# Heinz von Foerster: The Observer Who Is Part of the System

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**Fractal Academy**
Issue 3 (Autumn 2026). Block II, Article 4
Series: "Thinkers Who Changed the Map of Consciousness: From the 'Hard Problem' to a New Pedagogy"
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DOI: [to be assigned]
Publication date: 1.11.2026

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*Title (English):* «Heinz von Foerster: The Observer Who Is Part of the System»
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## Abstract

In this article, I take the next step after Morin: if complex thinking requires the modernization of the observer (Article 3), then what happens when the observer attempts to apply this thinking to themselves? Heinz von Foerster, an Austrian-American philosopher, physicist, and cyberneticist, and the founder of second-order cybernetics, gives a radical answer to this question: "The observer is part of the observed system." This principle sounds like a death sentence to naive realism, but simultaneously opens a path to overcoming the "blind spot" of science. I show that Foerster's principle provides the philosophical justification for epistemological recursion (Article 1) and the principle of epistemological commensurability (Article 1). Moreover, I demonstrate that the way out of the "strange loop" described by Foerster lies not in the abandonment of observation, but in increasing the complexity of the observer through the development of the mental mechanisms of the CCFP (Article 5). Thus, Article 4 closes the block "Awareness of Complexity" (Articles 3-5) and prepares the transition to the block "New Approaches" (Articles 6-8).

**Keywords:** second-order cybernetics, observer, observation recursion, radical constructivism, objectivity, strange loop, epistemological recursion, communicative-cognitive framework of personality, cognitive niche.

## Introduction: The Scientist Who Forced Science to See Itself in the Mirror

In the previous article, I analyzed Edgar Morin's concept of "complex thinking." Morin showed that to understand complex systems - such as the brain - it is necessary to modernize the observer's cognitive apparatus [5]. But he left one question open: what happens when the observer tries to apply this thinking to themselves? What happens when the object of observation becomes the observer themselves - or, more broadly, the system in which they are included?

Heinz von Foerster (1911-1995), an Austrian-American philosopher, physicist, and cyberneticist, provides the answer to this question. In 1984, he published a work that became the manifesto of what he himself called "second-order cybernetics" [1]. This work overturned my own understanding of what science does. And, as I will show further, it became one of the cornerstones of my hypothesis about epistemological recursion [2].

Before Foerster, science lived in a state that I would call "naive realism." Scientists believed: there is an objective reality "out there," and the scientist is an impartial observer who looks at it "from here, inside the laboratory." The observer and the observed are two different worlds. Science is a mirror that accurately reflects reality.

Foerster shattered this mirror. He said: "Wait. Who is looking into the mirror? And what if the scientist themselves is part of the reality they are studying? And what if our 'objective knowledge' is not a reflection of the world, but a construction that we create ourselves?"

Here it is appropriate to recall Lewis Carroll's "Through the Looking-Glass." Alice passes through the mirror and finds herself in a world where everything is upside down: to get closer, you must walk away from the object; to stay in place, you must run as fast as you can. This world seems absurd, but it has its own logic. Foerster invites us into such a world. A world where the observer is not "outside," but "inside." A world where observation changes the observed. A world where "objectivity" is an illusion. This world seems absurd, but it is precisely in this world that modern neuroscience lives - and it is precisely its absurdity that explains why we are stuck in the trap of correlations.

The distinction between "first-order cybernetics" and "second-order cybernetics" is the distinction between two epistemological positions. First-order cybernetics studies observed systems while remaining "outside" them. Second-order cybernetics studies observed systems by including the observer in the system. This is not just "adding the

observer to the object"; it is a change in optics: the observer ceases to be a "neutral instrument" and becomes part of what they are studying. This has radical consequences for all science - and especially for neuroscience, where the observer (the scientist's brain) and the observed (the brain as an object) are one and the same. These ideas were laid down in the early works on cybernetics, collected in a key volume edited by von Glasersfeld and von Foerster [9].

**First-Order Cybernetics: Science That Does Not See Itself**

To understand the revolutionary nature of Foerster's idea, one must first understand what he was criticizing. I call this "first-order cybernetics" - although Foerster himself used this term in a broader sense. First-order cybernetics is classical science in its traditional understanding. It is science that studies observed systems while remaining "outside" them.

Imagine you are studying an anthill. You sit outside, with a magnifying glass in your hand, and observe the ants. You record how they carry crumbs, how they build tunnels, how they interact with each other. You are the observer. The anthill is the observed system. You are not part of the anthill. You are outside. In this paradigm, the scientist is a neutral instrument. Their personal beliefs, their culture, their brain - all of this does not affect the result of the observation. Science is a "view from nowhere" (a term coined by the philosopher Thomas Nagel), an objective and impartial gaze.

This paradigm has brought science enormous success. Thanks to it, we have split the atom, flown into space, and created the internet. But Foerster showed - and I completely agree with him - that at a certain point, this paradigm stops working. It stops working where the object of study becomes the observer themselves - or, more broadly, systems in which the observer is included. And it is precisely at this point that we find ourselves when we try to study the brain.

"Naive realism" is not a philosophical school, but an unreflected attitude that dominates everyday scientific practice. A scientist can be philosophically sophisticated and still work within the framework of naive realism - because this realism is built into the very structure of the scientific method: there is an "object," there is a "method," there is a "result." Second-order cybernetics calls this structure into question: what if the "object" and the "method" are inseparable? What if the "result" depends on who is observing? This is not "relativism"; it is an acknowledgment of the observer's inclusion in the process of cognition.

**Second-Order Cybernetics: Science That Sees Itself in the Mirror**

Foerster proposed a radically different paradigm - second-order cybernetics. I will formulate its main principle as it sounds in my own work: "The observer is part of the observed system." This is not just a beautiful phrase. It is a fundamental shift in the understanding of what science is. And it is precisely this principle that I lay at the foundation of my concept of epistemological recursion [2].

Imagine you are studying an anthill. But now you are not sitting outside. You are one of the ants. You crawl along with them, carry crumbs, build tunnels. And at the same time, you are trying to study the anthill. How will you do it? You cannot be an impartial observer - you are already included in the system. Your observation changes the system. Your knowledge of the anthill is part of the anthill. In exactly the same way, I assert, following Foerster, when a neurobiologist studies the brain, they are not "outside." They are part of that very reality they are studying. Their brain is the very object they are investigating. Their observations are processes of the same type that they are trying to describe. Their theories are products of the same neural activity they are trying to understand.

This creates what Foerster called observation recursion: observation observes itself. Imagine two mirrors placed opposite each other. An infinite corridor of mirrors is reflected in them. This is recursion: a mirror reflects a mirror that reflects a mirror, and so on to infinity. A brain studying a brain is exactly such a mirror. It is precisely this "strange loop" - a term borrowed from Douglas Hofstadter [3], which we will discuss in the next article - that I call epistemological recursion [2]. This is not just a philosophical concept. It is a specific problem faced by anyone trying to understand the brain.

The principle "the observer is part of the observed system" is not just a "metaphor." It is a methodological principle that has specific consequences. First: the results of observation depend on the observer's position. Second: observation changes the system (if only because the observer is part of it). Third: knowledge about the system is part

of the system - which means it cannot be "objective" in the naive sense. These three consequences radically change our understanding of science - and especially neuroscience, where the observer and the observed are inseparable.

**Why is this a Problem for Neuroscience?**

I argue in my main article that modern neuroscience is stuck in a trap of correlations. And now, relying on Foerster, I can show: this trap is not an accident. It is a direct consequence of the fact that science has forgotten about its own inclusion in the observed system [2]. When a neurobiologist scans a subject's brain using fMRI, they assume there is a clear division: "I am the observer, the subject's brain is the observed object." But this division is an illusion.

Imagine you are looking at yourself in a mirror. You see your reflection. But who is looking? You. And what if you try to see the very process of "seeing"? You cannot - because to do so, you would have to step outside your own vision. You cannot see your own eye when it is looking. In exactly the same way, a neurobiologist cannot fully objectify the brain, because they themselves are a carrier of a brain. Their observation is a process of the same type as the processes they are observing. Their understanding is a process of the same type as the processes they are trying to understand.

This creates what Foerster called the "blind spot" of science: science does not see itself. It sees the world, but it does not see how it itself constructs the image of this world. And it is precisely this "blind spot" that I propose to eliminate through the development of mental mechanisms within my CCFP model [4]. MM-5 (Socratic dialogue) and MM-6 (critical thinking) are precisely those tools that allow the scientist to see their own inclusion in the system.

The "blind spot" of science is not an "error" that can be corrected with a "better method." It is a structural characteristic of cognition: the observer cannot see themselves in the act of observation. It is like an eye that cannot see itself. That is why the "blind spot" is not eliminated by accumulating data; it is eliminated only by increasing the complexity of the observer - developing the ability to see one's own inclusion in the system. This is what I call "epistemological recursion": not "stepping outside" the system (which is impossible), but maintaining awareness of one's inclusion in it.

**Constructivism: We Do Not Reflect Reality, We Create It**

From the principle "the observer is part of the system," Foerster draws a radical conclusion that I fully share: we do not reflect reality, we construct it. This direction in the philosophy of science is called radical constructivism. I formulate its essence as follows: our knowledge is not a "copy" of the external world. It is a model that our brain builds based on sensory signals. And this model does not have to correspond to "reality as it is" - it only has to be viable, that is, allow us to navigate the world [1].

Imagine you are wearing glasses with blue lenses. Everything you see appears blue. You can build a very accurate "picture of the blue world." You can predict which objects will appear dark blue, which will appear light blue. Your "picture" will be very accurate - but it will not correspond to "reality as it is." Because you do not see the world without the blue lenses. Foerster asserts - and I agree with him - that our brain is exactly such "blue lenses." We do not see the world "as it is." We see a world constructed by our brain based on sensory signals. And this constructed world is the only reality we can know.

This does not mean that the external world does not exist. I am not an idealist. I only assert that we cannot step outside our own cognitive apparatus to see the world "as it really is." It is like trying to see your own back of the head without the help of a mirror. You cannot - because your eyes are facing forward. In exactly the same way, you cannot "see" reality without the mediation of your brain. And here my hypothesis takes a key step: if we cannot step outside our own cognitive apparatus, it means we need to modernize this apparatus. To develop it, make it more complex, more reflective, more capable of seeing its own "blue lenses." And this is the task of CCFP pedagogy [4].

Radical constructivism is often misunderstood. It is not "everything is relative" and not "reality does not exist." It is an epistemological position: we cannot know reality "as it is," because our knowledge is always mediated by our cognitive apparatus. This does not mean that all constructions are equally valid; it means that the criterion for evaluating constructions is not "correspondence to reality," but viability: the ability to allow us to navigate the world and achieve goals. For neuroscience, this means: theories of consciousness are evaluated not by whether they "reflect"

reality, but by whether they allow us to work with consciousness - to predict, explain, and treat. These ideas are developed in detail in Foerster's later works, collected in the volume "Understanding Understanding" [7].

**"Objectivity" as the Illusion of an Observer Who Forgot They Are Part of the System**

Foerster does not just criticize naive realism. He shows that the very idea of "objectivity" is an illusion created by observers who have forgotten that they are included in the observed system. I consider this thesis one of the most important for understanding why neuroscience is stuck in the trap of correlations. Imagine you are playing chess. You make a move and say: "This is objectively the best move." But what does "objectively" mean? It means the best from the point of view of your strategy, your goals, your understanding of the game. Another player, with a different strategy, might consider this move bad. There is no "objectivity" here - there are only subjective assessments included in the game.

In exactly the same way, I assert, following Foerster, that scientific "objectivity" is not absolute truth. It is a consensus of observers who have agreed on certain rules of observation. But these rules are not "laws of nature." They are constructions created by observers. This does not mean that science is "everything is subjective." I am not a relativist. I only assert that scientific knowledge is not a "copy of reality," but a construction that proves to be viable in a certain context. Imagine you have created a map of a city. The map is not the city itself. But if it allows you to navigate, find the right streets, and avoid dead ends - it is "true" in the sense that it is viable. It does not have to be an "exact copy" of the city - it has to be useful. In exactly the same way, scientific theories are "maps" that allow us to navigate the world. They do not have to be "exact copies of reality" - they have to be viable.

And here my hypothesis takes the next step: if scientific theories are constructions, it means we can construct better theories. Not by accumulating facts, but by developing the observer's cognitive apparatus. And this is the task of CCFP pedagogy [4]. The distinction between "objectivity" and "intersubjectivity" is the key distinction for understanding Foerster's position. "Objectivity" implies a "view from nowhere" - a position that does not depend on the observer. "Intersubjectivity" implies an agreement between observers - a consensus achieved through communication and verification. Foerster asserts that science can only claim intersubjectivity, not objectivity. This is not a "weakening" of science; it is its refinement: science is not a "reflection of reality," but a collective construction that is verified through practice.

**Recursion: A System Describing Itself**

The central concept of Foerster's philosophy - and my hypothesis - is recursion. In mathematics, recursion is a process where a function calls itself. In Foerster's philosophy, and in my concept of epistemological recursion [2], it is a process where a system describes itself. Imagine you are writing a book about how to write books. You are describing a process of which you are yourself a part. Your description is part of what you are describing. This is recursion. In exactly the same way, I assert, when a brain studies a brain, it describes a process of which it is itself a part. Its description is part of what it describes. This creates a paradox that Foerster called a "strange loop" (a term borrowed from Douglas Hofstadter [3], which we will discuss in the next article).

Imagine you are trying to write complete instructions on how to write complete instructions. You will get stuck in infinite recursion. The instructions will include instructions that include instructions, and so on to infinity. This is a "strange loop." A brain studying a brain is exactly such a "strange loop." And it is precisely this loop that creates that very "hard problem of consciousness" that Chalmers spoke of (Article 1) and which I am trying to solve through the development of mental mechanisms [2], [4]. A "strange loop" is not just a "philosophical paradox." It is a structural characteristic of self-referential systems. The brain is a system that can create symbols denoting this very system. The symbol "I" is exactly such a "strange loop": it denotes the system that created it. Hofstadter (Article 5) [6] will expand this idea into a theory of consciousness. Foerster (Article 4) shows that this loop creates an epistemological problem: a system cannot completely describe itself without stepping outside its limits. The solution is not in "stepping outside" (which is impossible), but in increasing the complexity of the system, which allows it to hold the recursion without collapsing.

**How to Escape the "Strange Loop"? My Answer**

Foerster does not leave us in a dead end of infinite recursion. He proposes a way out, which I make central to my hypothesis: increase the complexity of the system. Imagine you are stuck in a maze. You walk in circles, unable to

find the exit. What to do? One option is to raise your head and look at the maze from above. But to do this, you need to rise above the maze - that is, move to a new level of complexity. In exactly the same way, I assert, following Foerster, in order for a system (the scientist's brain) to adequately describe a system (the brain as an object), it must increase its own complexity. It must develop new cognitive tools that allow it to "rise above the maze" and see it as a whole.

And it is precisely here that my hypothesis takes the step that Foerster did not take. I show: "increasing the complexity of the system" is not an abstract philosophical idea. It is a specific pedagogical project. The eleven mental mechanisms of the CCFP [4] are precisely that toolkit that allows the brain to "rise above the maze" and see itself from the outside. But here I want to make an important clarification, without which my answer would be vulnerable. Increasing complexity does not guarantee an escape from the "strange loop." It creates the conditions of possibility for such an escape. Even the most complex cognitive apparatus cannot "see itself" completely - it can only maintain awareness of its inclusion in the system. This is not a "solution" to the problem, but a way of working with it.

The distinction between "escaping the loop" and "working with the loop" is the key distinction for understanding my position. Foerster speaks of "increasing complexity" as a way to exit recursion. I clarify: a complete exit is impossible, because the observer always remains part of the system. What is possible is working with recursion - maintaining awareness of one's inclusion, which allows one to see more than the "naive" observer sees. This is close to what Varela (Article 6) calls "neurophenomenology": not "stepping outside" experience, but working with experience from within. And this is exactly what CCFP pedagogy does: it forms the ability to work with recursion, rather than "solving" it.

**Connection to the CCFP: Why the CCFP is the Answer to Foerster**

My hypothesis is a direct development of Foerster's ideas into a specific pedagogical program. Allow me to show this as clearly as possible. Foerster asserts: the observer is part of the observed system. I show: this means that to study the brain, it is not enough to simply accumulate more data; the observer themselves must be modernized. Their cognitive apparatus must be developed, made capable of holding the recursion of observation [4]. Foerster asserts: science does not see its own "blind spot." I show: the eleven MM of the CCFP are precisely those tools that allow this "blind spot" to be seen. MM-5 (Socratic dialogue) teaches one to ask questions about the very foundations of science. MM-6 (critical thinking) teaches one to question basic axioms. MM-11 (strategic forecasting) teaches one to hold multiple perspectives [4]. Foerster asserts: in order for a system to describe itself, it must increase its own complexity. I show: how exactly to do this. Through the purposeful development of mental mechanisms within the framework of the CCFP. Through guided neuroplasticity. Through pedagogy understood as a strategy for the evolution of the species [2], [4]. Foerster asserts: we do not reflect reality, we construct it. I show: this means we can construct better theories. Not by accumulating facts, but by developing the observer's cognitive apparatus. And this is the task of CCFP pedagogy [4].

The connection between Foerster and the CCFP can be formulated as follows. Foerster describes the problem (the observer is included in the system, and this creates recursion). The CCFP describes the solution (the development of mental mechanisms that allow one to hold recursion). Pedagogy describes the process (the formation of these mechanisms through education). Three levels - epistemological, psychological, pedagogical - form a single chain. Without Foerster, the CCFP would lack philosophical justification; with him, it becomes an answer to a specific epistemological problem.

**Specific Mental Mechanisms as Tools for Overcoming Recursion**

Allow me to show exactly how specific mental mechanisms of the CCFP allow one to overcome the recursion of observation that Foerster spoke of. MM-1 (Establishing deep cause-and-effect relationships) allows the scientist to go beyond simple observation of correlations and see multi-level connections, including the connection between the observer and the observed. In the context of neuroscience, this means: not just recording "Area A is active during Task B," but understanding how the very process of observation affects the result [4]. MM-5 (Socratic dialogue) allows the scientist to question their own foundations. This is precisely the tool that allows one to see the "blind spot" of science. In the context of neuroscience, this means: the ability to ask the question "What if the very paradigm of neuroscience is a construction, and not a reflection of reality?" [4]. MM-6 (Critical thinking) allows the scientist to see their own cognitive limitations. This is precisely the tool that allows one to "rise above the maze." In the context

of neuroscience, this means: the ability to question the dominant neurocomputational metaphor and seek new conceptual frameworks [4]. MM-10 (Spatial imagination and 3D visualization) allows the scientist to hold multidimensional models in mind, including the model of their own brain as part of the observed system. In the context of neuroscience, this means: the ability to intuitively grasp the recursion of observation, to see how the brain studies the brain [4]. MM-11 (Forecasting and strategic thinking) allows the scientist to calculate the development of a scientific problem several steps ahead, including the consequences of their own theoretical constructions. In the context of neuroscience, this means: the ability to understand how the theory we are creating affects what we observe [4]. Thus, the eleven MM of the CCFP are not just a "set of skills." They are a specific toolkit for overcoming the recursion of observation, designed to solve a specific task - the task of understanding the brain.

The list of MM relevant to overcoming recursion is not limited to those listed. Any of the six core mechanisms (Article 5) can be a tool for working with recursion, because they all constitute the act of re-conceptualization. I highlight these five in particular because they are most directly related to Foerster's task: seeing multi-level connections (MM-1), questioning foundations (MM-5), seeing one's own limitations (MM-6), holding multidimensional models (MM-10), and calculating consequences (MM-11). Together, they form a minimum set of tools for working with recursion.

**Foerster and Ethics: The Responsibility of the Observer**

Foerster drew another important conclusion from his concept, which I consider critically significant: if the observer is part of the system, then they bear responsibility for what they observe and how they observe it [8]. Imagine you are a doctor. You do not just "observe" the patient - you influence them. Your observation is already an intervention. You cannot be neutral - because you are already included in the "doctor-patient" system. In exactly the same way, I assert, following Foerster, a scientist cannot be a neutral observer. Their observation is already an intervention. Their theories are already constructions that influence how they see the world.

This creates an ethical dimension of science. The scientist bears responsibility for what constructions they create, what paradigms they promote, what "realities" they construct. My hypothesis takes the next step: this responsibility extends to pedagogy. If we develop certain mental mechanisms in children, we are constructing a certain type of observer. And we bear responsibility for what type of observer we construct [4]. This is the very responsibility that turns pedagogy from an "applied discipline" into a strategy for the evolution of the species. We are not just "teaching children" - we are constructing the future of science, the future of cognition, the future of humanity itself [2], [4].

The ethical dimension of science in Foerster is not "adding ethics to science." It is a consequence of his epistemology. If the observer is included in the system, then their actions have consequences for the system. This means that science cannot be "ethically neutral" - it is always already ethically charged. For pedagogy, this means: the formation of a cognitive apparatus is not a "technical task," but an ethical act. We are responsible for what type of knower we are forming.

**Key Quote: The Phrase That Changes Everything**

Here is a quote from Foerster that should become an anchor for the reader and that has become one of the cornerstones of my hypothesis: "Objectivity is the delusion of an observer who has forgotten that he is part of the observed" [1]. This phrase is the essence of second-order cybernetics. It shows that science cannot be an "impartial mirror of reality" - because the scientist themselves is included in the reality they are studying. My hypothesis takes the next step: to overcome this illusion, it is not necessary to abandon observation, but to modernize the observer. To develop their cognitive apparatus, to make it capable of seeing its own inclusion in the system. And this is the task of CCFP pedagogy [4].

Foerster's quote is important because it formulates the epistemological diagnosis of modern science. "Objectivity" is not an "ideal" to strive for; it is an illusion that prevents one from seeing the real structure of cognition. Overcoming this illusion is not an "abandonment of objectivity," but a transition to a more complex understanding: science is not a "reflection," but a construction that is verified through intersubjective practice. For neuroscience, this means: theories of consciousness are not "reflections" of consciousness, but constructions that allow us to work with it.

**Bridge to the Next Article: Douglas Hofstadter and "Strange Loops"**

Foerster showed that the observer is part of the observed system, and that this creates recursion. But he left an open question: what if it is precisely this recursion that is the source of consciousness? It is precisely this question that becomes central for the next scientist - Douglas Hofstadter. Hofstadter, in his famous book "Gödel, Escher, Bach: An Eternal Golden Braid" (1979), introduced the concept of a "strange loop" - a system that, rising through levels of hierarchy, unexpectedly returns to its beginning [3]. Hofstadter asserts: consciousness is exactly such a "strange loop." It is a system capable of referring to itself, creating symbols that denote this very system. The "I" is not a "thing," but a process arising in a sufficiently complex symbolic system. This is directly related to my hypothesis. I assert: the development of mental mechanisms is precisely the training of the brain's ability to create such "strange loops." MM-5 (Socratic dialogue) and MM-6 (critical thinking) are precisely those tools that allow the brain to reflect on itself, to create symbols denoting the very process of thinking [4]. But more on this in the next article, where I will analyze Hofstadter's concept in detail [6].

The connection between Foerster and Hofstadter is the connection between a problem and a solution. Foerster describes the problem: the observer is included in the system, and this creates recursion from which it is impossible to escape by simple methods. Hofstadter describes the solution: recursion is not a "problem," but the source of consciousness. A "strange loop" is not a "trap," but a mechanism that generates the "I." This distinction is important: for Foerster, recursion is something to be overcome; for Hofstadter, it is something to be understood. Both approaches are compatible: we can understand recursion (Hofstadter) and work with it (Foerster), without trying to "eliminate" it.

**Practical Conclusion: How Foerster's Idea is Used in CCFP Pedagogy**

Foerster's idea of the "observer as part of the system" has direct practical application in my pedagogical model. Development of metacognitive reflection through MM-5 and MM-6. Foerster showed that the observer is included in the observed system. Within the framework of the CCFP, this means the purposeful development of MM-5 (Socratic dialogue) and MM-6 (critical thinking) [4]. The student learns not just to record facts, but to reflect on their own process of cognition, to ask questions: "How does my observation affect what I am observing? What constructions am I creating?" Formation of constructivist thinking through MM-1 and MM-11. Foerster showed that we do not reflect reality, we construct it. Within the framework of the CCFP, this means the development of MM-1 (cause-and-effect analysis) and MM-11 (strategic forecasting) [4]. The student learns to understand that any knowledge is a construction, and that they bear responsibility for what constructions they create. In the context of neuroscience, this means: the ability to understand how theory affects observation. Cultivation of scientific responsibility through MM-3 and MM-7. Foerster showed that the observer bears responsibility for what they observe. Within the framework of the CCFP, this means the development of MM-3 (emotional intelligence) and MM-7 (constructive debate) [4]. The student learns to understand that science is not an "impartial mirror," but an activity in which living people with their own values, beliefs, and responsibilities participate. Preparation for a scientific revolution through MM-9 and MM-10. Foerster showed that to overcome recursion, it is necessary to increase the complexity of the system. Within the framework of the CCFP, this means the development of MM-9 (information search and analysis) and MM-10 (spatial imagination) [4]. The student learns to see their own cognitive limitations and develop tools to overcome them. In the context of neuroscience, this means: the ability to "rise above the maze" and see the problem from a new angle. Formation of transdisciplinary thinking. Foerster showed that the observer is included in the system. This means that to understand complex systems, it is necessary to go beyond the boundaries of a single discipline. Within the framework of the CCFP, this means cultivating transdisciplinary thinking - the ability to see connections between neuroscience, philosophy, pedagogy, cybernetics, and phenomenology [4]. The eleven MM are precisely those "cross-cutting tools" that work at the intersection of disciplines.

The practical conclusions from Foerster's ideas are not an "appendix" to the theory. They are a consequence of his epistemology. If the observer is included in the system, then education must form a reflective observer - one who is aware of their inclusion. If knowledge is a construction, then education must form a responsible constructor. If science is a collective practice, then education must form a communicative participant. These three qualities - reflectiveness, responsibility, communicativeness - are exactly what I call the "virtuous knower" (Article 11).

**Conclusion: From Observer to System**

Foerster showed that the observer is part of the observed system, and that this creates observation recursion. He formulated the principle of second-order cybernetics and showed that "objectivity" is an illusion of an observer who has forgotten about their own inclusion in the system [1]. For my model, this means the following. The CCFP is not just a set of dispositions, but a set of tools for working with recursion. The MM are specific tools that allow one to maintain awareness of inclusion in the system. Pedagogy is the practice of forming an observer capable of seeing their own inclusion.

And here we approach the question that will become central for the next article (Article 5, Hofstadter): what if recursion is not a "problem," but the source of consciousness? Hofstadter will show that a "strange loop" is not a trap, but a mechanism that generates the "I." And this will give us the key to understanding what it means to "be conscious" - and how pedagogy can contribute to the development of consciousness. The conclusion closes the block "Awareness of Complexity" (Articles 3-5). Morin (Article 3) showed that to understand complexity, the observer must be modernized. Foerster (Article 4) showed that the observer is included in the system. Hofstadter (Article 5) will show that recursion is the source of consciousness. Together, they form a complete picture: complexity requires the modernization of the observer; the observer is included in the system; inclusion creates recursion; recursion generates consciousness. And it is precisely this chain that lies at the foundation of my CCFP model.

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**Conflict of Interest**
The author declares no conflict of interest related to the publication of this article.

**Funding**
The research was conducted without external funding.

**Data Availability Statement**
The data discussed in the article are contained in the text of the publication. Additional materials can be requested from the author.

**Author Contributions**
Aleksandr Kleymenov - concept, research, text writing, final editing.



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