Scientific knowledge

Transformation of scientific knowledge through imagery

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Generating new knowledge

Epistemologically, researchers gain new knowledge when they introduce a distinction that is conceptually compatible with existing knowledge. The conceptually redefined knowledge either a) fits into the order of established knowledge or b) arranges it in a different, new way. In science, according to Thomas S. Kuhn (1976), researchers produce this new knowledge in two ways. The first route relies on proven theories, methods, and empirical evidence and gradually expands the existing body of knowledge within a paradigm in order to consolidate theories and solve recognized problems and puzzles. The second route involves a sudden change of perspective, which leads researchers to understand an object in a new way and to approach its study differently. He writes that such a fundamental change is usually preceded by a crisis, when anomalies accumulate and researchers reach the limits of their ability to understand and explain phenomena and connections with existing theories, concepts, and methods. These circumstances ultimately create the conditions for previously less discussed approaches in the research field as well as approaches in other disciplines to receive greater attention and ultimately pave the way for a paradigm shift.

From linguistic exchange to transformative imagery

Characteristic of Kuhn's theory of scientific knowledge generation is that when shifting perspectives, he focuses primarily on conversations with other researchers and discussions of other approaches. This exchange makes it possible to borrow and transfer concepts and terms from other fields of research. However, this easily creates the impression that for him linguistic transfers primarily drive a change of perspective. Less attention is paid to imagery, although imagery can indeed have a transformative effect in research.

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Transformative imagery is based on the assumption that the change of scientific perspectives is not only accompanied by a shift in the network of concepts (Kuhn, 1976), but can also be traced back to pictorial forms and forms that are not (yet) conceptually fixed. In other words, something fundamentally different from language, the meaning of which is initially accessible in a pre-conceptual way and establishes references (Boehm, 2007). Of course, it is those image meanings that viewers recognize and label in the image that can be considered conceptually communicable (Imdahl, 1996). To this end, they interpret the visual elements of an image by drawing on socially shared knowledge of institutionalized signs and symbols (e.g., religious representations, pictograms, signs). Regardless of this, however, the two-dimensional and relational composition of visual elements in an image also creates something meaningful in an image-specific way. For example, the meaning of institutionalized signs and symbols in an image changes depending on its position, size or relation to other visual elements. In other words, the formal pictorial composition also structures the possibilities of interpretation for the viewer.

Applied to the practice of research, a scientific problem can, on the one hand, be dealt with figuratively by transferring recognized meanings. On the other hand, the pictorial can have a transformative effect because the formal composition and form help create meaning. This makes it possible on a pre-conceptual level of the pictorial sense to see a scientific problem in a different form, to understand it, and finally to verbalize it from a new perspective. The specificity of the pictorial can thus enable a new way of looking at things, where previously no concepts, formulas, and models were available for solving a scientific puzzle. Viewed as a process, pre-conceptual pictorial forms can offer a solution that is linguistically unambiguous as a (visual) model, ultimately becomes connectable to communication in terms, concepts, and theories, and can initiate a change of perspective in a research field.

The transformative moment thus lies in the transfer of meaning from image to image, but a perspective shift in science only begins with a conceptual translation of the meaning of the image into a model that can be clearly communicated scientifically. Science research also emphasizes this circumstance in the relationship between visualization and knowledge. It is primarily models, including visual ones, that enable other qualified scientists to understand new perspectives (Sachs-Hombach, 2012). They can then readjust their own future research based on these perspectives.

An example

A historical example of transformative imagery is August Kekulé's discovery of the benzene ring in the 19th century (Rocke, 1992). In the middle of this century, researchers like Kekulé were looking for a formal notation to describe the structure of benzene. In this context, he described a daydream in which the problem of representation was resolved by another image. He described how the image of swirling atoms that had closed to form a circle appeared to him. In the pictorial arrangement of the atoms in the form of a ring, he finally recognized a structure that he pictorially transferred to the properties of benzene he was already familiar with. The shift in perspective was therefore based on the pre-conceptual transfer of an image (ring shape). For transformative imagery, it is therefore crucial that the transfer took place from image to image. He saw structure in the visual and transferred it to his own subject matter, whereby the transformative moment of the pictorial was concealed when translated into scientifically compatible terms, formulas, and models. In particular, he succeeded in structurally understanding and explaining the chemical compound benzene. However, his structural representation also fundamentally changed the way in which compounds were viewed and noted in chemistry using structural formulas.

The reference to the importance of transformative imagery for fundamental scientific breakthroughs adds another facet to science studies and thus a field of research that has hardly been explored so far. In-depth examinations of pre-conceptual views offer the opportunity to understand fundamental new orientations in science in an image-specific way. Based on the difference between the meaning of an image and a meaning that is only generated verbally, it is necessary to ask, for example, how the specific nature of an image helps to structure connections to meaning and which perspective is verbalized and how. In this way, it can be clarified whether and how the specificity of an image shapes a certain perspective. Such structuring methods would also be further proof that groundbreaking research is to a large extent random and pre-predicative. New insights and findings are therefore not necessarily bound to tried and tested rules and principles of scientific practice.

At the same time, it should be kept in mind that little is known about the role that transformative imagery plays in changing scientific perspectives. There are indications that imagery can make a significant contribution to solving scientific puzzles. However, it remains

unclear to what extent and in what contexts. Further research is therefore needed to understand what role the pictorial plays in principle in scientific shifts of perspective.

A more detailed examination of transformative imagery in science can be found here.

References

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