometry

 In textbooks such as The Elements, Euclid created a foundation of geometric knowledge based on axioms and definitions to prove more complex geometric knowledge. With the perspective of geometric certainty, supporters believed Euclid had created knowledge that described absolute knowledge about physical world (Davis 322). Rationalists, such as Plato, adopted Euclidean geometry as an example to prove that accurate knowledge is obtained with reason and logic. In contrast, empiricists argued for the necessity of the senses to gain knowledge through experiences. However, the knowledge of non-Euclidean geometry called into question Euclidean geometry as an accurate description about the physical world. Therefore discovery of non-Euclidean geometry, consequently disproved Euclidean geometry, and proved that man obtained knowledge through his senses and not through reason.

Plato’s Meno provides an argument for rationalism through the recollection of universal forms, such as math and geometry. In the Meno, Plato’s character Socrates proves that a slave boy who has never had the experience of learning math in school still knows the area of the squares based on the Pythagorean Theorem (Davis 322). Using this example, Plato illustrates that the slave boy has knowledge without directly experiencing it through education. Plato claims that the slave boy knows the areas through the recollection of everlasting true knowledge, or what he calls the universal form. Plato uses the idea of recollection of the universal forms to justify the concept of rationalism to apprehend the forms and to gain knowledge. Plato also claims that knowledge of geometry, just like math, is a universal form because geometry provides accurate knowledge about the physical world (Davis 323). By referencing math and geometry, Plato is able to create an argument for man’s ability to gain knowledge of the universal forms with rationalism. Plato believes that man can only have access to knowledge through reason and logical deductions. However with the discovery of non-Euclidean geometry, Plato’s argument for rationalism has been disproven. The mathematical accuracy of non-Euclidean geometry proves that Euclidean geometry no longer the only reliable geometry about the physical world.

However before the knowledge of non-Euclidean geometry, Euclidean geometry was a critical asset for the argument of rationalism. Rationalists believed that through the assistance of reason, man is able to gain knowledge of absolute truths without relying on sense experiences (Davis 326). Euclidean geometry justified rationalism because rationalists relied on geometry to provide knowledge of the physical world. Rationalists such as Descartes claimed that man is unable to trust his senses because his senses can be deceiving. Descartes creates the Dream Argument to illustrate that man cannot trust his sense to obtain knowledge because his senses are unable to distinguish the difference between when he is awake and not sleeping (Descartes 490). The deceptiveness of senses can be seen when Spinoza writes, “I may be mistaken in thinking that I am sitting at my writing desk composing this sentence, and I surely may be mistaken that the sun will rise tomorrow, but by no means can I be mistaken in my knowledge that the angle sum in a triangle equals a straight angle” (Davis 326). Rationalists portray the senses as inconsistent and unreliable to represent the uncertainty of knowledge gained through senses and experiences. Therefore without the validity of the senses, rationalists can only use their intellect and reason to gain knowledge. Like Spinoza, rationalists justify that the knowledge of geometry is true regardless of the skepticism in his senses. The unarguable evidence that Euclidean geometry was certain knowledge proved that geometry was an accurate description of physical world.

Before the discovery of non-Euclidean math, empiricists could never completely disprove the argument that Euclidean geometry was a valid depiction about the physical world. Unlike rationalists, empiricists argued that all knowledge, except mathematical knowledge, comes from sense experiences (Davis 327). Supporters for empiricism believed that through repetitive experiments, tested experiences with man’s senses, man can make conclusions about the physical world. However, geometry had always been a contradiction for empiricists like Hume, because of the long-standing perception that geometrical knowledge could be obtained independent of the senses. With the discovery of non-Euclidean geometry, empiricists could disprove rationalism and Euclidean geometry because geometrical knowledge is no longer an absolute truth about the physical world. Therefore man acquires knowledge by referring to his senses and observations to make conclusions and deductions about the physical world. This use of empiricism can be seen in scientific experiments that require repetitive experiences to gather information, analyze data, and make conclusions ( ). Rationalists no longer have a sound argument for the basis of reason to acquire knowledge about the physical world.

If taken to an extreme, the evidence for non-Euclidean Geometry and for empiricism consequently justifies the skepticism of all knowledge in the Physical world. In Hume’s argument for knowledge obtained through the senses, he develops the Copy Principle, which states that ideas are less vivid copies of impressions or sense experiences (Hume 769). Hume claims that all ideas are derived from experiences, thus knowledge is obtained through experiences. For example, a blind person without the ability to see color cannot have the idea in his head, since a blind person has never directly experienced color (Hume 769). As a result of the Copy Principle, man cannot have knowledge of cause and effect because man cannot directly experience the connection between two separate events with his senses. Man understands the concept of cause and effect through repetitive experiences that cause our mind to form conclusions and make assumptions between two separate events. Therefore since man cannot be certain of cause and effect, man cannot be certain of anything beyond the present moment. Man lives in completely uncertainty and must be skeptical of any events in the future beyond the present. The existence non-Euclidean geometry disproves both Euclidean geometry as an accurate description about the physical world and the justification for rationalism. Based on Empiricism man cannot be absolutely certain about the knowledge in the physical world.

Even though empiricism is able to contradict rationalism through evidence of non-Euclidean Geometry, Kant tries to prove the possibility of knowledge without sense experiences. Kant rejects Hume’s assertion that knowledge is gained through observations with the concept of knowledge “a priori;” knowledge that is “timeless and independent of experience” (Davis 329). According to Kant, man has certain knowledge that is genetically inherited in all humans before he has experiences. Kant describes two types of knowledge “a priori.” “Analytic a piori” knowledge which is man’s natural ability to have preexisting knowledge of logic, and “synthetic a priori” which is man’s natural ability to have preexisting knowledge of time and space. Kant argues that man has natural instincts regarding space and time, based on Euclidean geometry and arithmetic respectively (329). Despite the proof for non-Euclidean geometry, Kant claims all humans still have natural awareness of Euclidean geometry, independent of human’s senses, because Euclidean geometry still provides a very close approximation about the physical world based on Earth’s laws of physics. Non-Euclidean geometry is only applicable at rare conditions such as black holes or the speed of light, so Euclidean geometry is relatively accurate on non-extreme conditions such as Earth. However, empiricists would argue that man learns about geometry through experiencing physical objects and arithmetic through experiencing time. Kant makes a reasonable argument for innate knowledge, but the overwhelming evidence in support of empiricism contradicts Kant’s concept of innate human knowledge

Evidence of non-Euclidean geometry, concludes that empiricism and skepticism is true, yet mathematical and geometric knowledge continues to be perceived as absolute knowledge. Descartes’ Dream argument illustrates that man’s senses are deceptive and cannot be trusted. Hume expands on this concept to conclude that humans must be skeptical of knowledge because absolutely certainty through man’s senses is impossible. Although man cannot be certain of anything according to Hume, man can in fact gather repetitive experiences and make assumptions that are nearly accurate. This slim margin of skepticism causes mathematics to continue without diminishing the value of their math. For example, non-Euclidean Euclidean is only applicable at extremes, such as high velocities or over large distance; mathematicians can still conduct research with relative certainty. Math and Euclidean geometry can still be perceived as certain because these rare extreme factors do not create significant errors in their calculations consequently their knowledge.

The knowledge of non-Euclidean geometry discredits Euclidean geometry as knowledge of the physical world. As a rationalist, Plato argues that man gained knowledge of universal truths through reason. Conversely, Empiricists claim that all knowledge derived through sense experiences. Geometry had always been rationalism’s strongest argument and empiricism’s unanswerable counterexample until the discovery of non-Euclidean geometry. New non-Euclidean Geometries successfully explained that Euclidean geometry was not an accurate description of the physical world, but it also justified that absolute knowledge is impossible because of deceptive senses. Mathematicians still trust in the relative certainty of math and Euclidean geometry because of repetitive experiences and lack of extreme examples on Earth.

Work Cited

Davis, Philip J., and Reuben Hersh. *The Mathematical Experience*. Boston: Birkhäuser, 1981. Print.

Descartes, Rene. "Meditations of First Philosophy.” *Classics of Western Philosophy*. Ed. Steven Cahn. Indianapolis: Hackett, 2006. 491-516. Print.

Hume, David. "An Enquiry Concerning Human Understanding." *Classics of Western Philosophy*. Ed. Steven Cahn. Indianapolis: Hackett, 2006. 763-828. Print.