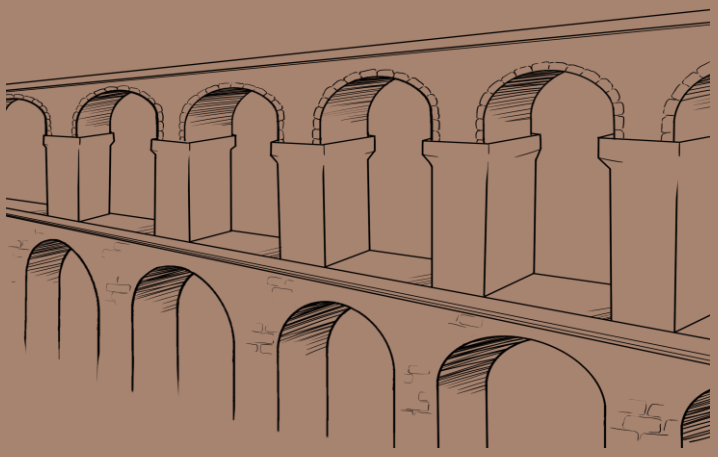

Metodologia II

Journal of International and Finnish Methodology

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Journal of International and Finnish Methodology

Issue II

Publication date 24.12.2021

Finnish Methodology Society

Cover illustrations Feodosia Jaatinen

ISSN 2736-9641

C O N T E N T S

Foreword

During this year, the most significant occurrence was at the beginning of the year when our journal was granted scientific journal Jufo 1 grading from the Publication Forum of Finland. Earlier the journal had also gained a peer-review label for the scientific standard peer-review process by the Advisory Board on Research Integrity (TENK).

Our journal is now developing more international ties and we are in process of registering the journal in as many sensible scientific journal registries as feasible to ensure that writers globally find the journal. Global demand for better development of methods in science is universally important academic topic. For this vast demand, we offer our free journal with a larger amount of text formats and highlight the freedom of expression by our writers. We believe in science. As a publisher, we do not believe in artificial rules, criteria without a basis for it nor any superficial demands. We review content and content only, not fashions of science or otherwise superfluous additions that are nothing to do with science. That has been our promise and the promise will be closely kept.

In this following issue II, papers range from physics and mathematical physics to interdisciplinary meta-analysis, educational practical views, and philosophical views on science and methods. The form of the text varies from peer-reviewed essays and articles (with the peer-review label) to general view essays on different scientific questions.

We wish good read for all our readers.

Editorial team & Juha-Matti Huusko Head editor

Tandem Piercer Experiment essay

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Abstract

This essay is based on the science project I am involved in as a duplicator of the nuclear physics experiment. The beam-split-like coincidence counting experiment with gamma-rays was invented by the American electrical engineer Eric Reiter in early 2000. The experiment, which I eventually started to call the Tandem Piercer Experiment, raises down-to-earth questions about the wave-particle duality, the early development of the atom model, the concept of a photon, and quantum mechanics. These questions are highly controversial in dissident science and brought me, as a layman, to the center of the sociological questions on how theories evolve in physics society and how science works. A lot of this controversy is dealt with polemically in the essay in conjunction with the overall description of the Tandem Piercer Experiment. I wish to present this authentic original work of Reiter as a delicate citizen science project. It is open to theoretical and philosophical speculation and calls for participation.

Keywords: photon, photoelectric effect, gamma-rays, wave-particle duality, quantum mechanics, coincidence counting, beam-split experiment, scintillators, semiclassical electron model, accumulation hypothesis, loading theory, citizen science, fundamental physics, demarcation problem

"It is the mark of an educated mind to be able
to entertain a thought without accepting it."

- Aristotle[1]

Controversy over new ideas

We often hear that we have built the entire modern technological civilization based on quantum physics and the Standard Model of fundamental particles. But, how much of the technological advancement is a merit of heuristic engineering rather than theories in physics? All phrases that come with cliches and infinitely repeated punch lines in public, like "*quantum mechanics is the most precisely tested theory in the history of scienc*e," deserve a re-evaluation at times. Hypes and bubbles are common in our digital harvesting culture.

There is one problem. If someone were to doubt the mathematical effectiveness of quantum mechanics, like the German theoretical physicist Alexander Unzicker[2], NASA science researcher Alex Vary[3], or the independent Spanish scholar Oliver Consa[4], they would soon get most of the mainstream physicists and technocrats against them. There are so many new inventions like semiconductors, smartphones, lasers, global position systems (GPS), medical imaging (MRI), quantum computers, and new exotic forms of matter. Quantum and relativity theories[5] have become cornerstones of the most advanced and sophisticated achievements in science, symbols of the new era in human history that no other culture has accomplished before. Those theories have enabled so much that they should not be examined with wrong motives by wrong people, or they would be called heretics.

At the same time, quantum and relativity theories are so remote from the everyday conception that one needs to develop nearly absurd ways of acceptance mixed with strange mathematics, logical paradoxes, weirdness, unintuitiveness, and expertise in various experiments, real and made by thought.

If we rely on the scientific method's most guarded principle, namely criticism, even the greatest theories should be included in continuous evaluation and re-examination. I have not yet fully understood how the science community resolves the issue of embracing skepticism and, at the same time, treating individual critical thinkers as heretics. I've been a few times in a conversation where thousands of people in "The Worldwide List of Alternative Theories and Critics" collected by Jean de Climont have been blacklisted as crackpots.

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[1] My favorite quote which is misattributed to Aristotle. The closest we can get to the quote is from Nicomachean Ethics, 1094b4: "for it is the mark of an educated mind to expect that amount of exactness in each kind which the nature of the particular subject admits." While the subjects in this essay are demanding, I do not want to bury the reader with the unnecessary depths of the formal mathematics behind the theories and technical details behind the experiments. That would require different types of publication. I want to take a minority side of the dissident and evaluate the theories of science covered in the essay from the angle of controversy with the conceptual level targeted to a dialog.

[2] Alexander Unzicker: Bankrupting Physics - How Today's Top Scientists are Gambling Away Their Credibility, 2013.

[3] Alex Vary: Critique of Physics Theory Inconsistencies, 2018.

[4] Oliver Consa: Something is Rotten in the State of Quantum Electro Dynamics, 2020.

[5] Please, see Appendix 1 to learn a short history and description of quantum mechanics and relativity.

Maybe that is due to resource handling. We try to be efficient in addressing only the new open problems that have good chances to be solved relatively quickly. But let us think of people who are not so much interested in building a career in science, making innovations for companies, or creating just new content. Let us propose for the duration of this essay that science is a way to pursue truth and ask specific questions about reality like why, how, when, what, from where, and to where.

In one of his interviews[6], Alexander Unzicker said that there are two possible ways to fail in scientific pursuit. When you question everything and when you doubt nothing. We have no time to verify every reference and source or derive everything all the time from the first principles. We need to start from some assumptions, somewhere in the middle, and see what kind of picture we can build. Further, if there are assumptions that we cannot confirm, study, and understand, they are probably not worth believing.

Looking for other appearances of puritanism in science, one might add competition between countries and the struggle for superiority between departments in the same university. Recently, I was listening to the World Science Festival conversation between Brian Greene and Nobel Laureate Brian Schmidt[7]. I found that there is a tough competition to be the first to discover and publish and a strong separation between being right and wrong in the field. That leads to unhealthy side effects in social co-work, but also misleading communication to the public. Eventually, I think this will lead to problems in the scientific method itself.

The central question is how to develop critical thinking and appreciate *a taken* world view instead of *a given*?[8] Something seems to be missing from the communication when we do it by old-fashioned "ask me anything when I am on a lecture stage" way. It is nice, it can inspire and accumulate the feeling of togetherness, but does it bring us closer to the truth? The sleek presentation should not take over the hermeneutic dialogue. One-to-one trusted conversation is the way to go if gaining ontic understanding with the epistemic one is the main concern of the seeker. I am not totally convinced that the elevator pitches work well in this pursuit.

Research is a long way from immature thoughts, incorrect assumptions, imperfect interpretations, fuzzy data, and over-simplified idealizations to slowly filter out things that do not work, correcting, iterating, bettering things that do not match. Often it is a path to learn new things at the same time. Brian Schmidt wished that people should instead seek cohesion than using their time to prejudice or postjudice who is right or wrong.

Suppose the discussion starts from the final results and the most recent news. In that case, no one realizes how it came to be; solving the problems, being wrong, hesitating, agonizing over, and doubting your reasoning to the point you think you have become crazy. There is already so much displeasing among researchers when they put something on the public table that anyone can analyze and falsify. It is very different from creating fantastic theories about cosmological origins, expanding spacetime metrics, dark forces, and parallel universes, all those sub-Planck scale theories that possibly cannot get any evidence of in our lifetime. We are fluid in talking about the scientific

[6] Conversations on Fundamental Physics: https://www.youtube.com/watch?v=Uo5MAhLpNu4

[7] Cosmology and the Accelerating Universe: https://www.youtube.com/watch?v=nO1eWxjQqaA

[8] See the concept of pregivenness by Edmund Husserl phenomenology: https://brill.com/view/journals/rip/50/1/article-p31_3.xml

method and empiricism, but at the same time, we fear simple experiments and workable theories because they are potential destructors of our ideas.

Modern physics is built on a vast and tight set of intervening principles and theories. If we change even a tiny part of the fundamentals, we probably need to re-analyze the whole system to see the consequences. We need to see if everything holds up in the bigger picture after modifying some current theory or using an alternative model.

The change need not to be enormous in equations after all. Sometimes we turn old words to mean something new and different, which may well lead to the most giant leap in understanding. This is, for example, what happened to the concept of time when it was tied to the geometric notation of spacetime in the Special Theory of Relativity. Einstein's 1905 paper "On the Electrodynamics of Moving Bodies" contained trivial algebra only, but shifting already parametrized time from the absolute background coordinate to the moving coordinate systems had radical implications in the conception of time[9].

Also, the concept of an atom changed its meaning from an original indivisible substance (Greek *atomos*) once it got split into smaller and smaller pieces starting from the hands of the cathode ray experimentalists in the 19th century. Scientists made the mistake of borrowing a metaphysical concept about the hidden substance of Leucippus and Democritus to a physical substance that scientists were improperly sure that it could not be split into smaller parts in the future.

The æther suffered by a similar take of scientists in the 18th century when it was used as the luminiferous æther, referring to some medium where light, magnetism, and gravitation would propagate. That is relatively far from the elemental æther spoken by ancient Greeks or quintessence spoken by medieval alchemists. And further it got when electromagnetism came first to work in, then to displace the æther. So, when we say that Einstein gave a death blow to the æther, we should at least know what æther he was, and we are referring to.

Words matter. In his later writings, Einstein suggested that his relativistic spacetime model for gravity in general relativity could be regarded as the æther, but no one bought that idea anymore. He was also sorry that philosophers misused the relativity concept and wished he could change its name to invariance theory. Laws are the same for all inertial frames of reference, the speed of light is constant for all observers, and spacetime is the all-existing geometrical framework where everything physical happens. That entails something absolute, stable, and permanent. But again, it was too late. People were already apt with the idea of relativity of everything. Words do really matter.

[9] Richard A. Muller: Now, the Physics of Time, Chapter 2 (2016).

Unquantum concept of Reiter

The Threshold Model that the American inventor and electrical engineer Eric Reiter proposes is about the fundamental interactions with electrons and combining the photoelectric effect equation $\boldsymbol{E = hf}$ [10] with the de Broglie wave equation $\boldsymbol{\lambda = h / mv}$[11]. The Threshold Model takes Planck's constant $\boldsymbol{h}$ as a maximum of action. Emission is quantized, but absorption is continuous and thresholded. We call it a semiclassical model where light is treated as a wave, and only matter is quantized.

The Threshold Model challenges the picture of reality if built upon the commonly accepted concept of the quantum jump and all spookiness caused by that. It is a small, kind of invisible change under the hood, but below the division line, the Threshold Model would significantly change the understanding of the fundamental interactions in an atom.

Another controversial thing is that the Threshold Model extends a long-ago proposed second theory of Max Planck which he debunked himself in 1923[12]. Similar approaches to the model of an atom were also called the accumulation hypothesis and the loading (or pre-loading) theory at that time. Reiter's approach is not totally new, but he asks, if the experiments were adequate, if precise enough details were taken into account, and if the trial was fair?

With the Threshold Model of Reiter, the old theory is lifted from the grave. But to be exact about Planck, he said that the resonator idea in his second theory had been disproved "*at least in its extreme form.*" Reiter's model is a modification of Planck's second theory, and thus taken to the perspective of that time in 1923, Planck might have thought differently about the Threshold Model, who knows.

One common criticism against Reiter's work is that "there must be something wrong in the experiment." In the Tandem Piercer Experiment, two scintillation detectors side by side measures a single beam of gamma, causing coincidental photoelectric effects, i.e. full-height pulses/clicks, in both detectors[13]. One might see these two statistically counted full-height pulses as a violation of energy conservation law. On the other hand, we do measure those two pulses, and it is a basic duty of the experimentalist to repeat and verify that there are no errors in the result.

To conserve energy for individual atomic processes, keep up with the conventional quantum theory, and have the double full-height pulse, there we have an unsolved dilemma. One suggestion is to look up the definition of energy conservation in Bohr-Kramers-Slater theory, where energy conservation was temporarily considered a more general statistical law[14]. In the wave-based Threshold Model, energy would be conserved in the same manner as a statistical law that allows two full-height pulses on two tandem detectors.

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[10] Energy **E** is Planck's constant **h** multiplied by frequency **f** (often written with Greek letter Nu **ν**).

[11] Wavelength **λ** (Greek letter Lambda) is Planck's constant **h** divided by momentum, which is mass **m** times velocity **v**.

[12] Helge S. Kragh, James M. Overduin: The Weight of the Vacuum, Chapter 3: Planck's Second Quantum Theory (page 17), 2014.

[13] Please, see Appendix 2 for the more details about the beam-split, the coincidence, and the tandem experiment. Exact details of the experiment you will find from Reiter's original works retrievable from his website https://www.unquantum.org/ and from the Reiter's publications mentioned in the bibliography of this essay.

[14] Helge S. Kragh: Bohr-Kramers-Slater Theory, 2009.

The quantum mechanical model cannot explain the result with the given constraints. Instant quantum jump in no time with the burst of energy packet in the electron emission process should release energy with not enough left for the second full-height pulse. Thus, Reiter provides the name Unquantum Effect for the mechanism of the experiment.

Sometimes it is regarded as a subtle issue only that the photoelectron emission and the quantum jump are in direct conflict in the Maxwell fields. Ashok Muthukrishnan writes with his collaborators in the revisited paper (2003) about the concept of the photon[15]:

> *Where we depart from a classical intuition for light is a subtle issue ... that there is negligible time delay between the incidence of light and the photoelectron emission. While this is understandable from an atomic point of view - the electron has finite probability of being excited even at very short times - the argument breaks down when we consider the implications for the field. That is, if we persist in thinking about the field classically, energy is not conserved… We just do not have the authority, within the Maxwell formalism, to affect a similar quantum jump for the field energy.*

This is a proper example that depending on the premise, either we discard the (semi)classical model because it contradicts with the energy conservation and the time symmetry from the quantum mechanical point of view, or we could take the dissident stand that the principle of energy conservation reveals unsolved problems in quantum mechanics.

Classical fields with fixed spacetime respect the energy conservation law, but that is not in harmony with the photoelectric effect in short time scales. Because the consensus is that quantum mechanics is “the most precise theory in the history of science” at the moment, we look at the situation through that lens and discard the classical paradigm. To me, this sounds like a rather rough area of problems that are swept under the carpet. This fact alone justifies all the fundamental questions and criticism against the quantum hype. Do we understand the development of the competing theories and how the consensus was reached? Where are the results of the comparison of the models and interpretations? Have we used enough time for the comprehensive experiments? Do we study enough counter-examples?

Reiter’s work fuses historical research, theoretical formulation, and experimental practice that we could genuinely test, try to disprove, and observe from many different angles. Not many modern alternative theories come even close to that extent. Since Reiter has delivered the model, the experiment, and the results with his interpretation, I think it is a duty of conventional physics to explain the exact mechanism, how the energy would be conserved in the Unquantum Effect. Might the explanation be some sort of x-ray fluorescence radiation, gamma escape peak, gamma backscattering, double Compton scattering, etc., that gives coincidence rates greater than a chance in the tandem detectors. And even more should be done for severe and constructive criticism, perhaps constructing a variation of the experiment with new parameters that can be tested. There must be some further resolution to Reiter’s experiment, which should be issued by a fully elaborated scientific method.

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[15] Ashok Muthukrishnan, Marlan O. Scully, and M. Suhail Zubairy: The concept of the photon - revisited (2003).

In his various papers, Reiter points out the exact places where the assumptive theoretical and engineering mistakes happened. The conception of an atom changed rapidly between 1911 - 1932. There were many models and lively development. Reiter argues that decisions related to the atomic model were made hastily. How many physicists there were working with the new ideas, who were responsible, and members in the jury for the decisions?

When I read the historical publications about atomic models in the first part of the 20th century, it did not particularly strike my eye that everything was in the constant stream of testing and verifying things. Experiments seemed to be very rare indeed. Talks, gedanken - thought experiments[16], and theories dominated. It is tempting to think that the comprehensive routine of testing was nonexistent because better automation came only after computers were invented. That would explain why they did not find the variation of the beam-split experiment that Reiter found at the end of the 20th century. The foundational beam-split test should be made with gamma-rays, scintillators, and photomultipliers. Thus, it is the irony of nature that to be able to prove the wave model, the Tandem Piercer Experiment is done in the most particle-like situation with an extremely high frequency gamma-ray spectrum of electromagnetism rather than with a lower frequency x-ray or a visible light like it was done earlier in history.

Photomultiplier alone with too widely distributed pulse-height spectrum has a significant limitation that experimentalists had not realized before. In the Tandem Piercer Experiment, gamma-ray beams produce photoelectric effect in the Thallium-doped Sodium Iodide scintillators in the correct energy arena where the photoelectric effect does not get mixed with the Compton effect. That shall form a proper detector setup. According to Reiter, when detectors are oriented in a tandem geometry, and the gamma-ray pierces both detectors, it would reveal the real substance of light and allow us to see through the illusion. Who would have ever thought of this kind of experiment?

Of course, there is a big risk when resurrecting old theories. If we stick only with the grandmasters of modern particle physics: Lenard, Lorenz, Planck, Einstein, Curie, Heisenberg, Schrödinger, de Broglie, Noether, Bohr, Born, Dirac, Pauli, etc., we may fall off the wagon of addressing issues they just could not handle, but which are well examined in the 21st century. It is not at the reach of this essay to address the most recent development in these topics. But, certainly, knowing the original papers of the founding fathers and knowing the historical development of particle physics is a significant advantage in understanding the current controversy.

One relatively common plea to impugn Reiter's experiment is that it has not been accepted and studied generally by physicists. It is a common pitfall to think that inventions and discoveries would happen overnight. When we read in the science magazines that something new is found, we might get the wrong impression that something happened suddenly or that something is definitely proven. Often it is quite the opposite, especially if individuals do the work without institutional horsepower.

Verifications might take dozens, even hundreds of years, due to required technological advancements and the critical path everything goes through in a validation process in a scientific community. For example, gravitational waves, black holes, slowing clocks in gravitational fields, and many other predictions made by Einstein’s relativity theories have been experimentally tested

[16] https://plato.stanford.edu/entries/thought-experiment/

just recently, almost a century later than they were first speculated. Verification of the relativity experiments is still under debate, in the dissident world, at least.

Unfortunately, some could also abuse the long acceptance time as a defense to any theory. Superstring theory has been under heavy criticism recently because it could not hold to expectations in the last twenty years. Logically speaking, it is *not* possible to show that superstrings can *not* get evidential support in the future. By the criteria of slow progress, string theories could still be going on for many decades and turn out to be useless to anything else but mathematical achievements. Did we suddenly get into other thoughts about the principle of falsifiability?

Some models are dismissed even if evidential facts support them. That is alarming. It raises the question of what causes this social thing to happen? How have certain people earned their position to present quantum mechanical fantasies or subtle modifications to Einsteinian relativity where other people would directly be called heretics or denials? Some social platforms such as Reddit, StackExchange, and YouTube have started to act as police in this subject and ban people who offer critical non-mainstream theories. It is about information warfare, the back kick culmination of the post-truth that I think science will not benefit in the long run. The extensive worldwide list of dissident scientists[17] shows how many flourishing ideas there are beyond mainstream science. We just need to distinguish scientific dissent from totalitarian denialism and be ready to reap the fruit.

Beauty, truth, or both in theories?

There is no such thing as a sudden acceptance of a scientific theory, not to mention swift paradigm changes and revolutions. It has also been said that - at least in theoretical physics - nothing can ever be definitely and finally proven. One can show only the supporting evidence from the measurable event. Sometimes observations come first. Sometimes theories are first. But eventually, they should agree.

It looks like some theories are nurtured to maintain hope without any evidence. These theories rely on the beauty and symmetry factor coming from the mathematics of the theory. The principle of elegance and simplicity has guided many theorists to successful discoveries in physics, but could these principles lead us astray as well? The German theoretical physicist Sabine Hossenfelder argues that it can[18]. The current overall stagnation of physics is due to praising beauty and symmetry argument, according to her.

If we think beauty is a subjective view and can hold researchers' personal semantic meanings, I believe any argumentation pro or against beauty will fail as a generalized principle. Would you trust your nose if it leads to faults, disharmony, separateness, malfunctioning hypothesis, illogicalness, and wrong answers? Anything that tries to achieve truthfulness is a beautiful orientation from the philosophical point of view. Some people might take symmetry-breaking models of reality as well as dreadful statistical data as an astonishing, gorgeous, and harmonizing idea. If we are guided by truthfulness in the form of beauty, does it really make sense to argue whether beauty is misleading

[17] Jean de Climont: The Worldwide List of Alternative Theories and Critics, 2020.

[18] Sabine Hossenfelder: Lost in Mat - How Beauty Leads Physics Astray, 2018.

or not? Those virtues would be strongly tied together. It would make every true theory beautiful. But every beautiful theory is not necessarily true in the sense of having a physical counterpart in the known world. That could be the trap.

Finally, there is this Einsteinian danger zone. Suppose one would deliberately or accidentally challenge any of the mainstream accepted theories of Einstein. That would give a quick green card to the promised land of waste to such scientists. In the Threshold Model, the unquantumness against the quanta of the photoelectric effect could be regarded as an insult to Einstein's heuristic Nobel work[19]. This is considered very, very bad by loyalists.

Summary of Reiter's research in his own words

Reiter explains all these controversial points in his works, so it is not short of comprehensive work and careful thought. One needs to dig deep behind the different layers of the research to see how these questions are addressed. In the more recent reply[20] to Arvin Ash video about the Bohmian Pilot Wave Quantum theory, Reiter gives a nice summary of his research, quoted here entirely with his permission:

> *In the early days, there was the accumulation hypothesis, also called the loading theory. It was worked on by Planck, Sommerfeld, Debye, and discussed by Lenard, Millikan, Kuhn, Whittaker, others. Planck explained in his second theory of 1911 that it was continuous absorption and explosive emission.*
>
> *Tests were performed on the idea most famously by Lawrence and Beams to find the Element of Time in the Photoelectric Effect. Its results were misrepresented in many famous textbooks like Halladay and Resnick to make us think that the accumulation hypothesis was wrong. The hypothesis was not represented fairly because those textbooks (and other) treatments did not consider a pre-loaded state that would explain the discrepancy between measured time and calculated time.*
>
> *The way it worked, according to Planck, is that h was a maximum value and that action can be sub-h, but experiments would not see it. I figured out how to see it in the beam-split coincidence experiment. That is a famous test of quantum mechanics that is really a physical test of Einstein's definition of the photon.*
>
> *According to Einstein, as stated by Bohr in his book, Atomic Physics, and Human Knowledge, a photon would go one way, and only one way, or another at a beam splitter, but if you reconverge the beam, you would build up an interference pattern. This is the real wave-particle duality.*

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[19] https://en.wikipedia.org/wiki/Annus_Mirabilis_papers#Photoelectric_effect

[20] Reiter's comment in Arvin Ash video: https://www.youtube.com/watch?v=eNJFUo7yHhQ (6/4/2021).

The first part of the thought experiment, the beam-split experiment, was performed by Clauser and later by Aspect. They did it with visible light and tried to assure us that quantum mechanics was correct. They made major mistakes, mostly due to not understanding what would be a reasonable alternative to QM.

The conceptual breakthrough I discovered was to do what Planck did to h, also upon e and m, of the electron. If you think the electron is a particle with mass m and charge e, the photon is inescapable in the photoelectric effect experiment. A charge can be understood as thresholded because the quantized nature was deciphered in experiments of zillions of charges that rallied an ensemble effect.

There are other details of my theory, of course, but the important part is that I did the experiment that demonstrates the distinction between QM and what I call the Threshold Model. We compare coincidence rates in the beam-split test to the chance rate. QM predicts chance. I am the only one to do the test with gamma-rays. Surprise! Coincidence rates exceed chance rates big-time, like 10 to 100 times, depending on how it is done. It is not a special case, it is repeatable, many sources of artifact were eliminated, and it varies as a function of physical variables in ways that make sense.

Then I did the same thing with alpha-rays. The atom does not always act like a particle either, and we expect that because rest mass also shows wave-particle duality. These tests and my theory reveal the flaw of QM and resolve the wave-particle problem.

Based on the private conversations with Reiter, it is clear that he does not deny all quantum physics. Quantum mechanics mostly work, as we can see. But, it cannot explain the anomaly shown in the Tandem Piercer Experiment. Reiter's main point is to clear out the paradoxical wave-particle duality and clarify that the semiclassical Threshold Model could explain all weird, counterintuitive quantum phenomena. At first sight, this seems plenty said, but on the other hand, many of the concepts in quantum mechanics are inseparably connected. If the beam-split experiment can be explained by other means, it would yield foundational ideological effects cascading through the whole conundrum of quantum theory.

Bold claims

Controversy is the main ingredient of the natural philosophy of science. There is a constant struggle between experiments and explanations of the experiments. Controversy happens before anything is shown; it stays meanwhile and continues afterward when all should be clear and certain.

The Tandem Piercer Experiment indicates an anomaly that may require an update to the quantum mechanical model of particles. Moreover, it may suggest even new physics not explained by the current Standard Model. That is confirmed by the Finnish theoretical physicist Dr. Matti Pitkänen. He has researched quantum mechanics since the 1980s when he started to build his own Topological Geometrodynamics theory that unifies quantum mechanics and Einsteinian relativity in his Ph.D. thesis.

Pitkänen takes the results of Reiter's experiments seriously, although he does not support the original conclusion made by Reiter. Pitkänen has spent a significant amount of time understanding Reiter's experiment. I was often amazed how a purely theoretical approach can eventually achieve the same results as experiments. It just does not happen without going through endless iterations and thought processes.

Based on personal collaboration with Reiter and Pitkänen, I now know it takes a considerable amount of time to investigate other people's work. Anything will take, if we start to think about it ourselves rather than rely on the previous knowledge and general consensus. In some sense, we need to buy the idea and see the world through it to adopt enough information to discriminate against the new theory. That requires close teamwork and collaborative methods from the inside out rather than trying to operate merely as an objective operator. That was one of my most important lessons. The holistic view comes from having both the inside and the outside look at the topic, subjective and objective combined. That asks for social and cognitive skills along with the other scientific virtues from the researcher.

Pitkänen has built up his interpretation[21] of the Unquantum Effect from the Topological Geometrodynamic[22] point of view. He uses a coherent quantum state of N-gammas to explain how there could be a single appearing gamma[23]. It has a similar state in the quantum realm, or maybe even the same as the Bose-Einstein condensate. If we presume that a) quantum mechanics is ok, b) the experiment result is tangible, and c) the condensate could happen at room temperatures, then we might want to expand the theory of quantum mechanics. It would be less painful than totally leaping over the quantum jump.

Can the N-gamma model explain convincingly why the true coincidence test gives us uniform distribution meaning that scintillators show only one detection at the time? And, how could experiments demonstrate that N-gammas spreading in the same direction are real? We have the same criteria here to fulfill; all phenomena related to the experiment must hold up, not only the special cases.

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[21] https://www.researchgate.net/publication/352537350_TGD_based_interpretation_for_the_strange_findings_of_Eric_Reiter

[22] Matti Pitkänen: Topological Geometrodynamics, 2016

[23] Based on private conversations with Matti Pitkänen and his draft paper "TGD based interpretation for the strange findings of Eric Reiter" in 04-06/2021.

In the near future execution of the Tandem Piercer Experiment, our team will be testing these models as well as bettering the test by keeping x-ray fluorescence and gamma escape peak predictions of conventional physics particularly in mind. We expect to find it not a problem because the pulse-height filter already addresses the fluorescence or other not-gamma-related effects. Unfortunately, there is no such thing as absolute certainty in this business.

Claims about the new physics, new particles, new interactions, anomalies, and so forth are easy to say for brave people, but at the same time, they are insanely bold. Only particle accelerators can indeed do most of those kinds of experiments nowadays. As famously said by Carl Sagan: "*Extraordinary claims require extraordinary evidence.*"

But, there might still be exceptions like the American radio amateur Grote Reber who started his radio astronomical survey in 1936 and worked for a decade alone before he got recognized. Astronomy and biology are starting their new age of discovery when citizen scientists are getting along[24]. Particle accelerators can already be built at a home garage[25], as did Michio Kaku at his high school age. Many modern smartphones would outperform The Deep Blue supercomputer that became famous by beating Garry Kasparov in 1997.

It is easy to prejudice work that is in progress or offers controversial considerations. We may take a quick, clean, and lazy path, trusting that the house will eventually win, or we can take a dirty, unpredictable way, make our bet and live in excitement. For a few celebrities like Stephen Hawking, betting was adequate, but without the fame, it would be regarded as a shame for most of us. That should not be the case.

With less secrecy and more encouragement, nowadays, we have better possibilities than ever for creating new experiments and theories. That would require a shift in the scientific methodology where the study process would be made transparent to the public. The results need to be shared without paywalls and overly complicated scientific jargon so that the public can participate in projects.

[24] https://en.wikipedia.org/wiki/List_of_citizen_science_projects

[25] Build your own particle accelerator: https://core.ac.uk/download/pdf/327368343.pdf

Science - the duty of a citizen

> *Science is a universal human right, according to UDHR [Universal Declaration of Human Rights] Article 27. Therefore, everyone should have the right to participate in science, be heard, and present their research in relevant scientific media*[26].

The setup for the Tandem Piercer Experiment is not that hard to arrange. It requires a few weeks of dedicated spare time work. My subject of astonishment is that nobody has tried to replicate the experiment earlier, although Reiter has been demonstrating it for twenty years already. After a few months of looking at the old discussions and building up new discussions on the topic, I cannot think of any other good reasons but prejudice over the proposal.

Exaggerated expressions about the illusory nature of quantum mechanics and the omission of particles on behalf of waves might have shot to the presenter's leg. How could you attack quantum mechanics by the experiment that uses quantum mechanics? Doped scintillators, gamma-ray source isotopes from the nuclear fission products, electronics in the photomultipliers and oscilloscopes, they are all based on quantum physics, right?

Technically speaking, since Reiter explains the Unquantum Effect by the non-quantum Threshold Model, he is not arguing quantum mechanics against quantum mechanics, as the other side would claim. Outrageous straw man argument does not work because it puts words on a mouth. Explaining how all other things work in the world, that is not a thing for a single man to do. Apparently, a lot would be rewritten and many things that were drawn under quantum mechanics would be rearranged, if the anomaly gets verified and the Threshold Model is true.

Moreover, why wouldn't you be allowed to express your honest conclusions as you see them in your own experiment? The area of conjectures is a free zone, after all. Anyone can and should build their interpretations based on the experimental data independently. If it is done without knowing each other, even better.

Other prejudices might go to the outline of the articles of Reiter. His research has been pretty organic. It may or may not comply with the rules of some institutions and peer reviews. Critics have been about the incoherent layout of the publications. The defense is that there is only that much one man can do. While I embrace individualism in thinking, I must also recognize the power of teamwork in scientific contribution.

I'm thinking of science as a road to reality, not as a throne of truth. Peer reviews should be places where scientists are assisted in orienting the research outline rather than filtering what is acceptable and conforms to the mainstream - general opinion of scientists - and what is not. If peer reviews are places trying to build up authority, the whole idea of the scientific method fails at that point.

My impression is that there is increased criticism of how institutionalized science in its hierarchy and methods fails. The reason for their unwillingness to investigate unconventional

[26] See Marco Perduca's comment in Nature: https://www.nature.com/articles/d43978-021-00013-w

proposals may relate to the issue of economy and capitalism that rule over the hunt for the truth. Proposals will not get through the walls of Jericho but via certain authorized gates only. It is not enough to be correct, but you need to provide compelling content for a more complex and demanding society of researchers.

Peer-reviewed journals are used kind of a joke after all because anyone can discredit journals in the discussion favoring their own preferred journals and supposedly showing their ability to critical thinking. One cannot build any constructive dialog when soft-engineered by questioning what a respectful journal is and what is not. In the end, only the articles published in Nature and Science magazines will get attention and significant publicity which might be beneficial to the individual researcher.

The peer-review tradition that started from the London Royal Society in 1665 had its place, but for example, Einstein's 1905 papers did not go through any referees. Instead, they got published solely by editor's choice, might it have been Max Planck or some other person in *Annalen der Physik* German journal[27].

That said, Reiter's work has been published in the peer-reviewed journal "Advanced Studies in Theoretical and Experimental Physics: Progress in Physics, vol. 2 / 2014". It could have been more profiled, said Reiter. It looks like it has been a terrific job to get a voice out into the community.

Most physicists just refuse to comment on anything related to intensely controversial topics in public. That is a sign of silent pressure to dismiss some selected work and favor the other that fits the currently accepted range of theories in science. Indeed, I do not believe that this is how the research should be done, especially a genuine scholarly study. On the contrary, it reveals to me an unsophistication in pursuit of truth.

Personally, as used to free and independent thinking, lifetime learning, and divergent communication in other areas in my life, I am a bit worried about this fact. I see a close relation to religious-like scientism in the structure and foundations of some regions of science.

It is no coincidence that some scholars have started to talk about the church of science, where a community tightly holds up the strings of currently accepted views. Yet, I do not think that there is any single institution behind scientism. No conspiracies. It is more like a tendency toward a certain kind of human thinking that collects similarly idealized people to defend antiheretism. We should have better tools and more nuanced thinking for dealing with the demarcation problem.

It is sometimes claimed that from the 19th hundred onward, citizens and laypeople could not contribute anything to science anymore, at least hard sciences like physics. Only decades of academic study agreeing methodological positivism, with huge loans paving the way to the elite group of scientists, or the multibillion-dollar lab teamwork, worldwide satellite telescope installations, and nuclear collision projects are counted as real science, a sign of academic inquiry. The more money it takes, the more real it is. Have we become $ize-blinded?

In his latest writing, "Something is Rotten in the State of Quantum Electro Dynamics", the independent scholar Oliver Consa argues that politics and world economy came into the science

[27] https://mindmatters.ai/2020/05/einsteins-only-rejected-paper/

picture at the time of the Manhattan Project. An enormous amount of money and power was concentrated on the hardcore physics by the atomic bomb explorations and people who worked with them. Ivory towers and hegemony were built, and it is still kept up with certain academic-political requirements. In the 1960s and forward, particle physics and cosmology got married by colliding interests, and today they hold the most strictly ruled foundations of science, where there is no room for the different schools of thought. Postmodern relativistic truth does not fit their agenda.

However, this is good news for citizen scientists who want to study the world's phenomena or contribute to the common good purely from their innate interest. The Tandem Piercer Experiment can be done with the home lab equipment. This experiment is a fantastic opportunity to study fundamental physics in theory and practice. It is an excursion to the social aspect of science too.

We have made our best in the Tandem Piercer Experiment to do it all responsibly as citizen scientists should do[28]; carefully and honestly investigated, critically, truthfully, open-minded, the team reviewed, transparent, replicable, well tested, intelligibly documented, and communicated in the old fashion of the mentality of a natural philosopher with a modern twist of understanding and technology.

Of course, one should not underestimate the time needed to properly understand the Tandem Piercer Experiment's details. Even seasoned physicists might not get everything right by a short peak to the Tandem Piercer Experiment and the Threshold Model. I have witnessed this several times already. Probably only a few people have ever heard or taken a closer look at the second theory of Planck before. The inner functions of the scintillator detectors and the coincidence counting are hardly known but to specialists beforehand. They are not hard to understand, simply not a piece of common knowledge shared in elementary schools.

[28] Ten principles of citizen science: https://osf.io/ugy4t/

Wave-particle duality and photon

Another good thing for a layman or people coming from different fields might be that they have no established theory load and bias that one might get from the physics orthodoxy. But even then, the intrinsic idea of atoms, particles, energy, and photons might be a challenge. These ideas come from a society filled with the conventional models of things we have achieved in science in the last few hundred years.[29] Blobs of objects are easier to grasp, unlike waves and fields, especially mathematics related to them. Particles tend to come so naturally from the mouth.

I have encountered the same problem on the other topic of my interest, namely the concept of time. If our position is that time is not fundamental, or it is an illusion, we are kind of dragged into a paradoxical situation. Our everyday talk is surprisingly full of nouns related to timekeeping. It is almost impossible to talk without referring to time. Surely time must exist!

Interestingly enough, it turns out that only in the last decade, we got closer to having objective experimental evidence for the single-photon corpuscles. The best substantiation of the photon is based on the technique called spontaneous parametric down-conversion, where the signal and idler photons are statistically post-calculated[30]. Weirdly, in statistical analysis, because it is an approximation, we must detect less than a single photon too, or the average would be greater than one photon. That is against the idea of quanta, which should mean the smallest packet of energy. Difficulty in defining the photon is still actual as it was in the 20th century[31]. Definitions vary from a point-like geometrical abstraction or a stochastic vacuum fluctuation in the quantum field to an event in a photomultiplier, a wave packet on the Maxwell waves, or simply to a statement that we should not ask what photon is but instead define that a photon is what happens[32].

Initially, we built the wave-particle duality theory based on thought experiments and effects from electron diffraction. Then we tested the theory in Bell's inequality experiments by assuming a particle-like model solely and not assuming a wave-like model[33] as a control model. The concept of a photon in quantum experiments was a convention only, albeit a strong one. It was later shown that the earliest experiments, starting from G. I. Taylor in 1909, could not produce single photons assuringly because the photon bouncing effect was not realized[34]. Also, the photoelectric effect itself cannot be used to argue unequivocally for the particle nature of light[35]. We need much more direct and convincing evidence to answer the questions: what is a photon, what is the size of the photon, and how is the single-photon made and observed[36]?

Tandem Piercer Experiment is a gamma photon coincidence counting experiment by its core, which is why these matters concern me greatly and were quite surprising findings to me. Not too

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[29] https://www.scientificamerican.com/article/the-human-eye-could-help-test-quantum-mechanics/

[30] https://www.nature.com/articles/s41598-017-16773-9

[31] Arthur L. Robinson: Demonstrating Single Photon Interference - Even a single photon can manifest both wave and particle natures according to quantum theory, but demonstrating this is not so straightforward (1986).

[32] Ashok Muthukrishnan, Marlan O. Scully, and M. Suhail Zubairy: The concept of the photon - revisited (2003).

[33] https://www.nature.com/articles/s41534-018-0117-8#Sec8

[34] https://aapt.scitation.org/doi/full/10.1119/1.4955173

[35] Philippe Grangier: Experiments with single photons, 2005.

[36] Chandra Roychoudhuri, Katherine Creath: The Nature of Light - What is a Photon?, 2005

many demonstrations of the wave-particle duality talk about the engineering side of the experiment, how single photons (or electrons) are made, or how they behave throughout the test. Instead, we have concentrated on demonstrating the paradox only with simple naive geometrical drawings and animations. Undoubtedly, the double-slit experiment with light is amusing when it is presented as it usually is. Still, I think we should be even more interested in the experimental setup, how it is built and manufactured, not just repeating the result, which was a thought experiment originally without direct evidence for several decades. I fear that the more recent experiments are biased by the conventional quantum mechanical models and do not give equal footing for alternative theories and considerations.

Building new intuition over illusion

It should be easy to intuit from an everyday experience of a human how cups of water can be prefilled with water. When the cups get enough water, they will spill over. We also see an excellent analogy of the threshold in a situation where a high-note vibrant singer can break up the glass with the resonating power of the voice. It is a sudden event as if it was done by shooting a bullet into the glass.

Thus, would be the pre-loading Threshold Model in action. Electron clouds start to resonate by the absorption of the gamma-rays. For the currently known instrumental methods, the value of the pre-loaded state is unknown and unmeasurable; we would say a hidden variable. When the threshold barrier breaks, an atom emits a fixed amount of energy called quanta. From that on, Reiter hypothesizes that emission happens in a wave format only. The same would happen with matter waves (alpha particles), not just with electromagnetic waves, as in the case of the gamma-ray experiment. But, this is not to be taken like there is no need for the particle concept. A particle is something that holds itself together, also known as a soliton, which is a packet of waves that maintains its shape.

It is different from the all-mystical quantum jump, where something changes a state from one to another without any intermediate steps and time. Or, let it be a quantum-entangled pair of particles related to each other in some strange way, possibly from the different sides of the universe, breaking the speed of causality laws. These were challenging ideas even for Einstein to accept. Should we just get over it without any journalism?

Intuition can be developed, matured, changed, programmed again by studying and repeating. Whether something is intuitive or not is not a good meter here. It is just something we are forced to start with. One can get used to the weirdness of quantum mechanics. Suddenly, the wackness in turn may begin to feel intuitive.

By the beam-split, the dual-slit, Bell's inequality theorem followed by the related experiments, and exciting twists in thinking, we are deceived into thinking that quantum nature is real, even if it is crazy. Classical laws cannot explain certain fundamental phenomena of physics from the Planck scale to multimolecular scales. Only above those scales, the classical equations start to dominate with the relativistic limits on the macroscopic scales. Deep in the level of the quantum foam, all is

about probability waves and either the collapse or branching of the waves. That is a common conception.

It is quite striking to think if we have missed something crucial in this narrative, yet can we do so much with quantum mechanics.

However, we should not forget that quantum mechanics is just a mathematical formalism that does not even try to tell anything about the world itself. It is up to our philosophy or worldview, whether we accept the realistic or the psi-epistemic interpretation of quantum mechanics[37], or some agnostic variation of them. But it does not remove the fact that probability waves are nothing close to things we will ever sense in human interaction with the world. Interpretation of quantum mechanics has always been an enormous challenge. People take different positions on it. Are we allowed to speculate, or just calculate the Copenhagen way?

If we think this a couple of times more, we might conclude that quantum mechanics is even worse than an illusion because it is not meant to illustrate the world as it is. It only shows how to calculate the smallest possible invisible things in the world with insane precision for ensembles. Magnetic momentum has been predicted to a whopping 12 decimal accuracy compared to the actual measurements, although Alexander Unzicker and Oliver Consa claim it was not factored honestly in the beginning. Yet, we do not get the size of the proton but only to the second decimal with the same quantum field theory (QFT), namely quantum electrodynamics (QED), so we need to get help from quantum chromodynamics (QCD). At the moment, many experimental and ad hoc parameters are added to the quantum theories making it a big mess where only specialists are able to shuttle. These technical issues are a separate issue themselves which certainly are not helped with the fact quantum mechanics lacks explanatory power. It drives us to either give up and follow the math or open our mind for mysticism. Well, unless we are open for philosophical discourse and require that science should also explain the world, not just act as an equation solver and calculator.

The metaphysician has yet one more card up his sleeves against four ace physicists. Are the classical concepts of waves and particles any closer to reality than quantum descriptions of the world? What does it even mean that some mathematical equations or understanding based on some models of the world would be closer or further from reality? Do the more precise measurement and prediction imply better understanding, or are we just on the way to defining understanding by that requirement? Maybe we have forgotten the mesocosmic observer's role in the equation while looking at and giving the special role only to the tiniest and the most gigantic things in the world. In his critical writing "Critique of Physics Theory Inconsistencies", Alex Vary writes:

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[37] In the jungle of concepts in the philosophical interpretations of quantum mechanics, anti-realism means the epistemic position (psi-epistemic) that we can have correct information or knowledge about the rules and laws of nature utilizing quantum mechanics. Still, anti-realism does not make claims about what reality is. The ontological position (psi-ontic) is that the quantum wave function (denoted by Greek letter Psi **ψ**) is reality. Thus, the psi-ontic position is also called quantum realism. Depending on the interpretation, the wave function can be separate from the physical reality. The collapsed wave function may exist in the physical world since it resolves to real number values instead of superimposed complex trigonometric density functions. So, both from the psi-epistemic and the psi-ontic perspective, superpositions of the waves could be real, but not in our dimensions and not for our comprehension. Finally, participatory realism or QBism takes the observer of the experiment to the central role. In this interpretation, a quantum state represents the degrees of belief in Bayesian statistical form, not reality. QBism differs from Copenhagen's interpretation, where the results of the experiment or observations are objective and real for everyone. QBism does not take a strict position with ontology.

> *We argue that the mesostratum is the transcendent foundation or substratum of our material world, the cosmos, and that cosmic physiostratum space-time is a granular discontinuum - that the physiostratum consists of oceanic array of tessellated space-time parcels.*

According to Vary, the conscious mind of the observer resides in both realms, and mesostratum would "*complete our understanding of fundamental physical reality.*" The study of consciousness has already started to retrieve scientific accuracy, rigor formulation, and instrumental experiments far ahead of pure philosophical discussion in the earlier decades. I expect this field to flourish in the coming decades when the old too simplistic mind-matter debates based on previous eras' logical empiricism ideology gives way.

Something new and intelligible

Reiter tries to make things sensible again. Rephrasing that something is both particle and wave simultaneously, carrying the idea of the wave-particle duality even if it seems contradictory and paradoxical, raises concerns about the consistency of our thinking. If the potential energy held by what we call a photon is indeed a semiclassical wave and resonating frequency only, and if we can show it by the experiment, then there are no paradoxes on that part anymore. The probability wave feature fades away, and the associated particle behavior with all strangeness related to them. It should be a good thing since paradoxes are almost the same beasts as infinities are in physics.

Solving the wave-particle duality's consistency problem by erasing quantum mechanics comes with a considerable cost, however. How would the new theory explain the rest of the phenomena that have been planted under the quantum umbrella? Who would be doing all that explanatory work? There is only so much time in one person's lifetime. It is not sensible or fair that one person should read all the quantum-related experiments and the following articles that have been published in the past hundred years, participate in those discussions, and give comments on all of them. A reasonable amount of precisely selected material in quantum mechanics should be enough to cover the demand for showing the familiarity of the scene.

Reiter's view is that most quantum phenomena we think of as separate revert to the beam-split, the dual-slit, and the coincidence counting experiments. We have built a complicated system of concepts that hides relatively simple foundations. Reiter's debate's single most crucial thing is that one should really try to explain the Tandem Piercer Experiment by conventional physics. There has been a need for experimental data to overcome the stagnation of physics over the last few decades. Novel experiments are rare and precious substances in our times. The experiment should have the privilege of being in the number one position because it is something concrete anyone can work with. The rest is speculation.

If any new theory is both giving the same or better predictions and simultaneously is simpler yet capable of explaining the world intelligible, could we think of it as a better candidate than the old ones?

It is hard to see behind the illusion of quantum mechanics, Eric Reiter has said. Some theoretical physicists like Steven Weinberg, Sabine Hossenfelder, Lee Smolin, and Roger Penrose argue that quantum mechanics cannot be the final answer. So thought Einstein. Quantum mechanics has brought highly suspicious theories and overly complicated experiments like the Delayed Choice Quantum Eraser[38] recently challenged by Hossenfelder.

Criticism is not just because quantum mechanics is formalism only and cannot explain the world coherently. The main reasons for the doubt are the measurement problem, the dimension problem, and the undecided role of the observer. Reason number four is that quantum mechanics cannot hold up with general relativity. But that is a whole different story relatively unrelated to the topic in question.

Whether quantum mechanics, the quantum jump, or the world itself is an illusion, that is with further ado waiting for the repeated experiments, further study, and bold thinking.

Acknowledgment

I have been advised in the experiment by Reiter in highly educational video chats we have had since April 2021. I have had numerous conversations on the topic with Finnish theoretical physicist Dr. Matti Pitkänen and an anonymous physics teacher in Finland, to whom I am grateful to get important critical views. In 2020, Pitkänen initially introduced the papers of Reiter to me. In spring 2021, I attended one of Reiter's online webinars, and eventually, we got into closer collaboration.

In summer 2021, I was delighted to have an opportunity to present[39] the experiment and inform the progress of it in the Discord “The Portal Book Club” in the Beta Study Group of Roger Penrose’s monumental work “Road to Reality” led by Ukrainian software engineer Iaroslav Karkunov. Also, the lengthy email discussion with Physics Foundations Society[40] has been helpful. I feel privileged to be able to participate in all these.

[38] https://www.youtube.com/watch?v=RQv5CVELG3U

[39] PowerPoint presentation of the Tandem Piercer Experiment: https://drive.google.com/file/d/1WUNwkBI4rkwGWLTAtJiZooO06VlrT72s

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3) Curt Jaimungal:
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4) Eigenbros:
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5) World Science Festival:
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8) The Royal Society:
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10) Dissident Science:
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12) Veritasium:
https://youtube.com/c/veritasium
13) Science Clic:
https://youtube.com/c/ScienceClicEN
14) Science Time 24:
https://youtube.com/c/ScienceTime24
15) EigenChris:
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16) Mathologer:
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17) NumberPhile:
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20) Neil deGrasse Tyson: https://www.youtube.com/channel/UCqoAEDirJPjEUFcF2FklnBA

21) Robert L. Kuhn: https://www.youtube.com/channel/UCl9StMQ79LtEvlrskzjoYbQ

22) Arvin Ash: https://www.youtube.com/channel/UCpMcsdZf2KkAnfmxiq2MfMQ

23) Matthew O'Dowd: https://www.youtube.com/channel/UC7_gcs09iThXybpVgjHZ_7g

24) Eric Weinstein: https://www.youtube.com/c/EricWeinsteinPhD

25) Stephen Wolfram: https://www.youtube.com/channel/UCJekgf6k62CQHdENWf2NgAQ

Appendix 1

Quantum mechanics, in the view of this essay

In 1800, the wave model of the light had just fixed its status in optics, and the wave model became foundational in Maxwell's electromagnetic fields. In 1900, Max Planck postulated that electromagnetic energy could be emitted only in quantized form, in packets of a fixed size. This started the shake of the pure wave model. Planck and his collaborators continued developing these ideas during the following years, which eventually became quantum mechanics (QM). In 1918, Planck received the Nobel Prize in Physics for his work on quantum theory.

In 1905, Einstein used Planck's mathematical treatment of the ultraviolet catastrophe in the black body radiation to explain the photoelectric effect. Only, when the electromagnetic radiation has a large enough frequency, that is, each of its photons carries enough energy, the radiation can strike electrons free from metal. Controversial at first, but in 1921, when Einstein received the Nobel Prize in Physics, the law of the photoelectric effect was mentioned as a reason.

The photoelectric and Compton effect suggests that sometimes light acts like particles: it carries energy in fixed quantities. The light particles are called photons. However, occasionally light acts as a wave: when monochromatic coherent light passes through a double slit with a certain size and dimensions, the resulting light waves create the interference pattern. Moreover, this is demonstrated in experiments with single-emit photons, which are thought to highlight the real quantum effect and confirm the dual nature of light. The conclusion is made that light - actually any fundamental matter particle as per de Broglie - has both features. This is referred to as the wave-particle duality.

Theory of relativity

In 1905, Einstein presented the special theory of relativity (SR), which stems from two postulates:

1. The laws of physics are invariant in all inertial frames of reference

2. The speed of light is constant in a vacuum

As a result, adjustments to Newton's laws are to be redone. For example, when observers move at large speeds, Newton's second law as a net force equals mass times acceleration has to be completed with general relativity. At low speeds, Newtonian mechanics still works well as an approximation.

During 1907 - 1915, Einstein developed the general theory of relativity (GR), an extension of SR. The general theory of relativity tells that gravitation is because of distortion of the geometrical spacetime due to masses. Equivalently we can say that mass is due to curvature of spacetime. In 1919, the first empirical evidence to support GR was obtained. In the experiment during a solar eclipse, it was observed that the Sun bent the light coming from distant stars.

The theory of relativity is separate from quantum mechanics. However, there is a strong pursuit to unite quantum physics and the theory of relativity. After creating the general theory of relativity, Einstein tried for almost 30 years to combine QM and GR until his deathbed. It turned out that the task was too tricky. The quest to merge these two theories with the known fundamental forces in the Standard Model is still open. The unified theory is hypothetically called the Theory of Everything, one of the biggest challenges of modern physics among the mystery of time, and the multidisciplinary subject of consciousness in science in general.

Appendix 2

Beam-split and tandem experiment

The wave-particle duality can be studied with the beam-split coincidence experiment. A light beam is split into parts which are then combined. Will the assumed photons be split? Will there be an interference pattern created as the superposition of two assumed merging waves? According to Einstein, each photon goes only one way in the beam splitter, but there will be an interference pattern.

The wave-particle duality is also studied in the Tandem Piercer Experiment developed by Eric Reiter. In the setup, gamma-rays go through two scintillation detectors, which are placed in tandem.

Scintillators are well-researched technical devices that can detect gamma-rays. The Thallium-doped Sodium Iodide scintillator emits optical blue light from the detected gamma-ray, which can then be converted to an electrical signal with a photomultiplier and finally acquired by an oscilloscope for statistical analysis. Isotopes like Cadmium-109 and Cobalt-57 are used to produce a constant beam of single-emit gamma-rays in the right energy arena (88KeV and 122KeV respectively) to distinguish the photoelectric effect from the Compton effect. Background noise, as well as x-rays and fluorescence effects, are filtered with the nuclear instrumentation modules.

It has been found in the Tandem Piercer Experiment that both detectors fire in coincidence at a rate notably greater than chance. When the firing, i.e. full-height pulses/clicks in the detectors, happens in the specific time window usually measured in nanoseconds, it is regarded as coincidental. That indicates a causal relationship between the detectors, a mechanism between the click one and two, which the conventional quantum mechanical model does not expect. By quantum mechanics, there should be just random noise.

As an explanation, Reiter offers the Threshold Model and suggests that light is a wave in the most fundamental level of reality. Only at the emission stage, when electrons have achieved a threshold level from the continuously absorbed and resonating electromagnetic waves, electrons emit energy measured in quanta. Reiter identifies what seems like quantized light as a threshold effect of charge, not a property of light. Reiter also did experiments with alpha particles and got the same result, making the subject even more subtle and interesting.

In conclusion, the Threshold Model by Reiter could explain the phenomena of two full consequent full-height pulses in the detectors, which conventional quantum mechanics cannot explain. That suggests that light is primarily a wave, in contrast to the commonly accepted wave-particle duality.

Meta-analysis on five systematic analysis method papers from Finland

Over several decades the methodology of systematic analysis has been developed in different fields of study to further the development of systematic methodology and perspectives in science. Most of the research heritage can be traced back to theology and later applications in systematic theology. Some of the developments have grown on the ideas of systems science or systems theory within certain fields of study, namely philosophy, biology, psychology, education, and earlier pedagogy. What interest us here are the development and different versions of systematic analysis. What needs further development in systematic analysis, and what perspectives require more consideration. For these purposes, this study analyses functionally different systematic analysis guidelines to make them more accessible for a wider audience since most sources are only in Finnish. In the current article, we meta-analyse these perspectives of five key publications (near 200 pages) about systematic analysis in terms of methodological scope, usability, and methodological limitations. Through understanding the functional differences in the perspectives of systematic analysis, we can analyse in what ways this method needs further development and what main directions we have for future development of systematic analysis. Thus far the majority of the studies are made for single corpus material. Using these method views and to study multiple corpuses with systematic analysis can easily add more procedurality for otherwise largely open method. If development is conducted erroneously or very subjectively, systematic analysis loses the value of openness as a method. This meta-analysis investigates not only the middle ground of procedurality and openness but attempts to find solutions for the increased need for scientific criteria when studies are dealing with the increasing amount of complexity.

Keywords: Systematic analysis, systems theory methodology, methodology, systematic philosophy, systems philosophy, philosophy of science, interdisciplinary methodology

Ari J. Tervashonka

Definition of systematic analysis

Analyses are made in a cohesive manner that logically permits for the formation of rational synthesis on the studied matter, thusly explaining something systematically.

Methodological development of systematic analysis in Finland

Systematic analysis is a scientific methodological philosophy that governs the criteria of scientific research. It is and it has been attempted to safe estimate in every country that has universities and people who try to create explanations of the world systematically. The notion, therefore, does not belong to any specific country or philosophy because the idea is in itself very simple kin to science as a systematic effort for explaining the world. This has taken many forms, such as the more well-known *systems theories* that are logically built structures of different fields of science. These lofty and decades needing theories have been built with similar traits of systematic analysis in mind to be able to create these theories in a sound and reliable manner.

Systems sciences are one of the applications of this methodological philosophy that is more globally recognizable. In addition to this more homogenous heritage, there are innumerable heterogenous variants of systematic analysis. Even in a country of 5.5 million people, such as Finland, there are tens of variants that can be compared generally but are used in different efforts as a methodological tool or methodological philosophy guiding tool of qualitative research processes. One of the starting questions could be why researchers use these very varied theory papers as methodological sources. The answer to this question is the development of heuristics of methodological frames of reference, entailing from the multitude of methodological philosophies and perspectives to even classification logic of very empirical evidence gathering. They are not only vital opinions while developing methodologically in direction of systematic thinking in science, but these papers also give countless numbers of methodological perspectives, always needed in a slightly different patterns when a person is orchestrating original research. It is a fitting effort for those who attempt to find unique solutions for each research question thusly making not only copies of the same research each time but ever slightly altering methodological choices with better method adjustments fit for the occasion.

Therefore, systematic analysis in all its conducted versions is the general cornerstone of systematic thinking in science. The following text is dedicated to the publication of a variety of ideas emerging from systematic analysis papers made in Finland for methodological use and development. We will analyse the key logic of each paper and make a comparison of the functionality of these versions of systematic analysis. This analysis also focuses on limitations and attempts to classify the use of these methodological papers for more varied uses. By organizing these originally Finnish materials, the goal is also to convey these ideas globally so that these ideas can be used for similar methodological efforts. The secondary goal is to gather the varied heritage of systematic analysis in Finland, not as an entire body of knowledge on the manner, but as a versatile variety of thoughts on systematic analysis to cover the maximum quantity of research questions methodologically.

For these purposes, we introduce the works:

Firstly, the paper of Jari Jolkkonen, *Systematic analysis as a research method* (2007), is used mostly in fields of theology and systematic theology as a methodological source. Yet still, a lot of other fields of science use and have used it, too.

Second, Juhani Jussila & Kaisu Montonen & Kari E Nurmi and their chapter on the philosophy of systematic analysis in the book Qualitative perspectives in education studies as well as their chapter

Systematic analysis as a method for pedagogical science (1989)[1]. The perspective of this chapter is the broad philosophical assessment of the methodological heuristics surrounding the use of systematic analysis. Despite or because of the philosophical focus of this source every time, this older book is almost in tatters in libraries due to its heavy reading use.

Third, one is Nurmi's later paper in form of Metodix article on Systematic text analysis (2004).[2] Earlier second guide of Nurmi and others is used here to compare the further development of this perspective.

Fourth, Aino Hannula has written on the use of systematic analysis of texts in the book *Openings to the analysis of quantitative studies* (2007[3]).[4] This writing highlights the practice of this otherwise philosophically challenging method and by practice thusly realizing the philosophy of systematic analysis for readers.

Fifth, in comparison to the earlier guide by Jari Jolkkonen and the works of Kari E. Nurmi, I published a systematic analysis hermeneutic theory (SAH-theory) (2020). The scope of this work was to extend Jari Jolkkonen's four classifications of topics[5] that systematic analysis can research in the theme of research of functionality[6] and to broaden the source limitations of the originally very immanently limited method regarding hermeneutic source considerations (for example when researching theory heritages).

Methodological functions of these five systematic analysis papers will be thusly analysed and compared in terms of theoretical heritage and directions. The choice of these papers is the similarity of their logic, sources, and reasoning to be able to form general comparison for them.[7] Not all functions or elements of these topics can be compared evenly, all of them extend to different venues methodologically. The important part of this consideration of differences is to show at the same time limitations and expanses of these methodological perspectives. If the content of these papers is familiar already to the reader, it is advisable to leap to the comparison chapter. The focus of the following five subchapters is to briefly translate and go through methodological key arguments of the materials as closely as these papers have been written. These five summaries have been made for nearly 200 pages of original materials that have similar common scientific heritage, philosophy, and sources. At the end of each summary of these papers, there are analyses on the methodological and philosophy of science content of the papers. After we have gotten through these papers, we form a comparison and synthesis of current systematic analysis uses and suggestions for new theoretical expansions.

[1] In this paper 1992 version of this book has been used, hence it is marked as 1992 and in sources 1989/1992.
[2] Not to mix with different text reviews that typically are very different in scope.
[3] Within this study we use 3rd edition version published in 2008.
[4] Hannula 2008, 111–125.
[5] Jolkkonen 2007, 12–20.
[6] Tervashonka, Suominen 2020, 49.
[7] For example, Nuopponen has used systematic analysis specifically for analysis of meaning with the heavier leaning into direction of systems sciences in theme of concept systems. These different views are very important for further views and development views but for the sake of baseline "cohort" similarity I have chosen papers with similar systematic logic for this article, therefore leaving systems analysis out of this topic. Nuopponen's views are still good example of combining qualitative analysis logic with systems approach in science. Nuopponen 2020, 94–122; Laaksovirta 1985, 35–44.

A part of the theology heritage on systematic analysis

In the very broadly used systematic analysis guide of Jari Jolkkonen, the assessment of systematic analysis is at the beginning very similar to the philosophy of Kari Nurmi. Jolkkonen, which suggests that the method indeed is a mixture of textual and conceptual analysis that creates together this very open but at the same time self-repairing method in use. He begins with four major classifications on different analyses that can be conducted with systematic analysis, but he also hints indirectly that there are at least these four directions by which to conduct the analysis. It is left open what other applications there might be. But by doing so, this choice displays good methodological reasoning since methods can be used in very varied ways sometimes even contrary to displayed major directions if the research topic asks for it. These four directions of analysis are elaborated in Jolkkonen's guide singular concept analysis (one concept at a time), singular argument analysis, argumentation analysis (general not singular), and prerequisite analysis.[8]

1. Singular concept analysis

Jolkkonen opens the explanations of these different analyses by contemplating the historical and theological load on each concept that is carried by its use. Words like divine communication, inspiration, tradition, or word of God. In the opinion of Jolkkonen, every meaning of the concepts can need singular classification to be found and understood by systematic analysis of the singular concept. For this effort he notes the following topics:

"-How often are the concepts used (important ones a lot, circular ones are rarer)

-What is the weight of the concept within the text

-What kinds of concept pairings are in text and what is the relation between them

-Is the concept being used in a normal or metaphorical way

-How are traditional theological and philosophical concepts used

-How closely are the concepts directed towards themselves"[9]

The unlocking of meaning behind the concepts starts with an understanding of the context and without an analysis of the concepts, it might be impossible to get a proper picture of the context or concepts. Jolkkonen uses the example of scholastics on this theme to highlight the qualitative rise in theology by dedicating attention towards meanings and by attempting to explain concepts unambiguously.

[8] In addition of these four major analysis directions I have written also about the suggested fifth one, analysis of functions, based on the works of Aino Hannula and myself in areas of earlier pedagogics and history of science, particularly history of theories. These will be discussed more later. Jolkkonen 2007, 12–19.
[9] Jolkkonen 2007, 13.

2. Singular argument analysis

Jolkkonen mentions the speech act theory of J. L Austin that determines that the use of language is not only descriptive but also acts and results in effects of these acts. The analysis of singular arguments has, according to Jolkkonen, at least three meanings:

1. The argument has certain *content*. This is the locutionary act of the argument.

2. Arguments are used to do something, for example, to describe, ask, greet, argument, complain and so on. These are the illocutionary acts of the argument.

3. Arguments are also used to trigger specific effects in the receiving person, such as strengthening the faith, guiding towards goodness, elevating social cohesion, triggering feelings of empathy and judgement, and so on. This is the perlocutionary act of the argument.

Jolkkonen continues with a similar list on what to take into consideration when analysing singular arguments:

"-Is the argument explicit or implicit?

-Is it the argument of the writer or the description of someone else's concept

-How strong is the argument; is it, for example, polemic in relation to the arguments of someone else

-Does the writer limit his/her arguments to other divergent arguments

-Are the arguments describing generally accepted facts or the writer's special highlighting

-How does the argument relate to classical theological and philosophical solutions"[10]

3. Analysis of argumentation

Jolkkonen builds this analysis on the shoulder of the previous two analyses by stating that argumentation analysis is built on concept analysis and argument analysis and attempts to deepen knowledge of them by concentrating on the reasoning behind them. It is seen as equally important to dedicate attention to singular and general assessments of the entire argumentation. For this analysis to succeed, the division of argument and explanation must be successful. In a broader way, the argument is not just an argument itself, but also the entirety of the argument: 1) claim, 2) reasoning of the claim, 3) background assumptions. Also, the explanation has three parts: 1) interpretive, 2) explanatory, 3) background assumptions. For the argumentation analysis, Jolkkonen suggests the following questions:

"-Are the claims in the text based on explicit or implicit arguments

-How are the arguments in the text documented or have they been documented at all

[10] Jolkkonen 2007, 15.

-What kind of arguments does the writer use

-Are arguments sound (coherent, factuality of premisses)

-Do singular arguments together form an inherently sound entire argument"[11]

4. Prerequisite analysis

When everything else is taken into consideration when researching arguments and the basis of those arguments, Jolkkonen notes the importance of prerequisites. The attempt is to explain how -based on the knowledge of prerequisites-, arguments (explicit and implicit) can be explained as soundly as possible. The question is on what fundaments the prerequisites are built on. He continues that a lot of systematic theological studies try to find a principle that structures the argument. Therefore, making the entirety whole in terms of logic of the subject. Jolkkonen highlights the following issues for this analysis type:

"-What is the relation of the writer towards different theological and philosophical schools of thought.

-What kind of reality supposition does the writer have behind his/her writings. Is reality, for example, portraited as spirit (idealism) or substance (materialism).

-What kind of ontological position does the writer have (realism, antirealism, monism, dualism).

-What kind of epistemological prerequisites are inside of the writer's perspectives. Can, according to the writer's information, those be based on foundationalism or is knowledge always conceptual (anti-foundationalism); can belief be founded on knowledge fundamentally or are belief and knowledge entirely different and incompatible (fideism).

-What kind of impression of God is displayed in the text.

-What is the impression of the spiritual message of the text (as a doctrine, presence, history, or experience).

-What kind of impression of humankind does the text presume.

-How are impressions that are displayed in the text related to classical fundamental theological questions (God doctrine, divine communication, Bible, history, tradition, reason, belief, concepts of theology and so on)."[12]

Jolkkonen continues that not all texts have a consistent fundamental logic or philosophical explanation of the entirety of the text. If this is the case, it is more advisable to dedicate an earlier argumentation analysis. Jolkkonen also displays the idea of system-immanency (immanent) that each source material has. Generally, when studying specific materials of an author, his/her text or texts can form an immanent self-explaining world with its own logic. It can be Bible or any monograph or other limited text corpus. Jolkkonen also uses the structural principle as a venue of explanation of the entire immanent text corpuses in terms of argumentative logic. When conducting research on the meaning of limited material, this logic can be found within the immanent understanding of thought

[11] Jolkkonen 2007, 17.
[12] Jolkkonen 2007, 19.

behind the text, not just referring to the text alone. He also continues that systematic analysis is often said to be system-immanent because the conceptual system is studied typically from "inside" following the rules of the text. In addition to this, the goal of it is to form a structural principle that means a fundamental solution, perspectives, or interests that are central for the writer and thusly explains the details of the entire subject.[13]

Although Jolkkonen's approach is brief and all the examples are dedicated to theology, many systematic analyses users have gained basic ideas from the guide of Jolkkonen. There has also been critique that systematic analysis needs development as Ida Heikkilä has voiced:

> "In Finland in systematic theology, the understanding and handling of method has been thin for a long time in comparison to conceptual questions. Negative certainty about that systematic theology does not have its own godly method has been strong but any positive alternative has not been done clearly and comprehensively. Jari Jolkkonen's Systematic analysis as a research method (2007) has retained its monopoly on dictating the method and quoting this clear but narrow guide from Batchelor thesis to dissertations has become standard. Baseless sentence "this research uses systematic analysis as a method" can be found in almost every study but the very rare sum of these can explain more broadly the magnitude of this method in choices of source materials, analysis of the sources and for demonstration of results. The pressure for clear and meaningful estimation of method has risen because of the co-operation of faculties and doctoral programs and on the other hand pressure by competition for funding: scientific research is more noteworthy when it can display a strong methodological foundation in many cases defined by ideals of natural sciences."[14]

Heikkilä has not particularly accused Jolkkonen of monopolizing somehow systematic analysis in theology even at national level. She has voiced concern over the fact that many studies are conducted in a more homogenous methodological manner despite the need for proper methodological vigour and borderless co-operation. This problem is reoccurring in each part of systematic efforts no matter the field of study. To really enchant the skills of method in systematic analysis broader reading on method and methodological philosophy is required like in any case when conducting proper research. In summaries of the next papers, there are more different fields of study applied. As a solution for the mentioned problem of Heikkilä, there is a door open to all other fields of studies where systematic analysis has been conducted, in some cases significantly more broadly scientifically.[15]

[13] Jolkkonen 2007, 20–21.
[14] Heikkilä 2020, 68.
[15] Heikkilä had also pointed out by comparison that Both Jari Jolkkonen and Lukas Ohly (in both cases of systematic theology) are highlighting the understanding of text by its own rules, as an inner world of the text, subjective and immanent in its form. This as a detail for those who would be interested on new developments of systematic theology in Germany. Heikkilä, 72.

Pedagogics and systematic analysis

The next paper on systematic analysis has been written by Juhani Jussila, Kaisu Montonen, and Kari E. Nurmi in the field of education. Their 51-page chapter 'Systematic analysis as a method for pedagogics' is a cooperative text that entails 6 chapters on the more philosophical sides of systematic analysis and is thusly the most extensive general explanation of the methodological philosophy of this method. Their paper offers very broad heuristics of systematic analysis as a method. It also mentions a large quantity of methodological heuristic problems that it is covering. As an aftermath of many other writings on systematic analysis, the only downside of it is practicality. The papers of Jolkkonen and Hannula have more to give in this capacity, although none of the other papers has such a broad scope.

One perfect novelty of this paper on systematic analysis is the broad consideration of those who have one way, or another used some systematic analytical thinking in their work of philosophy and science. The first chapters cover wide expanses of these examples from Aristoteles, Hegel and Leibniz to Husserl and Derrida as a critical point when solely reconstructive perspective was ultimately challenged with deconstruction in Derrida's thinking and as an earlier version in 'destruction' in Husserl's thought. This highlights the promise and usability of systematic analysis but also makes its limitations clearer. In essence, systematic analysis can be used in almost any scientific problem area, but how it is being used always varies depending on the case. It is vitally important to always view methodological books and writings as general or specific suggestions on how to maintain the scientific criteria and methodological heuristics within research.[16]

As for scientific criteria, this paper opens the task of systematic analysis in the form of analytical tasks and the creation of a synthesis. It is mentioned that there is no general rule for making synthesis, although it is always built on the combination of analysis. Analysis alone can only do the mental classification of the subject, content, meanings, context, and partly influences the reasons or understanding of prerequisites. But what makes the study systematically analytical is the creation of a sound synthesis that gathers and partitionalizes the results of the analyses.[17]

Therefore, the analytical work in the systematic analysis is conducted through the gathering of a systematic explanation structure by explanations of meaning, context, and the part that these single issues play in the whole system. In the end, every single analysis is compiled within the synthesis in a way that tells the relation between these pieces. By doing so, the synthesis builds up with the meanings and factual understanding but also with an understanding of the disorganization and arguments that speak for and against it. Writers also highlight that, because of how the synthesis is built, this kind of analysis needs a bigger picture in the form of a systematic overview over the entirety so that the study can be systematic analysis. This system is not always equivalent to systems theory or a rigid system, but in most cases, it is a system of thought. Logically arduous parts can be seen as nourishing parts for systematic analysis when trying to find analytical answers. Also, the entirety of the analysis must be limited in a sensible manner so that it can be supported in a meaningful way by the chosen methodological philosophy to make sure that the entire analysis has scientific integrity.[18]

The analysis can be conducted in a more limited form, for example on human thoughts, (thought system), organization, or anything out of which a corpus can be made. The focus is typically on the

[16] Jussila & Montonen & Nurmi 1992, 159, 162, 165.
[17] Jussila & Montonen & Nurmi 1992, 158.
[18] Jussila & Montonen & Nurmi 1992, 158–161, 170–171.

meaning of certain topics, terms, or some contexts created by the community, institution, or group. Another way of limiting the analysis is to share the details with the categories or phases chronologically or otherwise to ensure that the study has relevant limits. The analysis itself is mostly qualitative sorting, categorization and finding connectivity, meanings, and arguments and understanding these as a whole.[19]

The different methodological philosophies mentioned earlier -for example, hermeneutics and phenomenology- have given more insight into systematic analysis in the form of the intention of thoughts and formation of meanings and the concept of thoughts. The most importance on these themes is credited by writers for Aristotle researcher Franz Brentanon, phenomenologist Edmund Husserl and Martin Heidegger's thoughts as a deep systematic thinker. Also, the importance of this theme is central because it affects the phenomenological centre of a researcher, methodologically renewing intuition.[20]

In connection to this, the goal of systematic analysis is to explain the basic fundaments of the subject and the interaction among these fundaments. When the analysis has found even minuscule reasons and influences, the task is to find general principles that can explain the phenomenon that is being studied. The study can be conducted immanently, which means limiting study within the basis of certain text/corpus and leaving all the connectivities aside. The attempt is in both broader and immanently conducted study to theoretically attempt to understand thoughts and systems of thought reasoned from the material and to find the central reasoning or philosophy of this thought. Systematic analysis is therefore not only the reflection or reference writing but the deeper analysis of the inner world of the corpus material with its logic, reasoning, concepts, and meaning.[21]

In addition to this, understanding and thus critically examining source materials is more than subjective views. The text and the context of the text take preference because the text is always created in a certain time, culture, history, and by the minute feeling and intellectual notions of the entanglement of its creator.[22]

The difference, for example to content analysis and similar methods, is that systematic analysis attempts to build a deeper understanding of principles and views that create the possibility to master and compare thought systems that can be analysed from the content. Sometimes, it is also necessary to create new meanings or words or theories. This is a necessity when conducting the synthetical building of the theoretical entirety (for example analysing theories or thoughts). Sometimes, it is important to focus also on the influence and reasoning behind influences to be able to systematically explain the mechanisms of thoughts on the phenomena. If this is necessary, it is important to categorize in addition sources and to analyse meanings, to create a hypothesis of meanings and to illuminate the backgrounds of those meanings. Therefore, systematic analysis tends to add more layers of heuristics to the study and to create new possible reasonings. Studying meanings behind these hypotheses raises the understanding through bigger heuristics surrounding the study and thusly explaining better what the text entails.[23]

The writers Jussila, Montonen, and Nurmi divide the systematic analysis into three main tasks:

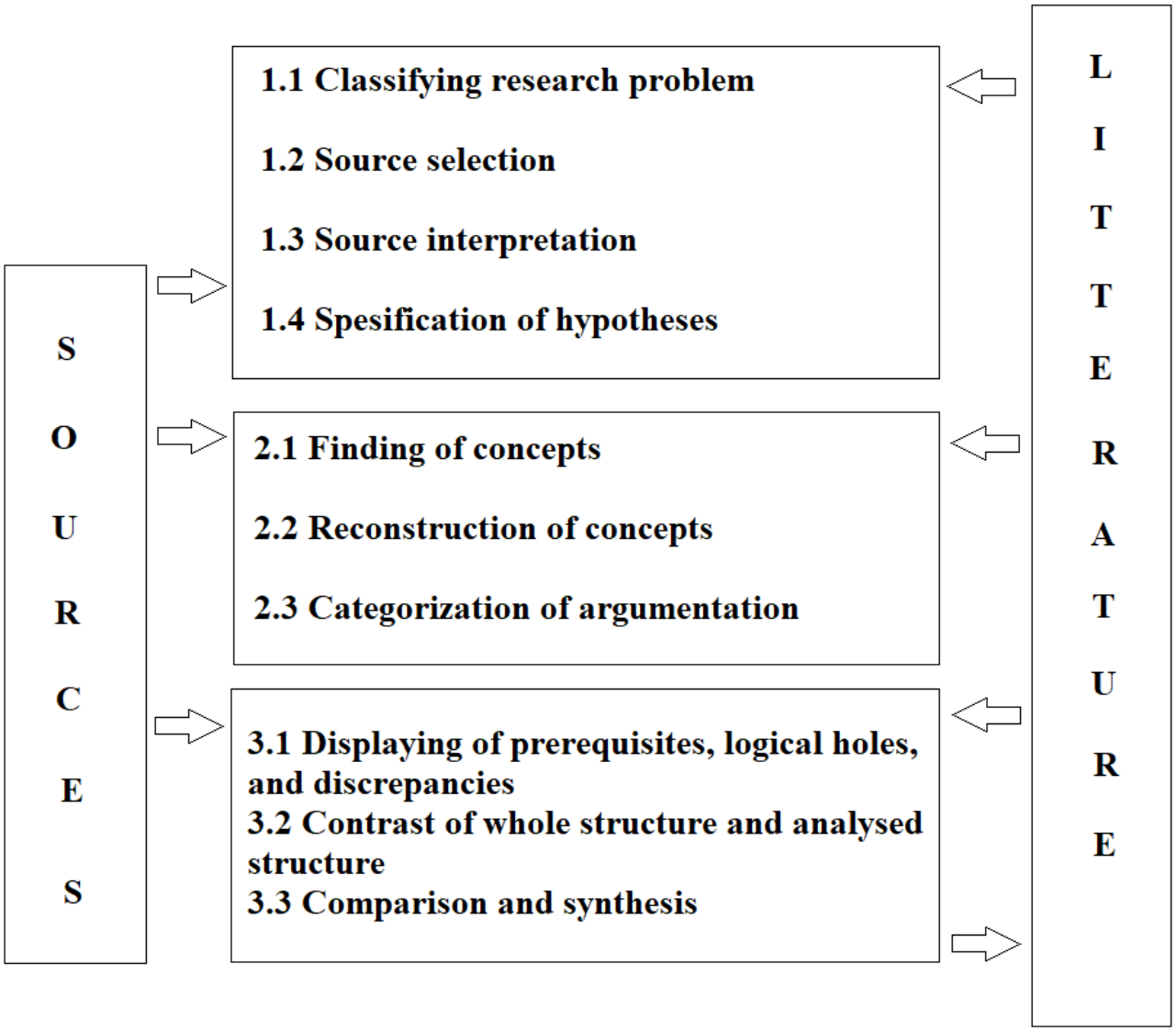
[19] Jussila & Montonen & Nurmi 1992, 196–197, 183–184, 197.
[20] Jussila & Montonen & Nurmi 1992, 167.
[21] Jussila & Montonen & Nurmi 1992, 171, 174, 198–200, 204.
[22] Jussila & Montonen & Nurmi 1992, 175.
[23] Jussila & Montonen & Nurmi 1992, 176, 184–187, 190.

1) Phase of understanding the problem and sources

2) Phase of analysis

3) Phase of explanation and use of analysis results

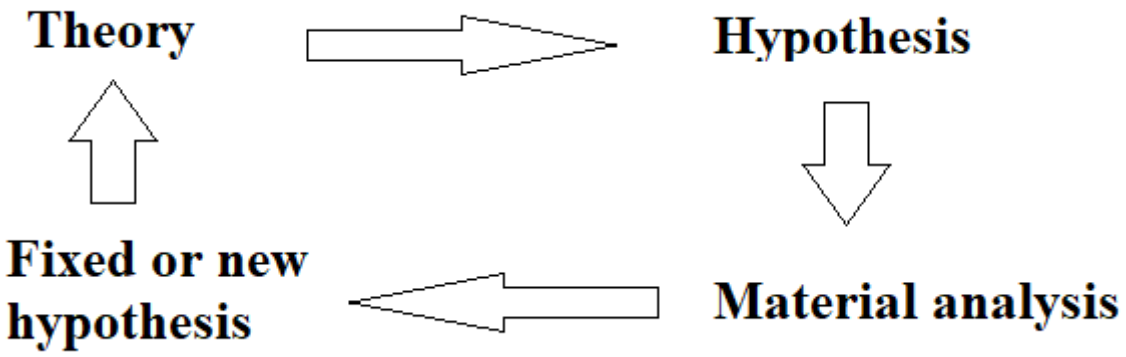
Jussila & Montonen & Nurmi Figure 1. Phases of systematic analysis[24]



[24] Jussila & Montonen & Nurmi 1992, 177–180.

In addition to these phases, there is analytical work on the creation of hypotheses that guides the phases of systematic analysis. These can be seen as follows:

Jussila & Montonen & Nurmi Figure 2. Theory grounded text analysis[25]



Hypotheses are trialled by going through this cycle as many times as necessary. It is vital to use theory parts of the source materials or support the new hypotheses on the basis of interpretation. In both cases, this cycle is repeated until the hypothesis can be deemed properly functional or as in many cases, it might turn out to be trivial. Also clarifying the science philosophical foundation of the researcher is needed so that the creation of reasons and processes can be judged more clearly.[26]

In addition to many details and explanations, the writers Jussila, Montonen, and Nurmi have remarked on how to review the quality of systematic analysis. Albeit that systematic analysis has basic elements of science as a method, its conduct cannot be reviewed similarly to single method-based research. Systematic analysis is gathered and modified by the philosophy of science, views, analyses targets, goals, and field of study related choices. Therefore, it is easier to think of systematic analysis as a mixture of analytical tools rather than a single method when reviewing the results. Thusly the analysed subject is one of the key nominators for review. This type of analysis, if made with immanent focus, cannot be reviewed as a general theory or frame of reference due to its before-mentioned limitations (we will also expand this topic in the case of the final paper SAH-theory).

Properly made systematic analysis attempts to get as near to the original system of thought of the original source as possible. To avoid critical subjective thinking flaws, the researcher needs to ensure the following according to Jussila & Montonen & Nurmi:

-Solutions for starting point, theoretical views and choices of texts are clear.

-Methodological solutions, background hypotheses, principles of interpretation are also displayed clearly. The research target is criticized and conceptualized in a way that the reader can understand the key thoughts and related details.

[25] Jussila & Montonen & Nurmi 1992, 189.
[26] Jussila & Montonen & Nurmi 1992, 189.

-Prepositions and interpretation heritages are not limiting the researcher's ideas too much; new interpretations must be possible, and through the comparison to old ones, new concepts can be displayed clearly.

-Justifications of interpretations are controlled by reviewing them with the connection of different parts of texts that are displaying similar themed thoughts.

-In interpretations, the first ideas are not typically satisfactory. The goal is to find as many multi-layered formations as feasible in addition to when certain concepts are used and how these have been supported.

-Displaying interpretation solutions that are not adhering to the researcher's own concepts.

After the holistically brilliant paper by Jussila, Montonen, and Nurmi we will go through more personally directed papers on the development of systematic analysis. Nurmi continued his contribution for systematic analysis in form of publication in 2004 polishing and clarifying some aspects of the method and advancing the amount of further reading on different classical sources of systematic analysis and different philosophies of science.

Later developments of Kari E. Nurmi – systematic text analysis

This later text of Nurmi is dedicated to the research of intellectual, philosophical, theory texts and the content of ideologies and worldviews within the qualitative analysis. This method is defined by Nurmi as a method based on immanent reconstruction that is handled systematically to understand the reasoning and concepts of texts, books, and corpus materials. It refers to the mixture of methods by which meaning, and structures of texts are studied with the purpose of reaching the reasoning of the concepts and connectivities, central ideas and the holistic view of the text.[27]

Systematic text analysis is applied in:

- **Philosophy and theology**: The study of earlier intellectual heritages, philosophies, theories or their parts, concepts and propositions, structures, and differing interpretations.
- **Cultural studies**: such as folkloristics, and literature studies, film and art studies, a study of cultural production and analysis of interpretation practices that belong to a culture.
- **Social studies and applied humanistic studies**: for theoretical assessment of already existing theories and analysis of different discourses.

The fundamental basis of systematic text analysis are typically linguistics and semiotic studies since any study of interpretation is also the study of meaning. In the opinion of Nurmi, because text analysis is generally applied for the study of classics or what is perceived as classical text, most of this endeavour is leaning in the direction of philology and the study of language structures in linguistics.

According to the perspective of research problematic, systematic analysis can be divided into parts that support each other as follows[28]:

- **Isagogics**: a study of the creation, appearance, genre, translation, and media variations of text.
- **Exegetics**: a study of original social contexts and connected meanings of the context of a text.
- **Interpretation history**: a study of chances of use and interpretation, and study of prerequisites and consequences of these changes within the text.
- **Hermeneutical study of** the text with present meanings.

Nurmi notes that although these classifications are artificial in nature, they still remind the researcher to ask different questions that have been already asked. That can sometimes lead to a new source or secondary source materials.

In the following parts, Nurmi introduces the different paradigms of text analysis within roughly four categories: hermeneutic-phenomenological, positivistic, critical and postmodern. These are introductory texts where basic explanations of these paradigms are expressed by linking them to

[27] Nurmi 2004, (sub chapter Application of systematic text analysis)
[28] Nurmi 2004, (chapter Science foundation of text analysis)

classical materials.[29] These provide the basis for the researchers to perceive different classical perspectives.

In addition to these perspectives, Nurmi offers five pairs of opposite views.[30]

1. Immanent vs transcendental

The analysis is immanent if the interpretations are limited to the own language, concepts and context and theory content. The analysis is transcendental if any outer logic from the corpus material is used within the analysis.

2. Reconstruction vs. deconstruction

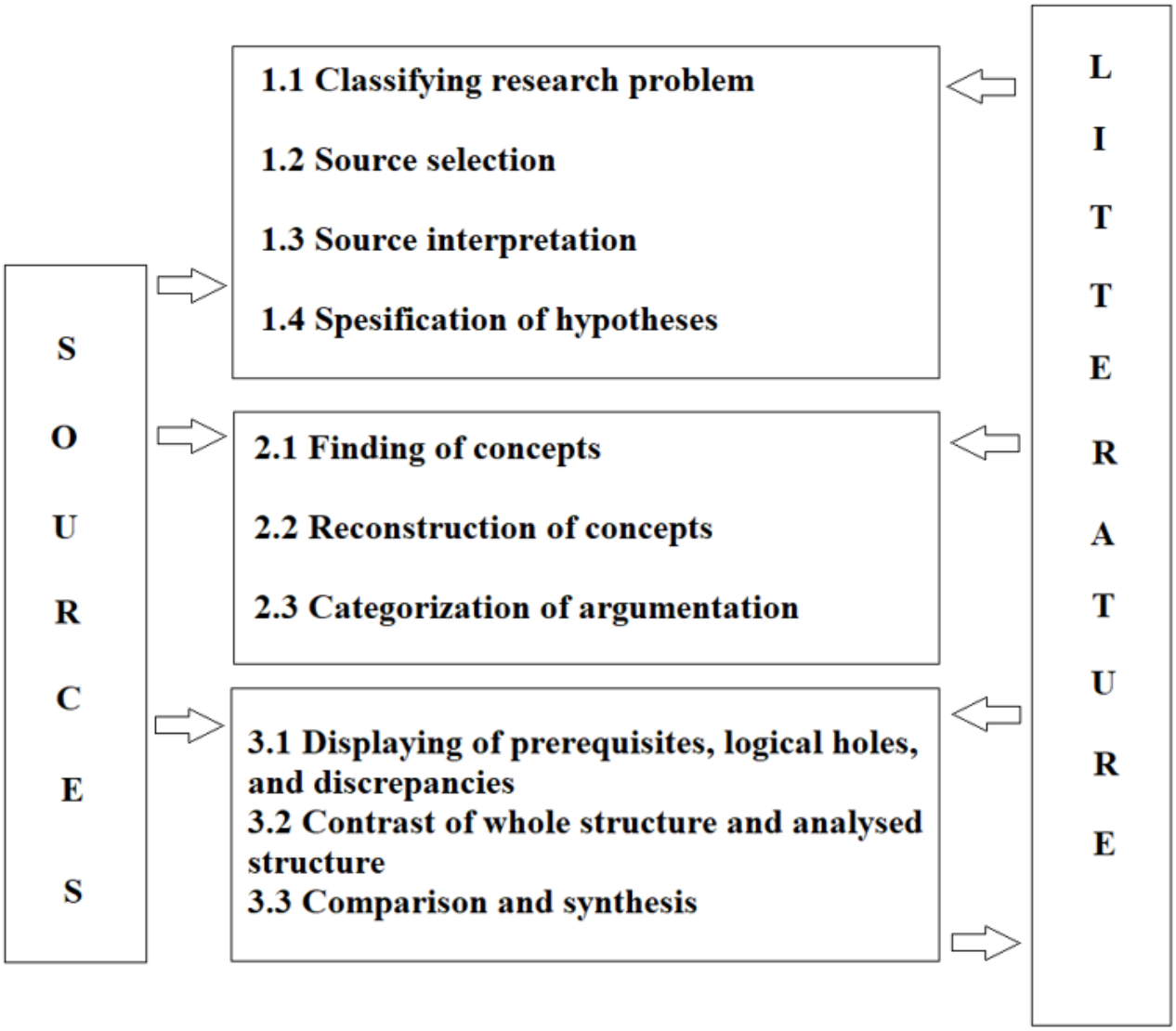
3. Categorizing vs. interpretation

4. Understanding vs. critical

5. Inductive vs. deductive

For research purposes, Nurmi has used the same formation here than originally in 1992, with the addition of subtitles in each part: 1) research problem and understanding sources, 2) analysis, 3) interpretation and use of analysis results[31]:

[29] All quoted and notified philosophers and scientists can be found on this part. Nurmi 2004, part 'Tekstianalyysin paradigmat'.
[30] These I have found useful in development of SAH theory.
[31] Nurmi 2004 (chapter Text analysis possibilities)



Immanent reconstruction

As explained before immanent systematic analysis works on problems of thought, philosophy in a personal or literary sense. The problem can be structural, argumentation related, conceptual, or contextual. It can also be applied as a secondary method for keeping the structure in research. Nurmi notes that this is done many times in the field of history and some cases in psychological or social studies.

The task of immanent reconstruction is to ask questions estimated by earlier studies and beginning knowledge of source materials. Systematic analysis is therefore iterational and typically based on heavy reading before, during and at the end of the synthesis of the analytical solutions. During these iterations of verifying answers for asked questions problem opens in a way that permits solutions eventually. There is no definite order of analysis and according to Nurmi it is normal that users of this method must return to earlier phases during research.[32]

[32] Nurmi 2004 (Chapter Immanent reconstruction)

To be able to form synthesis in the end the analysis is preferable to start with broader and open questions. In addition to this research must be critical about the limitations of understanding of conceptual theory created on the subject. In principle, every start of the analysis of earlier theories is based on systematic analysis. The research topic is also limited by the subject, timeline, and also limited by the original text. Also, hypotheses are created with the basis of earlier research and formed further if there is not adequate earlier research material available on the topic. On this occasion, researcher must face additional difficulties in finding the right questions. The function of these questions is twofold, it helps with the clarifying research process, and it helps a researcher to notice what they have learned during the research.

Choices of the texts that will be used for analysis are governed by the questions that the researcher must answer according to Nurmi[33]:

- What is the whole of the texts, text corpus where texts belong that is being analysed?
- What are the limitations of texts, where the analysed text begins and where it ends?
- What is the core of the text corpus, that concentrates on the issue researched?
- What alternative versions and their parts are being analysed?

Research problem needs to be defined as a clear question and hypothesis that can in principle be answered with chosen materials. The questions must be non-trivial, other ways said it must be in the form that the researcher's own and other researchers' hypotheses can be proven wrong. The hypothesis can be founded on the evident need that has to be checked with analysis. Otherwise, research traditions and increasing understanding of them within subject ruses the possibility of interpretation hypothesis. It is still important not to drown in hypotheses because text analysis hypotheses are different from experimental ones. Experimental ones do not automatically give the same results as earlier attempts. In text analysis interpretation hypotheses are based on the same sources but the researcher must be critical, exact, open, and logical to be able to find mistakes in the hypotheses. Sometimes researchers must take another road and forget everything and restart with a new hypothesis and read everything as new unknown material. It is easier if researcher chooses analysis methods that they haven't used before within the study.

Nurmi's thought and premise on the execution of texts analysis is that the thought system within the text is based on concepts and relations between them create connective propositions. Therefore, the text that is being analysed or a group of texts is a display of these propositions as a thought system in terms of theory and description. The text analysis is therefore finding of concepts, reconstruction of arguments, differentiating argumentation from the entirety of corpus, checking of prerequisites, and addressing holes in argumentation and contradictions.

[33] Nurmi 2004 (sub chapter choice of texts)

Early pedagogics research practices of systematic analysis

Aino Hannula has written in 2007 on the practice of systematic analysis. She has chosen the methodology background mostly based on the writing of Jussila, Montonen, and Nurmi in 1992 but has used this general philosophical view in a very pragmatic manner. The focus of Hannula's paper has been to explain in combination the methodological choices of her research on Paulo Freire's pedagogical classics. This methodological practice explanation includes a lot of phases and different descriptions of backgrounds of Freire's writings. These parts have been cut from this summary to ensure the clarity of Hannula's practical choices on how to conduct systematic analysis as a method.

Therefore, Hannula's pragmatic way has paved a pathway for many who are starting the practice of systematic analysis but are not yet very familiar with many philosophies of sciences and ideas surrounding the use of this method. By doing so Hannula has realized from the philosophy of systematic analysis most pragmatic tools, making her application of systematic analysis exemplary for the study of immanent corpus materials.

Hannula starts with similar positioning of the method by stating that the idea is to understand through understanding the inner world of the text, the philosophy and the thought of the original writer. Hannula has also given a comparison definition of the focus of the method. As a tool for the study of the content of the text discourse analysis, the focus is language and on content analysis focuses on the categorization of the text and by structural understanding maybe create quantitative data sets of the original texts. In systematic analysis, this task is another way around than in content analysis. In practice, the understanding of the inner world of the corpus material extends to used meanings, content, contexts, and inner logic of the creator of the text. It is therefore in addition study of hidden meanings, and the smallest details to form synthesis on how philosophy works.[34]

To achieve this task Hannula like Jussila, Montonen, and Nurmi use a divide between analyses and synthesis. Analysis in the systematic analysis is the practice of classifying thought systems from the text and synthesis task to gather the thought systems as a whole. (Here just to clarify it is not a study of systems in systems science sense, but qualitative focused more organic logic in terms of analysis). Hannula highlights the coinciding relation between analysis and synthesis by stating that within analysis the task of classifying earlier premises and through this understanding synthesis is based on this knowledge. Hannula describes this part as a process:[35]

[34] Hannula 2008, 113–116.
[35] Hannula 2008, 116–117.

> "Analysis is a way of thought journey in a world created by the concept- or theory system and the task is to raise, in perspective of thought, structures to lift essential thoughts to understand original reasoning as a whole."[36]

Hannula has here broadened the scope of reasoning between analysis and synthesis, making it manageable by bridging them together by stating that the relation of analysis and synthesis goes both ways. In terms of openness of systematic analysis, this view also helps to understand how synthesis is built on a practical sense.

In terms of analysis, Hannula uses similar open reasoning[37] of philosophy of science than Jussila, Montonen, and Nurmi and the choices even apply for later paper by Nurmi in 2004. If systematic consideration is done in terms of analysis and synthesis for different research questions different methodological or philosophies of science can be applied. Hannula mentions similar ones than Jussila, Montonen, and Nurmi as a different choice of perspective; reconstruction, deconstruction, structural, inductive, and deductive and philosophical perspective as Hannula has used can be hermeneutics and phenomenological or something else entirely. The choice of these selections of the researcher is left for the reader because different subject areas and questions always need reconsideration of methodological tools.

[36] Hannula 2008, 117.
[37] Hannula 2008, 111, 123.

Systematic analysis hermeneutic theory – from immanent to beyond

As expressed in earlier papers systematic analysis has been described mostly with the immanent application. This gives the method great criteria for source uses because it limits the scope of articles and bachelor- and master thesis. It has been used also as a help tool or as a main method in research and a lot of dissertations but when immanent has not been enough for the scope of the research there has not been much to go by without needing to think more on the scientific criteria, broader source logic, influences, or in my case study of theoretical heritages. These topics and many other topics that immanent analysis doesn't provide for in terms of scientific criteria. To be able to conduct research with more source variations but still, retain the reliability and validity of systematic analysis as a method I made systematic analysis hermeneutical theory (SAH-theory).

The foundation of this theory owes a lot to Jussila & Montonen & Nurmi. Almost everything is being thought at a fundamental level as they have written in 1992.[38] The biggest difference culminates into this division that Nurmi wrote later in 2004:

> "Immanent vs transcendental
>
> The analysis is immanent of the interpretations are limited to the own language, concepts and context and theory content. The analysis is transcendental if any outer logic from the corpus material is used within analysis."[39]

My task in terms of theory was to build criteria and phases for (to loan expression from Nurmi) transcendental analysis and to make it scientifically as viable as immanent systematic analysis has been despite its broader scope and harder limiting factors. This choice has however also added a limitation for this type of analysis. Systematic analysis in the transcendental sense can be conducted without limitations in between fields of study that conduct qualitative research. But in comparison to the immanent form of this method, the biggest limitation is its use. With broader use of source materials become many times the difficulties within research to be able to form synthesis from all the analysis based on different sources. It is not impossible and with work phases it is manageable, but the transcendental version of systematic analysis will always be in any form more work needing method than an immanent version for a lot of reasons. The equal conduct between source materials needs as extensive study of sources as conducted in the immanent version of this method. This means that the workload is many times more when comparing different corpus units to another and this comparison adds additional difficulties that need workable phases to be recognized each time. For example, if we compare different theories in terms of functionality or influence the task is in both cases not only to understand the workings of these theories and their development history but also categorizations and study of the weight of arguments and influences that made each of these theories stand differently in the field of study. Also, a theory is not always used the same way that it is built. Therefore, any comparison in between different text corpuses (that is required for any transcendental systematic analysis), must be made these and more limitations in mind depending on the asked research question. The biggest flaw would be to compare something that is not comparable.

[38] Jussila & Montonen & Nurmi 1992.
[39] (Transcendental philosophy) Nurmi 2004. https://metodix.fi/2014/05/19/nurmi-systemaattinen-tekstianalyysi/

Therefore, this adds to the difficulty of source material choices and categorization of different source corpuses in comparison to immanent systematic analysis.

Still, many studies need all or part of the transcendental logic of systematic analysis to be able to explain external issues within the subject. As Ida Heikkilä has mentioned (earlier quote on the theme of Jolkkonen)[40] there is a need for development for systematic analysis. To cover the needs in cases of interdisciplinary research or for any other transcendental systematic analysis cases I continued mostly from the point of view that Jussila & Montonen & Nurmi had formulated. In addition to this, I had great help from Vesa Suominen who built applications for my theory in the field of information studies to make the use of theory more accessible through application examples.

Theory starts with the perspective of Jolkkonen who named four categories of analysis target.[41] As an example, the theory is explained in terms of the study of the fifth suggested category, the study of functions of theories. The starting premise is very similar in systematic analysis in general, in this case, to be able to study functions concepts and arguments needs to be understood within theory examples to be able to understand the total functionality of certain theory and for further comparison of other theories, same applies for all of them. For the analysis part, I chose the division of two components for the philosophy of understanding and for limiting and finding problems and solutions from different corpuses. These two components hermeneutic understanding and deconstruction were meant to be used in the analysis as a polaristic pair of viewpoints to argue each fundamental point in each analysis.

Otherwise, analysis and building of synthesis based on the transcendental form of analysis were divided into five work phases. These phases are not necessarily in this order every time as openness is a necessity for building synthesis in systematic analysis. The phases are as follows:

Work phases of SAH-theory[42]

1. Balance between hermeneutic understanding and deconstruction
2. Logic of analysis – Logical confirmation
3. Validity of synthesis of analysis
4. Comparability of analyses
5. Exactness of synthesis, repeatability of synthesis

As hermeneutics and deconstructions are not only different perspectives in science but also fundamentally very different ideas of the philosophy of science, their relation is not synthetical. The point of using these viewpoints is to understand but same time argue and to find limitations with deconstruction against the understanding that the hermeneutical view carries. With this polaristic viewpoint arguing within analysis this polarizing pair nurtures a lot of new viewpoints and keeps analysis more scientifically limited. In addition, analyses must be conducted in the way that permits the building of synthesis based on them so the importance is always to keep analysis comparable

[40] Heikkilä 2020, 68.
[41] Jolkkonen 2007, 12–20.
[42] Tervashonka, Suominen 2020, 57.

between each other or comparable between those analyses that will be linked together with the same criteria in synthesis.[43]

The second phase[44] is to retain clear logic of conduct. Since there was no particular word of what qualitative logic of research is I coined the term *logical confirmation* to explain the relation of source analysis within qualitative studies. It entails two basic tasks in research, confirmation of facts from sources and explanation of the logic by which this act is conducted. There is also confirmation theory by Bayes[45], but these are meant for natural sciences and partly applicable for quantitative studies. Since my theory is mostly for qualitative research the term logical confirmation is to highlight the tools of the trade. This phase although very basics of science are more demanded for systematic analysis to retain the equal quality of analysis so that when the researcher builds synthesis the analysis that are parts of it are not uneven with how they were conducted in terms of analytical logic, consideration of source limits and qualities, same categorization if used. Logical confirmation is not only a general viewpoint of qualitative science making. It also has a task to provide clear enough logic of discovery for qualitative analysis so far that the general idea of the research could be repeated by someone else with the same source materials. This, of course, is an ideal goal that many kinds of research are not able to meet in each point of the text, but the quality of general reasoning for analysis in the systematic analysis is better when connectivity of sources can be logically confirmed.

Phase three is mentioned in case there is a need for making synthesis based on one or a group of analyses before final gathering synthesis. It is also needed when a final general synthesis of the whole subject is being made. The phase consists of consideration of how valid each analysis in the synthesis is and how synthesis as a form of unified analysis works equally with the reasoning of logical confirmation. Therefore, this phase is partly checking the soundness of logical confirmation of each analysis and in critical form the attempt to break built explanations to ensure their logical integrity.[46]

The integrity of analysis is important for the fourth phase because it lays the basis by which logical comparisons can be established within synthesis. For example, when conducting research on different theories if theories are compared, they have to be within the similar subject, and if these theories are not equal in influence, spread, scope, clarity of explanation, usability, or any other differences that could affect into comparison analyses of these theories, these differences have to be taken into consideration within comparison analysis of these researched entities. In many cases, it could mean that the categorization of researched entities would need rebalancing, or the entire comparison is not valid because targets are not comparable in the first place. These reasons re-start the whole process of considering whether or not theories or other entities can be compared and thusly be part of synthesis of analyses. Phases three and four are important for the understanding of limitations of argumentation and data, thusly being vitally important for clarifying what is the basis of interpretation made on the subject. This will leave us at least these three forms of qualitative analysis proofs (not to mix with mathematical proofs):[47]

[43] Tervashonka, Suominen 2020, 57–59.
[44] Tervashonka, Suominen 2020, 60–61, 65.
[45] Howson & Urbach 2006, 45, 51, 91–93.
[46] Tervashonka, Suominen 2020, 61–62.
[47] Tervashonka, Suominen 2020, 62–63.

Straight/immediate source proof

Analysis of the subject → deduction conclusion

Synthesis proof

Analysis of the subject → Synthesis → qualitative conclusion proof

Broad synthesis proof

Analyses of subject → syntheses → Whole general synthesis → qualitative multilateral synthesis proof[48]

The first one of these is the basic form of single analyses that can be already gathered as a deductive conclusion. Many cases of quantitative analysis are conducted like this in basic form. The basic form of systematic analysis requires the building of synthesis from unifying analysis (but not stacking them together like layers of cake). Proper synthesis is always a uniquely built explanation based on the components that analyses provide for it. For SAH-theory synthesis proof more typically multilateral synthesis is needed. This means that multiple syntheses are made within the subject. Typically, this scope is more for books or very large articles since each synthesis needs a consistent basis of explanations that require more work and pages. For example, interdisciplinary subjects sometimes in the more holistic form need this kind of broad proof work.[49]

The fifth and final work phase in SAH-theory is to ensure through repeating the synthesis proof bit by bit to test if the synthesis is apparent for readers and the logic of execution of final synthesis is within the sound basis. As Nurmi has written in the earlier paper some parts of the synthesis or the whole synthesis might not work in the end, thus researcher has to re-start whole consideration with either alternative methodological tools, a different philosophy of science or as Nurmi has mentioned, starting from a new perspective, and reading the data as a new data.[50] In this phase, therefore, the importance is laid on the repeatability of logic by which synthesis is built. It at the same time concludes the analytical result of the work but also explains how the synthesis was formed with the idea of logical confirmation. It is the confirmation for repeatability of argumentation and interpretations made within analyses.[51]

In terms of openness of the systematic analysis SAH-theory offers view that can combine increase of scientific criteria for conducting the method with larger amounts of corpus materials. To avoid losing the openness of the method by adding too much procedurality in it these five phases in SAH theory the phase one is analytically very open. The next 3 phases are to ensure that analysis is conducted in the manner that permits valid and combining analysis for creation of synthesis in the final phase five. This phase is left also more open as creation of synthesis is always organic intuitive process. Thusly,

[48] Tervashonka, Suominen 2020, 63.
[49] Tervashonka, Suominen 2020, 62–64.
[50] Nurmi 2004.
[51] Tervashonka, Suominen 2020, 64–65.

by this choice increasing the amount of studied corpus materials can be analysed without loss of openness of the method.

Comparison and meta-analysis

Now we have briefly summarized each paper in terms of methodological logic, execution and in some cases scientific limitations. Since these materials have been made with a similar idea but for different user groups, a lot of differences in explanations stem from this reason. Still, as similarly focused and with similar philosophical background comparison can be made. This comparison will be open so far that we won't be concentrating on every limitation of the applicability of each paper. The focus of this analysis is to dedicate attention to the major differences between these papers to find through general limitations and through understanding what each systematic analysis paper is for we can form a view on how to develop systematic analysis as a method further. There are innumerable choices and perspectives for further development. But there are limits on how fruitful these efforts might be and what is more needed as a new perspective methodologically. If we think of method as a practical instrumental tool or philosophy of science in both cases it will have its applicability, limitations, and hopefully logical reasoning. With this in mind, we will first form comparisons of these papers, discuss the variety and limitations of the contents and form views based on these comparisons what could be improved further.

For the comparison, it is important to keep in mind the differing uses of systematic analysis. Therefore, not all of them are on "equal footing" in terms of scope, usability, or accessibility. But these versions are connected to the same philosophy of systematic analysis thus making it not just acceptable to compare them but also making their comparison interesting for further development. This is the only reason why a comparison has been made thusly. In addition, we can see for what kind of projects to prefer certain versions over others. Because of the openness of systematic analysis, the problems are not to execute the method itself but in earlier choices on what perspectives are taken, what measures are done in case of analyses and what criteria need to be met every time when this open method is used. These questions and more are always at the beginning of each use of this general method.

The target of this analysis is therefore to classify selected papers in terms of applicability, usability, and scientific limitations. The secondary task is after an overview of the comparison to discuss resulting views on how to develop systematic analysis, thus granting different strategies for developing the method. My purpose has been to develop a systematic analysis for interdisciplinary problems that need not only a lot of bridges between differing corpus materials but also helpful stages for categorization of source analyses and creating sustainable applicability in between analyses. This effort is very important to be able to build sound synthesis rather than unique non-applicable to anything mixture results.

In this following comparison table, several categories have been used to better show the differences and functionality of each paper as a view on systematic analysis. Target audience and source consideration as the logic of how sources are applied in research by using each paper as a methodological source. Some of the categories are very similar but there are telling differences included that give us a great chance of differentiating the papers despite their inherently very similar reasoning.

Comparison table

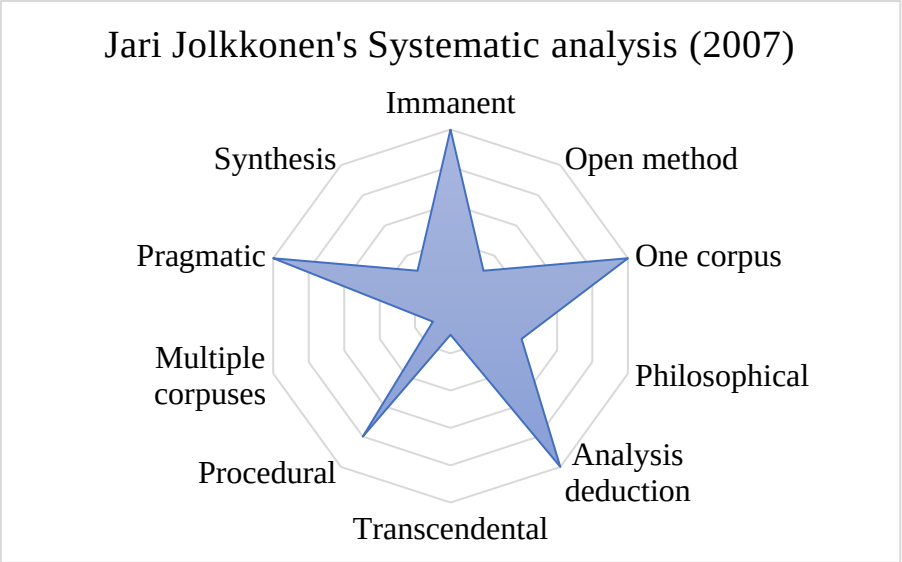
Author	Jolkkonen	Jussila & Montonen & Nurmi	Nurmi	Hannula	Tervashonka
Title	Systematic analysis	'Systematic analysis as method for pedagogics'	Systematic text analysis	Systematic text analysis	SAH theory
Publ. Year	2007	1992	2004	2007	2020
Target audience	Students	Researchers and dissertations	Researchers and dissertations	Researchers and dissertations	Researchers
Source consideration	Typically, one corpus material	One corpus, mentions plural possibility	One corpus material	One corpus material	Multiple corpuses
Source limitations	Immanent, limits to a specific corpus	Potentially Open	Open, but suggested to be limited	Categories of source importance	Categories of source importance
Disciplines	Theology	All qualitative	All qualitative	All qualitative	All qualitative
Application philosophy	Classification	Open immanent philosophical classification	Textual open classification	Textual immanent classification	Open transcendental classification philosophy
Application limitations	Classification questions	Single corpus requiring synthesis	Single corpus requiring synthesis	Single corpus requiring synthesis	Multiple corpuses requiring synthesis
'Example' field of study	Theology	Pedagogics	Not expressed	Early pedagogics	Theory history & information studies
General work phases	No phases	10 phases	10 phases	Analysis and synthesis	Five phases
Definition of systematic analysis	As a mixture of methods	Philosophical method	As a mixture of methods guided by systematic philosophy	Philosophical method	Interdisciplinary method
Method limitation	System immanent	Immanent general systematic analysis	Immanent reconstruction	Immanent reconstruction	Multiple text corpuses
Heuristics of the method	Classification tool	Philosophical systematic tool	Philosophical systematic tool	Method for systematic analysis and synthesis	Multilateral systematic method on multiple corpuses

As it can be seen Jolkkonen's and my paper are on the opposite of many categories and the other three papers have more cohesion because of their similar origins. The table has all the classifications from the original papers (summarized previously) on the methodologically important issues. Method limitation, source limitations and heuristics of the method have similar commonalities, but these take different perspectives depending on the case. I like to use heuristics of method in case of the whole "environment" of method use and depending on all other limitations it will take shape in designed or undesigned form. The question of heuristics therefore in the method is what is it for. These are not only what method makers will write about, but it is also the question of applicability and scientific limitation of the method as a functional tool.

Method limitation is specifically what classifies as a limit to the method. For the systematic analysis version, the biggest limiting factor is the source material since the purpose is to understand through certain corpus material what is the idea world of the subject and how it functions. Despite that SAH-theory is made for the use of multiple corpuses in research this choice also causes limitations for the method. We develop more on this theme. In the case of the other four papers immanent source limit of single corpus and immanent logic, therefore, has been used. In Jolkkonen's paper, interestingly he calls systematic analysis system-immanent[52]. Jolkkonen has used term system also in the description that systematic analysis in his guide operates from inside of the subject. The attempt is to understand the original logic of the original source maker as well as to be able to explain the gathering principle of the whole logic of the source. Thus, according to Jolkkonen systematic analysis is with this reasoning system-immanent, inside logic explanation of a system. The rest of the writers have used more descriptions like thought world, idea world or in my case thinking system to tell almost the same thing about the inner world of the corpus in terms of its logic.

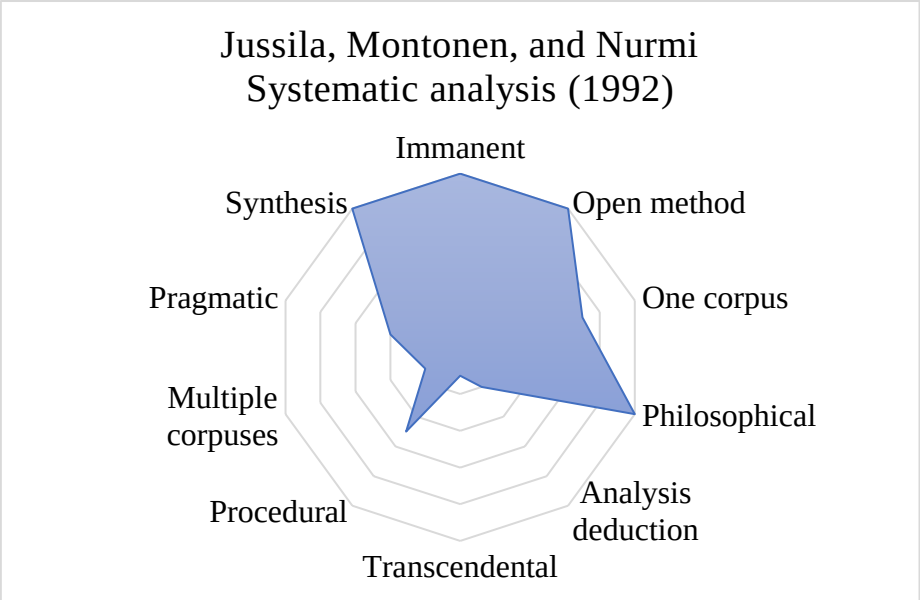
For more specific differences of these systematic analysis papers, the following comparison charts were made to illustrate qualitative functional differences in each case and to see what interests are covered in each case. This at the same time tells differences in scientific use, limitations, applicability, and usability depending on the nature of the research question. Naturally, estimates of the charts are qualitative approximations. Each category in charts have an opposing viewpoint at the opposing axis and the cover field mostly points out the wholistic general form of the systematic analysis in each case. In charts, there is gathered values, functionalities, and limitations of each paper on systematic analysis to generally illustrate and classify their major differences in terms of methodological perspectives.

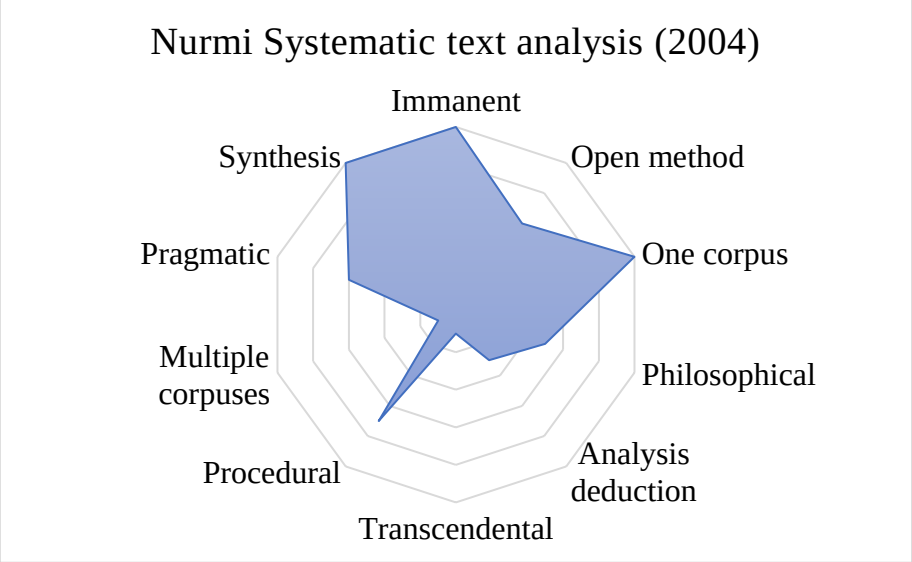
[52] Jolkkonen 2007, 21.



It is the reason why systematic analysis is typically perceived as a methodological broader philosophy rather than a method (or as Jolkkonen has put it, a mixture of analysing methods; I would add under one systematic philosophy). The biggest difficulty is that systematic analysis does not have a single philosophy from where everything is led. Only the conduct in terms of the systematic nature of this type of research is methodological similar. Nevertheless, it is also the biggest advantage of systematic analysis as a philosophical methodological tool because it can be modified methodologically in many ways and the methodological integrity of it can be maintained by not forgetting theoretical phases and views that in combination assure that the methodological application has been systematic. But in general use, the systematic analysis must be used in a more elementary manner as suggested in the guide of Jolkkonen (this guide has been made mostly for pupils and thesis works). But generally, science as a systematic endeavour no study that dedicates time into this systematic philosophy will fare worse than without it.

Therefore, the problem is not how deeply philosophical or general texts are being used but the lack of order by which people are introduced to this subject in varied fields of studies. This need for open and broad consideration can be found in the paper of Jussila, Montonen, and Nurmi (1992) but it comes with additional cost. While keeping the method open the choice has been to limit it with maintaining the immanent limitation of one corpus as a preferred research strategy as an example. This has been done with the perfectly justified reason that the applicability of the method, therefore, covers more cases since for article or even dissertation uses and shorter below one-year research efforts there is less needed to consider multiple corpuses at the same time. With this reasoning, I made the SAH theory in 2020 to develop this corner of choice further. It has many times less the number of the cases where theory can be applied but at the same time, it covered very needed cases of studies where multiple corpuses are needed for analysis and synthesis building. In the case of immanent analysis, Kari E. Nurmi developed this 1992 broad philosophical view in a more practical manner in 2004.





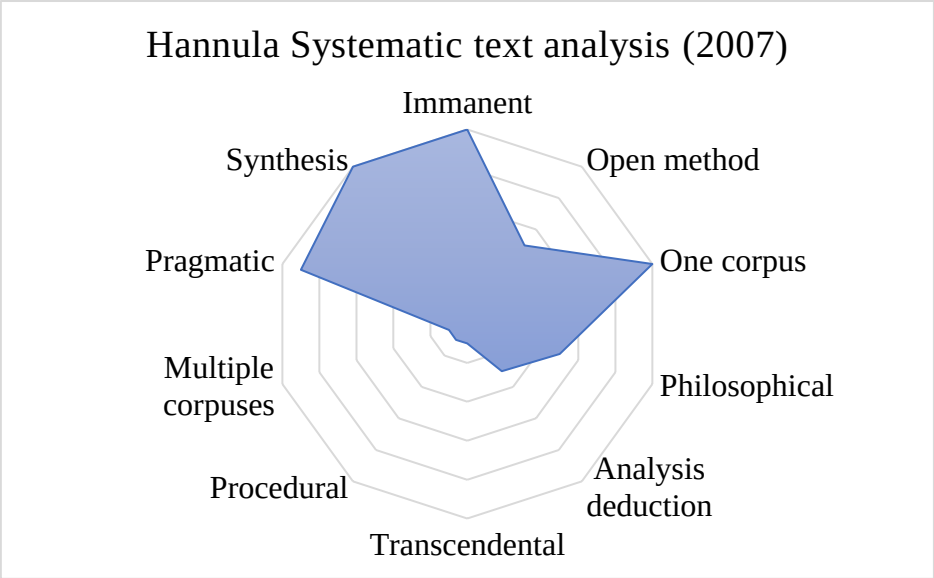
On the contrary to older text that was made in 1992 Nurmi has taken in this article a more educational position of expression. Still, true to the spirit of the interdisciplinary nature of systematic analysis Nurmi leaves the use and applications of the method open for methodological applications and maybe in the level of detail also on the interpretation of the method. This open form is also the key point of Nurmi's expressed analysis that highlights the biggest difficulty of systematic analysis but additionally the promise of discovery. In both texts Nurmi's message is to think on the criteria of corpus materials, form questions for analyses that strike on to the core of meaning by asking new questions, usually indirectly helped by systematic analysis. With Nurmi's recommendations for methodological use of systematic analysis is evident that users of the method must make a proper effort in acquiring information. The need for information to fuel proper investigation with systematic analysis not only needs information on key issues of the corpus material but also to understand any corpus material even with an immanent limitation for corpus extensive reading is required for understanding parts and relations of corpus material. This is a very typical problem for any research topic but within systematic analysis, this demand is highlighted. Without sound and exact analysis creation of synthesis will not be reliable or nearly as valid as it could. But as Nurmi has mentioned at the end, sometimes analysis has to be restarted as a new with different methodological considerations

or maybe different research question.[53] Despite this not very ensuring starting point for any method user systematic analysis creates almost self-repairing perspectives because of the use of the method. The relation between analysis and synthesis making forces consideration of not only singular analysis but also connectivities, prerequisites, meanings, categories, interpretations, and demand of sound logic drive analysis increasingly in clearer solution. This is done with the iterative process of building up every key argument and meaning from the most minor detail to the biggest abstractions without losing logic in between. As Nurmi has mentioned writer has to be careful about making clear of content so that the iterations are not showing and mixing readers.[54]

Moreover, iterations are a very important part of building proficient systematic analysis on any subject. It is not expressed as strongly as it might be needed within Nurmi's Metodix paper, but the basic purpose is to clear out mistakes and build scientifically stronger joint analysis and thus better synthesis as a result. However, the biggest problem of this is not the iterational part but finding each time sound criteria for thematical problems that have to be seen and taken care of within analysis. Each research question or new corpus material introduce always new methodological challenges. In the case of method, systematic analysis tends to be a very sturdy solution for any kind of qualitative problems or in some cases even quantitative problems. But it is not always self-evident what methodological leaning or philosophy of science might help with each problem. From to point of student research from thesis to dissertation basic systematic analysis will suffice but when dealing with broader questions the inner workings and logic can start to break within the analysis. If multiple stages of synthesis are needed the problems also multiply. Within this text, there is not much solution for this problem other than starting over in worst case. I admit sometimes it is the best call that can be made with a research project but on the other hand, people want from any some manner of trust factor that this method will give tangible help for the project.

Hannula's article on the practice of systematic analysis in 2007 might have had some effects on how Nurmi's paper developed in more practical consideration in 2004. This view is in terms of general direction rather than a very substantial change in the logic of the method. Still, Hannula offered a very pragmatic descriptions and views on the use of systematic analysis as a method in form of a valuable example of her study of Paulo Freire's pedagogical classics. The biggest novelty of her paper is the application of the broader philosophies and reasonings of open systematic analysis from Jussila, Montonen, and Nurmi (1992) making it more accessible for a wider audience and uses.

[53] Nurmi 2004, (chapter Parsing research problem)
[54] Nurmi 2004, (subchapter Total structure and parallelizing research subject)

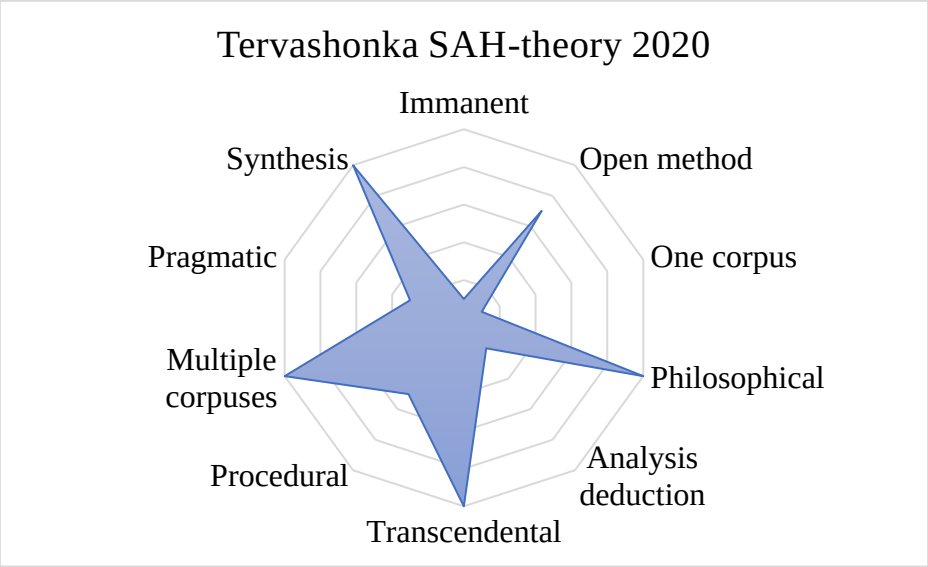


Hannula's article is one of the best starting points for getting to know systematic analysis as a method because it gives substantial background by which to work. Albeit only one corpus is being considered in many studies this approach is enough. The problem with these is not broad criteria fines but the difficulty of perceiving the inner world of the original writer and getting accessible reasoning that readers could follow while conducting immanent analysis. The problem is therefore not only of understanding but also how to explain something that sometimes cannot be explained systematically. Some of the reasonings or values might be inherently flawed, or it forms deformed or broken "systems" that can only superficially be described in a general sense. In essence, Hannula has given indirectly solutions for this for not going as far with the philosophy of science and dedicating attention to the minute details of the source materials. Since I have conducted my theory and writing in a totally different manner, I can still say that Hannula's perspective is more valid than my SAH-theory in the majority of research. The validity comes from pragmatism. As explained before SAH-theory considers vast amounts of corpuses, with the cost of higher demand for reading, everything used must be analysed similarly and with criteria that helps form synthesis based on these multiple corpus materials. In many cases, it is not the most fruitful position in research but for interdisciplinary research, it has a lot to offer.

As the reader can notice not only in the level of argumentation but also in terms of functionality SAH-theory is the opposite of Jolkkonen's version of systematic analysis. The starting point is very similar, but the functionality and considerations are total opposites as can be seen from the illustrative charts and in some ways in the comparison table. This comparison is the biggest divide in the whole cohort of papers mainly because the instrumentality of the method is thought differently in terms of immanent classification of single corpus Jolkkonen's model works perfectly. In the case of analysis of the Bible in the area of theology, it is indeed a great method for what it is used for. As Heikkilä has said Jolkkonen has to some degree achieved almost monopoly on this question in Finnish theology methodology if the systematic analysis is used. It gives a very reliable choice for those who do not only want to think about the meaning of the message or structure of it but also to follow how these ideas were formed in holistic sense.

The problem of immanent choice is its limitation. It is always unique to some extent depending on the creation process of the corpus. The larger applicability of the research is sold on the promise of conducting a study that can be handled more manageably. This is the biggest benefit of choosing an

immanent systematic analysis. The problem comes when we want systematic analysis with the subject to be more applicable, maybe even interdisciplinary. It is very hard to conduct immanent research on a topic that would yield highly applicable and combinatory interdisciplinary results. It is the similar problem when using discourse analysis. Immanent systematic analysis is very reliable. But this reliability comes with the limitation in comparison to methods that can be used for interdisciplinary research questions.



Despite that SAH-theory's purpose is to be a method not only for the study of multiple corpuses but also for interdisciplinary needs. It can be to some extent used for multilateral synthesis building where final synthesis is formed with multiple minor syntheses. Conducting this kind of research will demand more time and even articles made with it will only be miscellaneous parts of the total research. In SAH-theory the scientific hardship is the opposite of immanent theories of systematic analysis. The problem is not the applicability or openness of the method but forming and maintaining the same criteria in each analysis so far that synthesis can be conducted with multiple corpus materials in a sound manner. This raises the risk of analysis in terms of reliability with the benefit of higher applicability. This choice is not however quid pro quo in comparison between immanent and transcendental or one corpus and multiple ones because most of the studies will not need nearly as broad consideration methodologically. SAH-theory can be applied in interdisciplinary projects, creation of systems theory or as a connectivity philosophy in between researchers working on the same project with the perspectives of multiple areas of science. Therefore, I would not say that the audience and the number of users can be in any way be thought of as equal. In addition to this difference, the development of scientific criteria for different uses of SAH-theory will need considerably more development than the creation of theory took. In every case of the use of systematic analysis the implementation of the method must be considered as new. Many criteria work in similar ways, but every problem or new corpus material will need a new set of considerations, the logic of organizing and categorising evidence.

For Jussila, Montonen, and Nurmi the question was in 1992 also the philosophical methodological choice. Depending on the questions asked, with that it is being asked and from what material, different

philosophies of science can be and has been applied for the use of systematic analysis.[55] Similarly Nurmi continued the theme by forming polarized pairings of different philosophies of science to show in an elementary way how these philosophies can be applied in systematic analysis.[56] In these papers systematic analysis is expressed in very open method. The cost of it is mentioned in Nurmi's later article by stating that sometimes the analysis has to be redone with a new perspective as the data would be new. In many cases in other studies, this can happen sometimes but the difficulty in as open methods as systematic analysis is the risk is considerably higher. From the risk management point of view, there is also a risk the applicability of systematic analysis as a method that will be only conducted on "definite cases" despite its high applicability because of its openness as a method. This higher risk from the perspective of openness and criteria for scientific reliability can be justified by other strengths that systematic analysis has as a method, but this risk factor also creates problems for the applicability of the method. Systematic analysis is a good choice if a researcher wants to achieve mastery of the subject area, not only in knowledgeability but also by understanding the inner workings and logic of the subject. But at the same time, it is very time-consuming method, and it will ask a lot from the use of memory[57], intuition[58], and abstractization[59]. These demands can be read very openly from the uses of the method and from the theory papers on systematic analysis. This makes systematic analysis very demanding but also a higher-yielding method in terms of reliable results.

If we think of the comparison table as a whole and we compare the charts of each paper several notions can be found. This selection of papers now covers immanent single corpus material studies and with SAH-theory more extreme need of a larger number of corpuses but there is currently no a middle ground for these papers. In cases of 2–4 corpuses there is no theory for executing the research with systematic analysis in terms of current applications. This reduces the question to the state of an either-or question without a middle ground for several corpus sources. This leaves a lot of room for the development of middle ground in terms of source use.

Similarly, the balance between openness of the method and procedurality are two very polaristic features in the method. Every time stages, rules, guidelines, and other things that have to be followed within method procedurality rises with the cost of openness. Inherently systematic analysis is and must be a very open method and, in most papers, it has been conducted so. The only differences were Jolkkonen's paper where procedurality was a feature for making correct classification, but still keeping the eyes open for centrally important logic that the original text might have. In SAH-theory hence adding more stages into the study to ensure broader applicability this was done with the expense of total openness offered in more philosophical form by Jussila & Montonen & Nurmi in 1992. The paper displays all manner of applicabilities in the question of differing philosophies of science and shows through the historical build-up of the systematic analysis how different philosophies and ideas have affected the method. This will leave any developer of systematic analysis tricky question of balance of openness and procedurality of systematic analysis. In both cases, there are differing applications. Openness is needed for any qualitative research and the use of intuition. Procedurality however ensures more reliability for the use of the method when conducting research with a larger amount of complexity. In hindsight, machine learning of systematic analysis could start from this procedural point of view.

[55] Jussila & Montonen & Nurmi 1992.
[56] Nurmi 2004. (Chapter Text analysis possibilities)
[57] Hannula 2008, 113.
[58] Tervashonka, Suominen 2020, 59.
[59] Jussila & Montonen & Nurmi 1992, 158–159.

Conclusion of further development

One result of the comparison and meta-analysis of systematic analysis paper is that readers can now choose with more accuracy the needed philosophy and views on systematic analysis for their projects or use combinatory views. Systematic analysis as an open method has a very large tolerance for modular approaches in methodology. The limitation of this functionality is that basic rules of the systematic analysis must be prioritized in order to use the method correctly. If modular hierarchy is used wrong the method is not exactly systematic analysis anymore or it is used as a secondary help tool.

As a conclusion of the applicability Jolkkonen's paper offers fundamentally simplest conduct of the method and it is a good point of beginning for systematic analysis. Hannula's article offers in addition to this broader philosophical consideration with pragmatic focus and examples from Hannula's study of Paulo Freire's classics. Nurmi's Metodix article (2004) offers broader selections of philosophies of science and helpful views on what they can or have been used for. This article needs a further reading of the philosophy of science to be able to put it in proper use and scale in a scientific frame of reference. Similarly, earlier book article by Jussila & Montonen & Nurmi (1992) offers the broader philosophical heritage of the method, different detailed phases, and a lot of structure to build analysis on. Therefore, it makes the article of Jussila & Montonen & Nurmi essential for a broader understanding of systematic analysis and thus it has also a lot to give for more advanced uses of the method. In comparison, SAH-theory offers more particular methodological criteria for the use of multiple corpuses for interdisciplinary studies or multiple synthesis needing projects. Otherwise, work phases of SAH-theory can be used as an addition to 10 phases offered by Nurmi's model of systematic analysis in case of broader source consideration needs. If the study is dealing with singular corpus material the use of SAH-theory is not recommended.

Despite the differences of these papers there are still generally applying problems. As most of the systematic analysis is built on the basic idea of analysis and synthesis I would like to go back to the beginning of the reasoning of this method. How do we get from analysis classifying or content to the synthesis? This relation in between is very organic in nature and differs almost every time with logic with each case. Do we have any remedy for this or guidelines on how synthesis, in the end, is created? I am with the same opinion as Nurmi that there is and probably cannot be more than very general rules for the creation of synthesis because the creation process is always unique based on the content even in both immanent and transcendental applications of systematic analysis. Still, the question remains how to arrange the process of synthesis creation, and how to develop reliable synthesis. Today none of the papers have an answer to this question, including my paper.

The question of reliability is always important for the development and spread of applicability of any method. If we raise the complexity of the task that we use systematic analysis more unified analysis logic must be maintained to be able to conduct several syntheses needed in more complex studies. Similarly, the applicability difficulties of a very open method with higher work demands need to be justified at least with qualitative proves in terms of results. For complicated research questions of interdisciplinary research systematic analysis has a lot to offer either as a main method or in applied form like suggested in SAH-theory. Systematic analysis cannot be conducted with "less work". It is a deep analysis and the demand for it is very clear and time-consuming. The only way to develop the method is therefore the general results of using systematic analysis. If and because of the reason that systematic analysis is a very open method, the applicability of the method can be seen as a key feature that it offers. Today it has a promise of solving complicated problems but the development of it needs

more theory papers in case of its applicability. Within this study, there have been several factors for this but the balance between open method and procedural not as intuitive method causes development limitations. With more complex research questions this polaristic relation typically goes in the direction of procedurality with the expense of openness for the sake of reliability. Still, keeping systematic analysis open as a philosophical method serves a lot of purposes of qualitative research where intuition plays a bigger role within synthesis creation. For this purpose, SAH-theory has offered partial solution for balance between openness and procedurality when dealing with more complex research questions. By the world partial I want to highlight that SAH-theory currently covers least number of studies as a method out of all five papers. Still, with the similar method strategy this balancing factor offered in SAH-theory can be re-used in other kind of theories of systematic analysis to ensure at the same time increased need of reliability when dealing with complex research questions without losing ground of intuitive openness of the method to procedurality.

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The Impact of Covid Pandemic on Students' E-learning in the Higher-education Digital Pedagogy in Nepal

Basanta Prasad Adhikari[1], Cha-Hsuan Liu[2], Krishna Bahadur KC[3], Sarad Kafle[4]

ABSTRACT

COVID Pandemic 19 has created a significant challenge to educational institutions, teachers, students, parents, government authority, and other stakeholders of educational institutions around the world, with no exception of Nepal, situated in the Himalayas. The available digital pedagogy design in Nepal today is based on traditional pedagogy as a supplement to the face-to-face class experience, which may hinder the practical students' learning experiences and their rights to quality online courses for a long period. This study aimed to examine the students' experiences and opinions on the availability of digital pedagogy features during online courses in Nepal's Higher educational institutions. Quantitative data were collected from 459 Nepalese college and university students by using a self-administrated online survey. The statistical results show that students were not satisfied with the current digital pedagogy practices of online classes. The difficulties faced include the low quality of the online course design, hardware and software, content quality, and supportive digital learning method. The results further indicate that there was a significant association between temporary educational strategy, students' motivation in digital pedagogy, quality of digital pedagogy, standard features of the digital pedagogy, and students' experiences for their satisfaction with digital learning methods in Nepalese Higher-level educational institutions. This study's implication will help educators of Higher-level institutions and policymakers improve digital learning pedagogy.

***Keywords*:** Educational institutions, Covid-19, digital pedagogy, learning satisfaction, online education

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INTRODUCTION

The first case of COVID 19 was found on November 17, 2019, in a 55-year old citizen in the Hubei province of China. In a few months, the COVID 19 pandemic has spread to more than 200 countries globally. Seeing no race, gender, or social class, the COVID-19 virus has affected both developed and developing countries (Livingston and Bucher 2020). To date, although vaccination has taken place, mainly in the developed regions, scientists and government authorities over the world have had not yet answered when the spread of the COVID 19 will be contented. The situation is especially drastic for low-income countries.

In Nepal, the pandemic was formally identified on January 25, 2020, when a 32-year Nepali student tested positive for COVID-19 after returning from Wuhan city. All schools, colleges, and university campuses in Nepal had been temporarily closed for nearly more than two months after January 25, 2020. As of the second week of May 2020, UNESCO had estimated that about nine million students in Nepal would be affected by these closures in response to the pandemic (Nguyen and Huynh 2020). The compulsory closure of schools, colleges, and university campuses for a considerable period of time has led to dramatic changes in the education system, with a distinctive shift from traditional teaching methods to online learning systems.

This transition to digital pedagogy systems also posed challenges for educators who were used to traditional education delivery systems. For example, educators must adapt to new digital delivery methods in order to provide high-quality education in an online environment. Online learning needs to be created within a curriculum design framework that focuses on practical pedagogical principles to avoid a poor-quality learning experience. It is further supplemented by understanding what makes online learning work for students (Evans, Kandiko, Howson, and Forsythe 2018).

While teaching and learning are being undertaken remotely on digital platforms through E-learning, there are many challenges around equitable access to these digital platforms. it was estimated that only 56% of Nepalese people have internet access, where 35% of schools have internet access but only 13% of schools can run online classes (Pandit 2020). Khati and Bhatta (2020) pointed out that students in Nepal experience four main issues with online education. Firstly, students find it challenging to adapt to technology for their online education, and often struggle to post assignments and log in to their classes. Secondly, some students consider online classes to be less

interactive. Third, poor Internet connectivity in many areas of Nepal has made it difficult for students to attend classes and post assignments. Fourth, the unavailability of computers poses a challenge in learning. Three of them concern the accessibility to online courses. More importantly, when institutions have turned from face-to-face learning to virtual learning, they have to make sure that whether the students have proper devices to participate in the virtual learning to fulfil or not. Although students have no computers to participate in E-learning pedagogy, they use different phone sets to participate in E-learning classes. Electronic devices are fundamental for the effective implementation of E-learning along with the good internet connection and electronic devices are fundamental features of physical facilities during virtual learning practices. Because of poor monetary conditions, uneven geological territory, and mal foundation, students have confronted difficulties with admittance to the internet facilities. Nepal lies in the 123rd position in the world in information communication and technology (ICT) service (Sharma & Kim, 2016). This straightforwardly affects the legitimate execution of online education

There is a large gap among people in low-income countries such as Nepal regarding their socio-economic, education, and literacy background. The COVID-19 pandemic has created a severe complication to the achievements of students' learning experiences. Nepal's existing education system and the uneven distribution of its resources often widen the gaps between rich and poor citizens (Dawadi et al. 2020). In the advent of COVID-19, the digital divide and the uneven access to E-learning have fostered these gaps by widening the inequalities between social-economical advantaged and disadvantaged students. While several schools, colleges, and universities in urban areas have already started online classes to minimize the impact on students' learning activities, schools in rural areas were still dealing with the low accessibility of internet service. Yet, the Nepal Government has not yet launched any new digital learning strategy to help rural areas students to cope with the pandemic's educational environment and inequalities that have been noticed regarding students' access to digital learning. According to Dawadi et al. (2020) and Fay (2020), more than 55% of students do not have online access to Nepal's digital classes and over 55 million students are still out of Nepal's digital learning system. Moreover, the students' drop-out rate has increased after the pandemic intruded in Nepal (Mahato et al. 2020). Paudel & Neupane (2021) concluded two main reasons for the rise of students' drop-out rates. First, many parents have lost their jobs due to the Pandemic and their economic crisis has been worsened than ever before, by which some parents may not be able to afford their children to attend schools. Second, the

discrepancy of the current Information Communication Technology (ICT) infrastructure and its distribution of access in the urban and rural areas have created the second-tier inequality of education in Nepalese society (Saraswati et al. 2020). The first one is the gap between students who live in the urban and the rural area, and the latter is the gap between the rich and poor who can barely afford to access internet facilities. students could not continue their education because of the limited access to the online course.

This study aims to deepen the understanding of the current operation of online education in low-income and less technologically advanced countries such as Nepal and seek possible solutions to mitigate the hurdles based on the students' experience. Since a wide range of organizations has embraced online learning education, a research survey of students around Nepal is adopted in this study to explore more profound aspects of the situation. It encompasses two main objectives. The first objective is to investigate the impact of the digital learning platform on the student learning processes as compared to a traditional school, college, and campus education. Second, this research investigates the possible challenges that students might face during the transition and suggest solutions to ease the tension. The six-factor model of digital pedagogy (Ozkan and Koseler 2009) is introduced below as the theoretical framework of this research. The results of this study help instructor, learners, educators, and curriculum designers proactively enhance their educational insights and develop better online teaching and learning solutions.

Digital Pedagogy

In the second decade of 21 century, digital pedagogy is rapidly emerging in the current education market. Both students and instructors have invested a large amount of costs and time to adapt to this new way of learning. Practitioners, educators, school leaders, and policymakers have been facing the constant challenge of refining teaching and learning techniques to keep up with students' increasing demands and expectations, described as digital excitement (Lewin, Cranmer, and Mcnicol 2018).

E-learning as digital pedagogy

One of the identical characters of digital pedagogy is the use of E-learning methods which has been widely used in medical education across various specialties, educational settings, and training levels (Chu et al. 2019, Zainuddin et al. 2020). E-learning is a digital platform using web browsers as an interface method to communicate with learners and other programs and is considered an innovative studying method that utilizes technological devices consisting of a tablet, computer, laptop, interactive television, audio, video, Internet connection, satellite broadcast, and so forth to deliver the content of the lessons (Kaplan-Leiserson 2000; Vermeer, 2001). While E-learning is the most well-known and extensively adopted phrase used in teaching and learning activities (Strutynska & Umryk 2020), other terms are used interchangeably to define this education method, such as distance education, electronic learning, internet learning, online courses, or learning portals (Gewirtz 2020). Being a digital platform, the E-learning system can store, manage, or modify educational content while also facilitating interaction between participants as they assimilate and input data. Digital pedagogy aims to provide education via the E-learning methods which allows learners to use web browsers as an interface method to acquire knowledge from and communicate with the education providers across other programs (Gewirtz 2020).

To meet students' needs and expectations on rich digital technology for their teaching and learning activities in the years of formal schooling via, the digital pedagogy has to cover the application of scientific knowledge for practical purposes, focus on its practice on community and collaboration, remain open to diverse, international voices, collect a discord of voices, and have its use and application outside traditional education institutions (Lewin et al. 2018). As information and communication technology advances, it changes the education process by affecting how

information transmission and communication are conducted. When the information process is involved, so are the operations and education organizations involved (Al-Rahmi et al. 2020).

The Six-Factor model of Digital Pedagogy

To optimize the performance of online learning, Ozkan and Koseler (2009) developed a six-factor model of digital pedagogy for educators' consideration. The six components of this model are system quality, content quality, service quality, instructors' attitude, learners' perspective, and the supportive issues of digital learning processes. These factors can be further concluded into two categories: human factors and technological factors. Chu et al. (2019) found that about 42% of respondents in their study in China reported that they had enough support from educational institutions before and during their remote study. Their study entitled Health Communication Through News Media During the Early Stage of the COVID-19 Outbreak in China. further added that many educational institutions were taking the initiative to adopt a new teaching environment and performed well in increasing support and encouragement for students.

It was further found that the service quality of educational institutions has a strong effect on user satisfaction. Shehzadi et al. (2020) highlighted that the quality of E-learning is embedded in the E-learning tutor's ability, the quality of material in the course, the quality of E-learning administration, and service support. Shehzadi et al. further highlight that the digital pedagogy system quality is associated with students' learning requirements, availability of better education, and web-based education systems (Ozkan and Koseler 2009).

There was a positive statistically significant relationship between learner's attitudes, system quality, information quality, supportive issues, service quality of the remote access. Overall, learners' satisfaction with digital pedagogy is associated with the assistants' attitudes, and the services provided by the administrative staff. It was further highlighted that motivation, belief, confidence, computer anxiety, fear, anxiety apprehension, enthusiasm, excitement, pride, and embarrassment were identified as learner characteristics by which the outcome of digital learning can be measured (Putten 2021). It was discovered in Indonesia that the average student learning experience is categorized as very good, although the study finds indications of difficulties and limitations in a whole online learning activity that can be further evaluated (Putten 2021).

Ozkan and Koseler (2009) found that specific factors of students' dissatisfaction were the lack of face-to-face communication with teachers and friends, distractions from the surrounding environment, inefficient time management, and decreased self-satisfaction. Our paper sheds light on the effects of the COVID-19 pandemic on high school, college, campus, and university students' experiences in Nepal. To optimize the performance of online learning, Ozkan and Koseler (2009) developed a six-factor model of digital pedagogy for educators' consideration. The six components of this model are system quality, content quality, service quality, instructors' quality, learners' perspective, and the supportive issues of digital learning processes. These factors can be further concluded into two categories: human factors and technological factors.

Service quality

Service quality is characterized by an evaluation of a service that contributes to customer satisfaction. This includes evaluating a service's quality level and convenience. Assurance, reliability, access, and IT staff competencies are dimensions of service quality. The users' experience with accessing and interacting with a service is crucial in identifying the quality level of the service (Al-Momani 2000; Wahab, Mohd & Al-Momani 2010). Service quality has been proven to directly impact users' satisfaction in various information systems (DeLone & McLean 2004). Haider and Riaz (2019) further pointed out that service quality directly impacts users' experience in the context of E-learning. High service quality provides users with simple navigation, ease of search engine used for needed information, and available technical support. Moreover, E-learning platforms with high service quality can also increase students' interactivity and eagerness to explore content.

Content quality

Content quality is defined as the system's final output, which is also called the system's outcome or information quality. Typical information quality features include accuracy, relevance, timeliness, adequacy, reliability, comprehensiveness, format, and accessibility (Al-Alwani, 2014; Bailey and Pearson 1983, 518; Seddon,1997, 247). Regarding E-learning, students assessed the quality of the information based on these features. The study of Roca, Chiu, and Martinez (2006) showed that the quality of information directly relates to the satisfaction of the user, and indirectly related to the perceived utility. Similarly, Harrandi (2015, 425) and Uukkivi (2015) found that

courses with well-structured content had a positive impact on students' E-learning motivation. Notably, the course content should be comprehensively planned by the instructor to ensure students are motivated to pursue the best material for their E-learning process. The students' self-exploration of the content is one of the main goals of an efficient E-learning process.

System quality (Hardware and software quality)

System quality is described as the quality of information transmission from web-based knowledge resources to remote learners (Delone and McLean 2004. 17). A particular example of an information system is cloud systems such as "Microsoft" and "Google", which offer free tools to educational organizations, including e-mail, contact lists, schedules, database stockpiling, document creation and sharing, and website creation (Shehzadi et al. 2020). Besides the essential contributions of human factors, service quality, and content quality, potential predictors for users' purposes and satisfaction include low complexity, reliability, and technical support (Fleming, Becker, and Newton 2017, 80). A program's consistency, knowledge, resource quality, and instructional quality positively impact user experience, in turn maximizing the E-learning approach's advantages. From this standpoint, the E-learning program itself is a critical component that improves student engagement and should be highly invested to maximize ease of use, ease of access, and versatility (Kim et al. 2012).

Learner's perspectives

Students' attitudes can be considered to have a significant impact on the E-learning process in which learners are highly encouraged to self-study, self-discover, and self-organize their learning procedures (Ozkan and Koseler 2008). Additionally, learners' attitudes are evaluated by self-productivity, pleasant experiences, communication with teachers and classmates, and learning. Passerini and Granger (2000) pointed out in their research that learner characteristics, such as attitudes, enthusiasm, confidence, and trust, must be recognized first. If the students' perspective is appropriate, the E-learning process will toil and vice-versa.

The student-centred approach, which generates substantial public interest, is an emerging strategy to improve the service quality in many educational institutions (Stodnick and Rogers 2008). This approach's fundamental concept is to consider students as customers, and the educational institutions aim to provide the best education facilities for students; thus, increasing student

satisfaction and loyalty to educational institutions (Martinez-Arguelles and Batalla-Busquets 2016). Due to this emerging student-centred strategy, many research types have been conducted to evaluate students' satisfaction with E-learning implementation in different levels of educational institutions.

Instructor attitudes and acceptance

Instructors are the key role players for the quality of the E-learning model during E-learning pedagogy. Personal qualities, for example, IT skills, creativity, innovative ideas, and personal innovativeness on technology acceptance are the main characteristics of an instructor who can make E-learning more effective and of standard quality (Ozkan and Koseler 2009). In this context, the study of Piccoli (2001) studied the instructor's characteristics and highlighted that instructor attitudes are the critical issue of E-learning for the acceptance and use of a learning management system (LMS). They are the major drivers of LMS because individual attitudes of the instructors positively affect the outcomes of E-learning for LMS. Usoro and Abid (2008), Levy (2008), and Wan, Fang, and Neufeld, (2007) suggested that the current level of computer skills and the extent of use of computing skills of instructors are significant issues on instructors' acceptance of technology use in education. The interactive teaching styles of the instructors are critical to the E-learning outcome via a digital learning system. Moreover, Lrvi (2008) insisted on the personal innovativeness of instructors is critical to maintaining the quality of the E-learning management system that has been recently highlighted in the E-learning literature. Schillewaert et al. (2005) found that personal innovativeness in the context of information technology mare person’s attitude reflecting their tendency to experiment with and to accept new information technologies independently of the communicated experience of others. Ozkan and Koseler (2009) argue that ‘instructor’ is the major aspect of E-learning. Within learning environments, instructors should have enough time to interact with students in their learning process.

Supportive issues of the E-learning management system

Support is required for the beginning, marketing, and promotion of E-learning programs which is imperative for establishing and managing technology platforms and infrastructure. The technical infrastructure staffed with technical talent such as network managers, web administrators, security specialists is deeply rooted in the supportive activities of LMS (Kaplan-Leiserson, 2000).

Assistance is also required for the management of feedback and its reporting. Supportive issues are essential organizational factors for the acceptance of learning management systems. The organizational factors influence the use of technology in teaching in terms of motivators, training, technology, alignment, organization support, and technical support (Nawaz & Zubair Khan, 2012). Ozkan and Koseler (2009) concluded that the wellness of microphones, earphones, electronic blackboards, electronic mail, online eased discussion boards, synchronous chat, and desktop videoconferencing are fundamental factors of supportive issues of E-learning. Nawaz and Zubair Khan (2012) argue that technical support is a key inseparable factor of the supportive issue of E-learning. It supports both teachers and students because teachers need technical support to ensure that they have sufficient resources and skills necessary for technology integration into the class practices. Similarly, technical support helps students in the acquisition of knowledge and skills necessary to fulfil their unique curriculum requirements. Al-Alwani (2014) conclude that supportive issues of technical support are installation, operation, maintenance, network administration, and security that increase privacy and security risks, web accessibility, the readiness of the users, requirement for further standardization of E-learning technologies, and social issues in term of increase of the digital divide.

Students' E-learning experiences and Digital Pedagogy

This study applied quantitative research to examine the effectiveness of digital courses which are currently used as an alternative teaching pedagogy during the pandemic in Nepal. The six-factor model of digital pedagogy is applied as the theoretical framework to investigate the relations between students' E-learning experiences and the current practices of digital pedagogy. Only the features of the six factors theory that is related to the learners' perspectives are included in the survey instrument: service quality', 'system quality', 'content quality' and 'learner's perspectives. This study aims to understand the impact on their learning experience and the applied digital pedagogy during the COVID 19 Pandemic.

This research contributes to educators, policymakers, and practitioners of Higher education to know current issues of E-learning practices and features in developing countries, such as Nepal, India, Pakistan, and Sri Lanka. This study will also be valuable to the educators of different educational institutions to improve their current digital learning model and the quality of E-learning in Nepal.

METHODS

The quantitative research method was applied to answer the research questions. Data concerning the E-learning (digital learning) experience and attitude of students in Nepalese Higher education during the Covid-19 Pandemic were collected by a self-administrated online survey. The use of the survey made it possible to discover the E-learning practice in Higher education in Nepal and the factors that influence the quality of existing digital pedagogy based on students' experience.

Participants

Full-time students in Higher education institutes in Province 3 and 4 in Nepal were invited to participate in the current research. Only the students who have attended compulsory online courses at Higher educational institutes in the first semesters of the academic year (2020-2021) were legitimated for research participation. In total, 600 students joined the online survey, and eventually, 459 high education students completed the questionnaire. The participants were selected from the Higher-level students who have enrolled in Management, Humanity, Science, and Engineering Faculties. The successful response rate was 76.5%. The sample consisted of 44% male (202) and 56% female (257). The age breakdown of the respondents was 6.3% between 18-20 years old, 86.1% between 21-24 years old, and 7.6% above 30 years old. About 7.4 % of students from government institutions (n = 34) and 92.6 % (n = 425) students from the private institutions have participated in this study. The majority of students were enrolling in the Bachelor's level (92.8%; n = 425). Only 33 students (7.2%) were studying at the Master's level. Higher percentages of female students (56%, n = 257) participated in this research compared to male students (44%, n = 202).

Procedure

A self-administered questionnaire about the compulsory online learning experience of Higher education students was made by Google Form application (https://docs.google.com/forms). The invitation for the participation was circulated through e-mail, Facebook messenger, Viber, WhatsApp, Twitter, and Instagram by different stakeholders of colleges, campuses, and universities – including teachers, institutions' representatives, students, and educators. The survey link was accessible only through students' study institutions (college, campus, and university). This survey questionnaire was posted online in the second week of August 2020. The access to the

survey was closed when the desired number of participants (600) was reached, which happened within six weeks of posting the survey in the last week of September 2020. The online survey was applied in both Nepali and English languages (see Appendix 3) and the participants could choose the version based on their language preference.

Measures

The survey questionnaire measured the opinions and attitudes of students of Higher-level educational institutions in Nepal. The survey instrument had more than fifteen (n = 15) variables assessing four components underlying system quality (Hardware and software), content quality, service quality, instructors' attitude, and learners' perspective, which are examples of the four domains of this study. These components were assessed on a 5-point Likert scale (i.e., strongly disagree, disagree, I do not know, agree, and strongly agree). The survey instrument consisted of demographic information which measured the following: the students' attitudes and opinions of their enjoyment of current online class teaching methods, severe impact of COVID-19 on their study, their satisfaction with the facilities of the currently practiced online teaching methods, the effect of the pandemic on their future educational development, and their current practices of digital pedagogy with the opinions of Yes, and no (see Appendix 3). We also asked the participants to choose the languages they use when communicating with their friends, neighbours, and family members on a 5-point Likert scale. We assessed participants using twenty-five items (Cronbach's Alpha ≥ 0.65). These items were administered from the literature of digital pedagogy.

The survey questionnaire measured the opinions and attitudes of students of the Higher-level educational institutions in Nepal. The survey instrument has twenty-five items (Cronbach's Alpha ≥ 0.65) assessing four components underlying system quality (Hardware and software), content quality, service quality, and learners' perspective on a 5-point Likert scale of statements related to students' online learning experiences (i.e., strongly disagree, disagree, I do not know, agree, and strongly agree). For example, "What is your experience and opinions for the features of the existing practices of digital learning pedagogy in Higher education institutions in Nepal?" and "What is your experience and opinions on the impact of the existing digital learning education in Higher education institutions?". These items were administered from the literature of digital pedagogy (e.g. Ozkan and Koseler, 2009).

The survey instrument consists of demographic information which measured the students' attitudes and opinions of their enjoyment of current online class teaching methods, severe impact of COVID 19 on their study, their satisfaction with the facilities of the currently practiced online teaching methods, the effect of the Pandemic for their future educational development and their current practices of digital pedagogy with the opinions of yes and no (see Appendix 3). We also asked the participants to choose the languages they use when communicating with their friends, neighbours, and family members on a 5-point Likert scale.

A pilot study of the survey questionnaire has conducted the instrument's reliability. The participants in the pilot study were carefully considered during this research. The instrument also examines the phenomenon other items match to what the authors intend to measure, which has ensured the instrument's validity. Age, sex, and educational levels were analyzed to understand their attitudes and opinions for the different online facilities learning features. The mean scores were used to examine the students' experience with currently practiced online learning methods and their satisfaction. Higher mean scores indicate a higher level of students' satisfaction, and lower mean scores indicate a lower level of students' satisfaction. The crisis management educational strategy in the COVID-19 pandemic, students' motivation in digital pedagogy, quality of digital pedagogy, and standard digital pedagogy features have measured the significant association between independent and dependent variables.

Analysis

The purpose of this study was to understand and explore the experiences of Higher-level students enrolled in Management, Humanity, Engineering, and Science to understand their experiences with how their digital pedagogy practices and features of digital pedagogy were facilitated for their online courses, as well as the perceived features of the digital pedagogy, and their satisfaction with the features of digital pedagogy during the pandemic. Principal Component Analysis (PCA) was used to examine students' experiences concerning digital pedagogy features due to its twofold nature. PCA reduces the dimensionality of the dataset by taking the dimensions that encode the most important information and removing the dimensions that encode the least important information. By reducing the number of dimensions, the data utilizes less space, thus allowing classification on larger datasets in less time. Further, by taking only the salient dimensions, PCA

projects the dataset onto dimensions that hold the most meaning, thus drawing out patterns in the dataset (Cohen, Manion, and Morrison 2018).

Binary Logistic Regression analysis has been applied to predict the probability of occurrence of a dependent variable (student satisfaction with E-learning pedagogy) given the values of Independent variables (four factors model of digital learning) (Creswell &Tashakkori, 2007; Cohen et al. 2007), and as to the satisfaction of the students, are you satisfied with digital teaching model was judged as the independent variable. Yes, was judged as “0” and No was judged as “1” in the Binary Linear Regression Model. Research questions, measurement scales, and subscales are tabulated.

Ethical considerations

This research is taken place and consisted out of an online survey with students in Nepalese Higher education. It is objected to protecting the student participants, making this study manageable and achievable, and fulfilling the research aims by minimizing the errors of the research processes and for the good governance of the educational research (Glass, 2013; Comstock, 2013; Creswell 2008). According to Roberts and Allen (2015), students in educational institutes should be considered as members of a “vulnerable” population due to the complexities resulting from the sensitivities within educational contexts. Therefore, extra care should be taken to minimize risk and adverse consequences, should students choose not to participate or withdraw consent before a study’s completion. To limit possible harm, this research has been established to ensure the participants' anonymity by avoiding collecting personal data that could be traceable and the emotionally triggering content. Protentional participants were provided with an informative consent form in both English and Nepali language to collect the rich data. Only those with consent were able to enrol in the online survey and can withdraw from the survey any time without giving reasons (Morrow and Richards1996; Khoo & Lantos 2020). The research design is approved and supervised by the research committee of Oxford College of Engineering and Management, Gaindakot, Nawalparasi of Nepal.

RESULTS

Descriptive statistics results

The PCA resulted in four subscales, i.e. crisis management educational strategy, students' motivation in digital pedagogy, the impact of the pandemic on students' mental health, and benefits of digital pedagogy. The results indicate that a higher number of students answered that they were satisfied with the current online classes model (58.2%, n = 267) compared with the students who chose not satisfied (41.8%, n = 192). The results further confirm that the mean score for the male students (n = 202) on the first subscale, *temporary educational strategy,* during COVID-19 (M = 2.79, SD = 0.891) was statistically significantly [t (424.91) = -3.615, p = .001] lower than the female students (n = 257) for the same variable (M = 3.09, SD = 0 .862) (see Appendix B). The results further indicate that the first subscale (3.17) has the highest mean value compared to the lowest mean value of the third subscale (2.69). Similarly, the fourth subscale has a greater mean value (3.02) than the second subscale (2.97). The Alpha values of each subscale are greater than 0.71 (see Table 1). Four hundred and fifty-nine (n = 459) students completed the questionnaire and shared their learning experiences of the digital pedagogy during the COVID-19 pandemic. The results showed how the COVID-19 pandemic commonly impacted students' learning experience. Among the participants, the most commonly used digital tool for the online course among respondents was Microsoft Teams (51.7%). Simultaneously, approximately 26.4% of respondents used Zoom Virtual while 18.8% of them used Tim Virtual. Few respondents used Google Meet (1.2%) and Messenger (0.07%). Only a small percentage of students (0.03%) went to Higher educational institutions to get their assignments individually during the COVID-19 pandemic.

The characteristics of Higher-level institutions are the government and private where the greater number of participants (n = 425, 92.6%) were from private Higher-level institutions compared with government Higher-level institutions (n = 34, 7.2%). The results show that 50.5% of students were involved in online classes from the same location of the Higher-level institutions, and 49.5% of students were participated in online classes from different locations of the Higher-level institutions, indicating that 49.5% of students of Higher-level institutions had enrolled from other locations rather than the institutions' locations.

Principal Component Analysis (PCA) was used to examine students' experiences concerning digital pedagogy features (four factors) due to its twofold nature. Four factors were derived from the variables of the questionnaire. The first factor covers strategy to retain existing students, loading (3.14), the strategy of receiving fees, loading (2.90), way of publication, loading (2.79), online procedural method, loading (3.14), only procedural activities, loading (3.25) and only considering government direction (3.10). Similarly, the second factor covers the best teaching method during the pandemic, loading (4.00), an effective online education method, loading (3.42), the last teaching method in the pandemic, loading (3.93), and the contemporary way of instruction during the pandemic, loading (3.71). The third factor covers online classes creating frustration, loading (2.58), depression, loading (2.13), and tension, loading (2.74). Finally, the fourth factor covers students eager to get online education, loading (3.21), easily time passed, loading (3.54), effective online classes, loading (3.26), all students have online access, loading (2.46) and parents have knowledge of E-learning, loading (2.10). Even though all students participate in current online education, this education method has created inequalities among students (see Table 1). Furthermore, four principal components (PCs) have been extracted from the Principal Component Analysis namely, *a crisis management educational strategy during COVID-19(six variables), students' motivation to digital pedagogy (four variables), the impact of the pandemic on students' mental health (three variable), and benefits of digital pedagogy concerning their satisfaction (five variables) (see Appendix 1).* The analysis indicates that students' satisfaction with the crisis management educational strategy in COVID-19 and students' digital pedagogical experience were the first and second PCs as the first and second scale variables (see Table 1). Both variables account for 49.86 % of the total variance explained, and the first PC accounts for a higher percentage of total variance explained (26.88%) than the second PC's total variance (19.99%). Again, the third PC (see Table 1), the impact of the pandemic on student mental health, and the fourth PC (see Table 1), *benefits of digital pedagogy,* were the other two PCs, which account for 54% of the total variance. The third PC accounts for a higher percentage of the total variance explained (34%) than the fourth PC (20%). The results are concluded in Table 1.

Table 1. Mean, standard deviation (SD), and Cronbach's Alpha of the subscales of Principal Component Analysis for the impact of COVID-19 on students learning experience (N = 459)

Name of the subscales	Mean	SD	Alpha values
SV^1 = Crisis management educational strategy	3.17	.904	0.70
SV^2=Students' motivation in digital pedagogy	2.97	.872	0.70
SV^3=Impact of pandemic on student mental health	2.69	.737	0.82
SV^4=Benefits of digital pedagogy	3.02	.799	0.71

The first subscale has the highest mean value (3.17) compared with the lowest mean value (3.03) of the fourth subscale, indicating that students were neither satisfied nor dissatisfied with the first and second subscales for online courses in different Higher educational institutions in Nepal (see Table 1). The mean values of the second and third subscales were lower than the average mean value (2.97 & 2.69 < 3), indicating that students were not satisfied with the existing digital pedagogy of online courses in corresponding Higher educational institutions (see Table 1).

The impact of COVID-19 on students' E-learning

After adding the data into SPSS, the second step was to conduct a multicollinearity test to understand ***the impact of COVID-19 on the service quality, content quality, and features of digital pedagogy on students' experiences in online courses in Higher-level education* institutions**. For this linear regression, as mentioned in tolerance and VIF (see Table 1) should be verified. The results show that both tests validated the variables since all tolerance values are greater than 0.1 and VIF values are lower than 10 (see Appendix A Table 2). Thus, the analysis can proceed. As previously mentioned, all independent variables were inserted in a single block due to this research's exploratory character. It is worth highlighting that only Block zero and Block 1 was generated because a single block was run.

Table 2. Summary table of block 1 models

Models	Chi-square	df	Sig.	Cox and Snell's R square	Nagelkerke's R square	-2Loig -likelihood
Omnibus T test results	130.210	4	.000			467..002
Model summary results				258	.346	
Hosmer and Lemeshow test results	3.140	8	.925			

Thus, the analysis presented focuses on Block 1 results. As shown in Table 2, the Chi-square test's significance values were all lower than 0.05, indicating that the model with independent variables was better than the model with no independent variables (Block 0). The second item to verify was the −2 Log-likelihood (overall model fit). It was useful to compare different models and identify which model better explains the information. This comparison cannot be made since this study analyses a single model; Nagelkerke's R Square value shows that its effect size is 34.60% (see Table 2). As stated by Chapman (2017), Nagelkerke's R Square adjusted Cox and Snell's calculus to enable the value to theoretically reach 1; therefore, Nagelkerke's R Square is always greater than Cox and Snell's. It is the reason for considering Nagelkerke's R Square value in this research. In Hosmer and Lemeshow Test, the significance was higher than 0.05, indicating that the model properly fits the data (see Table 2). The results of the classification table show that it is possible to observe that the model correctly classified 69% of the 459 cases. It is especially interesting when compared with the rate from Block zero, in which no variable was considered. This rate was 58.3% in Block zero, which shows that the validated variables positively impact the model since Block 1 correctly classifies a higher percentage of the 459 cases. Through the analysis of Table 2, it was possible to verify that all variables were validated by Wald's test (significance lower than 0.05) from all variables analyzed. The results indicate that it was possible to analyze the variables' impact on the model's odds. Thus, according to the model generated, [V^1 = *Crisis management educational strategy,* V^2=*Students' motivation in digital pedagogy,* V^3 = *Impact of pandemic on student mental health, and* V^4 = *Benefits of digital pedagogy]* for Higher-level students' satisfaction on digital pedagogy's learning experiences, the students' own beliefs lead to *crisis management educational strategy* positively influencing their engagement in digital pedagogy of online courses, showing the value of an odds ratio was 1.513 smaller than students whose beliefs lead to the impact of the pandemic on students' mental health during online classes (2.023) (see Table 3). The odds to engage in *students' digital pedagogical motivation* to online courses agree that their beliefs negatively lead to students' digital pedagogical motivation, showing the odds ratio was 0.627 greater than students whose beliefs lead to *students' digital pedagogical experience* on benefits of digital pedagogy (.516) (see Table 3).

Table 3 Binary logistic model Binary logistic regression model to predict the impact of COVID 19 on students' learning experiences by the factors associated with the students' satisfaction with digital pedagogy (N=459)

Independent variables	B	S.E	Wald	df	Sig	Exp(B).	95% C.I.for Exp(B) Lower	Upper
Crisis management educational strategy	.414	.129	10.365	1	.001	1.513	1.176	1.946
Students' motivation of digital pedagogy	-467	.134	12.229	1	.001	.627	.483	.814
Impact of pandemic on student mental health	.705	.124	32.339	1	.001	2.023	1.587	1.580
Benefits of digital pedagogy	-.662	.131	24.445	1	.001	.516	.399	.667
Constant	-.334	.114	8.620	1	.003	.716		

Results of Chi-Square Test between students' gender and the impact of COVID-19 for the future educational development during COVID-19

Table 4. Chi-square and one-way ANOVA between gender and students' future development.

Model = Chi-square				Model = One-way ANOVA				
	Value	df	Asymptotic Significance (2-sided)	Mean	Mean square Between Groups	Mean square Within Groups	F	Sig.
Pearson Chi-Square	7.711a	2	.021					
Likelihood Ratio	7.679	2	0.22	Male = 127	1.721	222	7.769	.006
Linear-by-Linear Association	7.765	1	.006	Female = 1.14				
N of Valid Cases	459							

H_0 There is no difference between students' gender and the impact of COVID 19 on their future educational development.

H_1 There is a difference between students' gender and the impact of COVID 19 on their future educational development.

The results indicate that the value of Chi-Square is 7.711 and the significant associated value is .021<0.05, indicating that the null hypothesis is rejected (see Table 4). We accept the null hypothesis that there is a gender difference in the mean percentage of the impact of COVID-19 on students' future educational development (see Table 4). This present study supports the previous research of Xiong et al. (2022), who found that demographic changes and shifting students' characteristics, such as their gender and preferences, were influential in impacting students' online class experiences via digital pedagogy. The results show that the F value is equal to 7.769 and its associated p-value is reported as .006, indicating the probability of the observed value is happening by chance. The results further show that the difference between the means of two groups (categories) of gender is significant. Thus, we accept the null hypothesis and say that there is the

difference in the mean Percentage of the impact of COVID 19 on students' future development across gender (see Table 4).

DISCUSSION

This study applied the six-factor model of digital pedagogy (Ozkan and Koseler, 2009) as the theoretical framework to examine the impact of COVID-19 on Higher education students' digital learning experiences. For the analyzed sample, only four variables that are related to the learners' experience were validated as determinants. It does not mean that the other motives were not present in reality, but they were not under our analysis. The purpose of this research was to examine how Higher-level students might predict their likelihood of being involved in virtual learning. This study used cross-sectional survey data gathered on 459 Higher-level students. A Binary Logistic Regression model was used to examine the impact of the COVID 19 pandemic and students' motivation on E-learning pedagogy. The binary model was verified for all reasons, which differentiated the experience of the satisfied and dissatisfied students with Higher-level institutions' digital E-learning pedagogy practices. Results from the study confirmed that a crisis management educational strategy during COVID-19, students' motivation to digital pedagogy, the impact of the pandemic on students' mental health, and benefits of digital pedagogy concerning student's satisfaction were significant predictors of students' motivation during COVID 19 pandemic. The research findings provide a foundation for continued research, as well as a framework for understanding how pandemics may influence Higher-level students' motivation to E-learning pedagogy in Nepal. The study identified a need for educators to understand the perceptions of Higher-level students on crisis management educational strategy, students' motivation to digital pedagogy, the impact of the pandemic on students' mental health, and the benefits of digital pedagogy have significant on students' motivation to E-learning pedagogy. Results from this study offer explicit recommendations and guidance to educational institutions for making guarantees how to improve students' motivation to E-learning pedagogy; it is one of a small number of studies in educational contexts to provide such guidance for students' engagement in E-learning pedagogy. (see Table 3). The current results have supported the previous study of Shamsudin and Abdul Majid (2019) and Papp-Dank (2019), who found that the digital pedagogy's currently used crisis management strategy was positively correlated with Higher-level students'

satisfaction with online learning activities during the pandemic. The results further supported the previous study of Hanaee and Rashidi (2020) and Crawford et al. (2020), who found that the Higher education providers have applied short-term strategies for rapid curriculum revision and redevelopment for fully digital offerings, they found that students' satisfaction in online learning activities via digital pedagogy was found satisfactory.

Further, digital modality should cover the different dimensions of students' online learning activities, consequently leading to different improvement strategies which can ultimately contribute to the promotion of the quality of digital pedagogy and the success of E-learning initiatives in Higher-level education institutions. Importantly, Higher-level students were found unsatisfactory with the current digital learning courses compared with lower-level students, indicating that the current virtual modality did not fulfil all online facilities (Crawford et al. 2020). Students at the Higher education level have identified four main issues regarding online courses during the pandemic as Khati and Bhatta (2020) found in our literature section. These all issues have been created inequality in education in Nepal.

The results show that there was a statistically significant relationship between students' satisfaction in online learning activities via digital pedagogy and their motivation in digital pedagogical modality, indicating that students' motivation in digital pedagogy has a negative impact on students' satisfaction with currently applied digital pedagogy of online courses (see Table 3). The current study has further supported the previous study of Azlan et al. (2020, 10-16), who highlighted that students who experienced that digital pedagogy was challenging to focus on curriculum content quality because of distractions, lack of engagement, and mental stress. They also shared that digital pedagogy's quality had technical problems, for example, poor internet connectivity and limited data plans, which also compounded the problem during online courses. The current study has also supported the previous study of Ivanytska and Kern (2015, 22-26), who found that low quality of digital pedagogy hindered students' learning opportunities, creating demotivation and dissatisfaction among students during the pandemic.

Our results indicate that there was a statistically significant relationship between the impact on pandemic on students’ mental health and students' satisfaction in learning activities with the digital pedagogy during the COVID-19 pandemic, indicating that there is a positive relationship between

the impact of the pandemic on students' mental health and students' satisfaction with current practices of learning activities via digital pedagogy. This current study supports the previous study of Hyun et al. (2019), who found that high quality of learning activities via digital pedagogy had decreased students' mental stress with their individual and group learning processes.

Together, this current study suggests a statistically significant relationship between benefits of the digital pedagogy and students' satisfaction with the existing digital learning courses during the COVID-19 pandemic, indicating that there is a negative relationship between benefits of digital pedagogy and students' satisfaction with current practices of online classes in their respective institutions. The result has supported the previous studies of Shehzadi et al. (2020) and Kanojiya (2020), who found that standard features of ICT, e-service, and e-information, low features and untimely interaction between student and professors, availability of poor technical support, unstructured online class modules, and poor conduction of practical classes negatively contributed toward students' satisfaction. The regression model summary indicates a negative correlation between the currently practiced digital learning pedagogical model and students' learning experience for their online learning satisfaction among Higher-level students in Nepal. Our results have supported the previous study of Miller (2021), who suggests that a Higher-educational institution can implement a crisis management strategy successfully is also contingent on a campus community's ability to be familiar with a strategy and its various parts, indicating that campus investors have to regularly review and practice the strategy something that even though considered significant is often ignored. We can argue that majority of Higher-educational leaders sent their students to campus learning due to the lack of stored crisis management plan. Very limited Higher-level institutions might have decided to implement crisis management plans who had already faced such type of crisis before (Miller, 2021). Our investigation highlights that Higher-level educational institutions need to improve the current features of digital learning to satisfy our students in a developing country, such as technological devices of E-learning, instructors' strong skills to deliver E-learning courses, interactive E-learning classes, and understanding the problems of students during E-learning courses (Khati and Bhatta 2020). We also highlight that the quality of E-learning motivates students in Higher-level students because E-learning is an element that affects students' motivation (Harandi, 2015).

Our investigation found that Private Higher education in Nepal has grown in size over the last two decades and exceeded public higher education. For example, Kathmandu University, a private university and has received large financial support from the government. The per-student University Grants Commission funding for Kathmandu University is more than the per capita grant given to the public colleges, affiliated with Tribhuvan University. Thus, while public institutions have got a poor number of students, private institutions have enrolled a large number of students. Private educational institutions have also served the middle and rich level classes that have attracted students to private educational institutions in Nepal. Our results also found that most of the private educational institutions had launched online classes in Nepal compared with public colleges. The reasons behind that would be the higher quality of education, different digital facilities, less bureaucratic enrollment processes, fewer students' union activities during the classes, parents' motivation to private educational institutions, and student's choice. Notably, private institutions have high fees structures compared with public colleges, however; students choose private colleges rather than public colleges. The present situation of public colleges is degrading in both quality and number of student's enrollment (Nikku, 2013). Our results also found that there were more facilities of E-learning classes in private institutions than the public institutions.

CONCLUSION AND RECOMMENDATION

This article aimed to analyze students' learning experiences via digital pedagogy during the pandemic to participate in voluntary activities using Higher-level education students' samples. It enabled the verification of what motives determine the learning activities in digital pedagogy participation via binary regression model. This study's primary purpose was to investigate the impact of COVID-19 on students' learning experience on digital pedagogy at Higher-level educational institutions in Nepal. The results show that the student's own beliefs lead to learning activities in digital pedagogy influencing their engagement in online classes. In addition to the relevance of students' beliefs and values, this study's findings showed the relevant role of temporary educational strategy, students' experience in digital pedagogy, quality of digital pedagogy, and standard digital pedagogy features in motivating students to engage in digital learning activities.

Higher-level institutions have several strategies to motivate their students through the quality and features of digital pedagogy. According to Higher-level educational institutions, there are several ways to engage students for each of these options, standard features, facilities, and digital pedagogy quality. From the findings of this study, it is possible to verify the relevance of online classes' digital pedagogical modality during the pandemic. Therefore, the need for quality, facilities and digital pedagogy support in Higher-level students to perform different online learning activities during the pandemic is mandatory for future research in the Nepalese context. Future professional educators should prepare to work towards support, ease, and accessibility to all students by considering the quality, facilities, and features of digital pedagogy (Khati and Bhatta 2020: Nguyen and Huynh 2020; Patrinos and Shmis 2020; UNESCO 2020).

Additionally, as highlighted by Adnan (2020, 45-51), few studies address this article's theme in developing countries, like Nepal. In this sense, this study contributes to the literature, providing evidence from Nepalese reality and enriching cross-country debates. This study's limitations must be highlighted. For example, the research data for this study were collected in Nepal and analyzed in the Nepalese context; thus, the findings will not be similar in developed countries. However, the sample size allowed for a binary regression model, providing interesting results to contribute to the literature. Regarding theoretical limitations, it should be cited that this analysis focused on quality, facilities, and features of digital pedagogy of online courses in the literature. The existence of other components of digital pedagogy is not under analysis.

Nonetheless, an extensive search in the literature was performed to ensure the quality of this research. Studying the current reality of Nepalese digital pedagogy of online courses regarding students' satisfaction provides opportunities for leaders of Higher-level education institutions to improve online courses' digital pedagogical modality based on this analysis. This analysis would enhance the facilities, quality, and features of Nepalese digital pedagogy of online courses possibilities and proposals for international debates regarding current digital pedagogy practices in Higher-level education institutions. An analysis of the features regarding advanced and fully equipped digital pedagogy model, future researchers have to conduct more extensive studies to address the current demands of the fully equipped digital pedagogical model.

The results confirm a gender difference between the study sample and their opinion on the impact of COVID-19 on their future development. The results show the severe effects of COVID-19 on students' learning outcomes at Higher-level educational institutions in Nepal. A modern digital modality needs to be discovered and implemented in Nepal's private and Government Higher educational institutions.

In this context, the digital learning environment's foundation must be improved in Nepalese higher-level educational institutions and manage equipped digital pedagogy. Minimal educational institutions have moved to strengthen the digital modality as online courses. Still, they need to formulate and implement the new educational policy for the compulsory digital modality at each Higher-level educational institution to meet digital pedagogy's international standards in Higher-level education institutions (Adnan 2020, 45-51). Three levels of the Government of Nepal and private sector educators have to investigate a large amount of annual budget to improve the foundation of internet facilities' infrastructure to give all Higher-level education students access to online classes.

This study revealed students' experience with digital pedagogy features, perceived satisfaction of the online class motivation, and how the digital pedagogy facilitated online classes for Higher-level students. Participants' experience with digital pedagogy for online courses was negative and did not prepare them for their future career development. These experiences led to information that may be used to assist with students' satisfaction with the features of digital pedagogy. Finally, the Nepalese government has to restructure its public colleges to compete with private colleges so that the impact of the crisis on students' E-learning motivation can be enhanced in public colleges. Future studies have to focus on E-learning motivation in public colleges students and the possible challenges faced by students.

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APPENDIX 1: Consent Form for Participants to Access Parts in Research

Please complete the portion of the consent form below:

Saraswoti Kendra Nepal assures Dr Basanta Prasad Adhikari and Mr. Sarad Chandra Kafle, who are crucial members of Saraswoti Kendra Nepal members. They are willing to commence their research in Higher education students' educational institutions at Kathmandu, Lalitpur, Bhaktapur, and Chitwan district. We kindly request Higher education students' educational authorities to support Dr Adhikari. Liu and Mr. Kafle conducted this study and solicited students' participation from different High education students' academic institutions, Nepal.

Date: ..... Name of the educational institution

Name of Faculty: .....Title and name of faculty head .....

We are happy to permit you to our organizations. Yes ☐ No ☐

Authorized signature**: .....**

Seal of educational institutions .....

Signature of the secretary of SKN

APPENDIX 2

Group Statistics

	Gender	N	Mean	Std. Deviation	Std Error Mean
Sub1	Male	202	2.7913	.89119	.06270
	Female	257	3.0899	.86207	.05377
Sub2	Male	202	2.2731	.86208	.06066
	Female	257	2.2082	.73151	.04563
Sub3	Male	202	3.4604	1.15605	.08134
	Female	257	3.6355	1.11488	.06954
Sub4	Male	202	2.9713	.83824	.05898
	Female	257	2.8222	.78193	.04878

Independent Samples Test (Levene's Test for Equality of Variances; t-test for Equality of Means).

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Sub1	.473	.492	-3.629	457	.000	-.29855	.08228	-.46023
			-3.614	424.918	.000	-.29855	.08260	-.46091
Sub2	2.922	.088	.872	457	.383	.06493	.07443	-.08134
			.855	393.843	393	.06493	.07590	-.08429
Sub3	.561	.454	-1.644	457	.101	-.17514	.10655	-.38453
			1.637	424.265	.102	-.17514	.10702	-.38549
Sub4	.473	.492	-3.629	457	.000	-.29855	.08228	-.46023

APPENDIX 3: The survey questionnaire

Please give your thoughts on currently practiced online classes

1. Do you have online access to continue your education? a. Yes, b. No
2. What is the level of your study?

a. Bachelor degree
b. Master degree
c. MPhil/PhD

3. Tick the type of your educational institution ……

a. Government b. Private

b. 4. Please mention our gender ……

a. Male b. Female c. Other

4. What is your age? …….

a. 18-20 years b. 21-24 years c. 25 years above

5. Are you in the same place where you study? ……
6. A. Yes, b. N
7. What types of internet facilities are you using for your online class? …….

1 = Mobile data. 2. Sharing from others 3. Internet support of relatives/friends'' house 4. self-house internet available 4. Others ……

8. What apps are you using in your online class? …….

a. Zoom virtual
b. Messenger
c. Tim virtual tool
d. Google met
e. Microsoft team
f. Teacher community support learning
g. Institutional visit assessment learning

Students' experiences on digital learning

13a Online course is an only procedural activity
13b. Online class has created tension for me. You can choose more than one options
13c. Online class is a strategy to retain existing students
13d. Online class is a strategy of receiving fees
13e. Online course was a way of institutional publication
13f. Online course was the only procedural method
13g. Online course was an effective method of online education
13h. Online course was the best method of teaching during Covid19
13i. Online course was an unavoidable way of teaching in Pandemic
13j. Running online approach was considering government direction only
13k. Online course was a contemporary way of teaching during Pademetic
13l. The features of online courses were minimal and low Quality
13m. Online classes were not properly structured as well as timely delivered during Pandemic.

Current practices of online education as an alternative method of teaching and its features

14a. All students have access to current online education
14b. Online education of digital pedagogy has created discrimination among students
14c. I am eager to get online classes
14d. My parents know about online education
14e.Online course has created tension
14f. Online class has created frustration
14g. Online class has created depression
14h. There is vast variation between online courses and face to face school teaching
14i. My time during the online class and handed assignments quickly passed.
14j. COVID19 has increased my time to watch T.V
14k COVID 19 has improved my skills to use mobile as a teaching tool
14l. I have got time to play the outdoor game during the COVID19
14m. COVID 19 has increased the distance between students and teachers
14n. I am very much worried about my future educational development
14o. Online classes via digital pedagogy were not useful.

Measurement variables

15a.Do you enjoy current online classes?
a. Yes
b. No
15b. Has COVID19 severely affected your study?
a. Yes,
b. No
15c. Are you satisfied with the facilities of the currently practiced online class?
a. Yes,
b. No
15d Has COVID 19 affected your future opportunity?
a. Yes
b. No
15e. Are you satisfied with the currently practiced digital teaching pedagogy?
a. Yes,
b. No

Essay

Are the social sciences reducible to the natural sciences?

Alireza Momeni[1]

Introduction

The natural sciences, based on *universal law* (1), historically, stand up distinctively valuable epistemic position over all field of sciences. On the other hand, *philosophy of social sciences* is based on some certain *concepts, which* are developed by a set of *social regularities/situations*. The most important questions, in this sense are the social sciences reducible to the natural sciences, particularly physics? Does social inquiry utilize the same "*scientific methods*" as natural science?

In this essay, I show that even before considering the social sciences as the real sciences, several epistemic fallacies were occurred leading somehow by two sets of perspectives including *Reductionism* and *Essentialism*. I emphasis on avoiding both two models of viewing to secure the social sciences standing which might be recognized as inferior discipline. Otherwise, by losing significance of the social sciences, several issues may arise for the field, for instance, receiving much less support and funding from government, universities, etc., than other disciplines, consequently discouragement of scholars who chose the inferior pursuits (2, 3).

Finally, I am going to argue that a compelling account of the social sciences based on the certain ontological principals in social phenomenon help us to build up the compatible and realistic expectations from the social sciences.

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The Social Sciences beyond of the philosophy of science

So many years ago, *Thales of Miletus* claimed that he knows the originating principle of the natural world by declaring water as the first cause of the nature[4]. The other Milesian, *Anaximenes* stated that the air is the source of every things[5]. *Heraclitus* insisted in ever-present change and motion of the univers[6]. *Socrates*, after six centuries later, was concerned that some of the early naturalist Greek philosopher explain things merely in favor of matter and motion regardless of human intelligent order[7].

The study of human behavior, over the centuries, had been the realm of theology and mythology, just *Rene Descartes* in 17th century attempted to explain human body function with mechanical explanation. In nineteenth century, *Aguste Comte*, as known as father of *sociology*[8] aimed to place social sciences in the scientific hierarchy [9, 10], however, his concern was that the new-established discipline may fall to pre-science realm – metaphysics and theology – it made him to refer to physics by developing concept of "*Social Physics*"[10] based on "*the positive philosophy*"[9]. At the turn of the 20th century, Science has historically been a physics-dominated field [11]. Since the early 1980, *the philosophy of social science*, which address certain basic philosophical questions toward the social sciences, has become a popular discipline [2, p xv]. Philosophers of science turned formerly to social realm for understanding how the *knowledge* can be acquired from social world as well as natural world. During the 20th century, Karl Popper and Thomas Kuhn built the most fundamental criticisms of knowledge created through induction in natural sciences. Karl Popper pay more attention to the social sciences, although he never hides his interest in the natural sciences [12]. He proposes the idea of "*unity of the method*", while he suggests the "s*ituational analysis"* more benefit method to the social sciences [12].

Viewing the social sciences through the essentialist lens and reducing it to the natural sciences and physics, such the epistemic fallacies make an unrealistic hierarchy for the sciences in which the social sciences might be recognized as inferior discipline. In next part, I deal with to show these misleading perspectives within emphasizing to avoid them through study sciences.

Essentialist lens

“Are the social sciences really inferior to the natural sciences?” To arrive at that question asked by Austrian-American economist, Fritz Machlup in his article in 1961 [(1)], at this point, you may think that; are the social sciences really science? The later question by itself bears a certain in-depth question that ask what science really is. As you see, Machlup’s question inquires the position of the social sciences in a hierarchical clustering of sciences, with holding implicitly the scientific nature for the social sciences in advance. It seems the first question lead us to go deeper and deeper into the subject until reaching the roots.

The philosophers of science, historically, moved most often from the surface to the depth; getting to the origins. They constantly seek out the common principles that lie in the underlying layers of sciences, attempting to reach the essence of the sciences, and finding a common ancestor to all the sciences evolutionarily. For instance, the controversy between the *rationalists* who hold the origin of knowledge as *rational inference* [(13)], and the *empiricists* who maintain the *experiment and observation* as the basis of knowledge [(11, 13)] is such a long story in philosophy of science.

This idea that “the essence of sensible things can be found in other and more real things-in their primogenitors or forms” [(14, p 317)] outlined by *Plato* and many of his followers [(14)]. The key role of science, therefore, is to discover the latent reality or essence. The most important question in this sense is; can we simply talk about the soul (or essence) of science with fixed and unchanged properties? Popper argues that the philosopher of science, by adopting such an essentialist approach that inquires what is, or what are and not why [(15)]. In other words, the philosopher of science might describe the science within its axioms, but by this way, the logic of scientific changes, internal complexity, and extrinsic networks of science will be eventually ignored, whilst the advancements in knowledge take place most often in changes [(16)]. On the other hand, the common principles of sciences, if any, seems are disputable and no discoverable easily. Applying such a mentioned approach, most importantly, may lead us to build a dogmatic hierarchy, somehow, in science, which boosts totalitarianism and authoritarianism [(17)].

Furthermore, detection of epistemic errors, in this sense, is more effective than looking for roots of knowledge. Popper proposed a magical technique so-called *Critical Rationalism* [(12, 15, 17, 18)] to avoid the *scientific dogmatism*. He writes, "Science must begin with myths, and with the criticism of myths; neither with the collection of observations, nor with the invention of experiments, but with the critical discussion of myths.” [(17, VII)]

Reductionism

"There is physics and there is stamp-collecting" this famous statement of physicist E. *Rutherford* (quoted by Crane, & Mellor, 1990) [19], recall the idea of *Reductionism* in science which is originated from unified science theory. In the 20Th century, *Rudolph Carnap* (1934), as a leading figure of the *Vienna Circle*, proposed the idea in his book so-called *the unity of science* [20], while it is old as even before philosophy of science was invented [21]. Reductionism most often covers view in which all of sciences regardless of several ontological and epistemological differences are reduced to one discipline such as physics. This reductive process may happen, therefor, in three aspects of science including vocabulary, laws, and explanatory principals [22].

Early philosophers of science, such as Auguste Comet, may initially thought that *demarcation* such a sufficient approach play key role to solve many social issues, and the following controversy in this sense – reductionism or the Unity of Science, never imagined before. Karl Popper, later pointed that "the believers in reduction who, for some philosophical or other reason, adopt a priori the dogmatic position that reduction must be possible, in a way" [15, p 8].

Social phenomena versus natural phenomena

In this part, I emphasize on the certain features of the social phenomena compared the natural incident, which may inspire to open the comparative discussion between the social sciences versus the natural sciences, and building up the compatible and realistic expectations from all both disciplines.

1. Complexity versus simplicity

The social phenomena, such the highly complex processes [3] have many interrelated parts inside, and a broad network of contributed variables outside, which make them to never acquiesce in the precision and measurability as well. In contrast, the natural phenomena are simple and susceptible to measure mathematical definition precisely.

2. Concept-oriented versus law-oriented

The social phenomena are based on *situations*, instead of the *universal-matter-based laws* of physics. The social situation is defined by a couple of concepts that are utilized by researchers to understand and explain no *absolute reality*, but at least like the real circumstance (verisimilitude) [12]. For instance, the brain drain in the low-income developing countries as a social phenomenon is explained by such concepts as poverty and new colonialism (concept), whilst the planet movements can be explained by the Newton's laws of motion.

3. Situational versus Universal

The natural events are explained based on the universal laws that are not limited to a space, time, and state. In contrast, social issues are situational and contextual, that change in a particular geography and time, declining the predictability of social phenomena as well.

4. Changeability versus stability

The social situations as mentioned, are based on a set of internal and external relationships which can be identified, and explained within its "time" and "place", the changeability, therefore, make them to be less generalizable than natural events. For instance, are the leading factors contributing to increase the rate of suicide in Tehran the same as Helsinki?

5. The social theories have many exceptions.

Finally, the social regularities, contrary to the laws of physics, have many exceptions. In the other words, there are a couple of social theories, which would never be falsified. Popper tried to avoid circularity of positivist *verification* by relying on the principles of his innovative method so-called *falsification* [15, 17, 18], but some hypothesis or theory may never have a potential to be falsified in some disciplines, especially in the social sciences.

Conclusion

To sum up, the study of sciences need mostly to adopt a non-essentialist (*nominalist*) approach not only to explain the nature of each science within its consequences, advances, and achievements, but also to develop a plural scientific world. The social sciences, accordingly, based on their certain ontological features, are not simply reducible to natural sciences.

Furthermore, the study philosophy of the social sciences illustrate that the fundamental differences of social phenomena compared to natural events make the fields not amenable to measure precisely definition within a lower power of predictability, generalizability, and uniformity rather than the natural sciences. Applying the same scientific methods as in all both disciplines and “the unity of method” seems as an ambitious approach as well as following the interpretivist which isolate completely the way for explanation in the social sciences. However, rethinking to basic ontological differences between two disciplines within maintaining the significance of each one and avoiding the epistemic errors help us to choose a middle way. Finally, let us to emphasize that the developments of knowledge and the transition of scientific patterns and paradigms throughout the time mostly occurs in the changes.

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Essay about some questions concerning zero energy ontology

September 28, 2021

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Abstract

Zero energy ontology (ZEO) gives rise to quantum measurement theory and theory of consciousness. There are several questions without a "final" answer related to ZEO.

At least the following questions related to both TGD proper and TGD inspired theory of consciousness are still waiting for a precise answer.

1. How uniquely does the preferred extremal property of the space-time surface fix the space-time surface inside a given CD = cd×CP_2? The simplest situation is that the data at the intersection of the space-time surface at either boundary of CD fix it completely. Space-time surface would be analogous to Bohr orbit or of a soap film spanned by frame.

   However, the dynamics of soap film is slightly non-deterministic: the frame does not determine the film uniquely. This analogy and $M^8 - H$ duality suggest that the non-determinism is not complete and that this non-determinism serves as a classical correlate for the non-determinism of state function reduction.

2. How unique is the interpretation of zero energy ontology (ZEO)? Here actually 3 options suggest themselves corresponding to western, eastern interpretation and their hybrid.

3. Sub-CDs of CD are correlates of subselves mental images. What is the precise definition of sub-CD and of subself? How subselves, that is sub-CDs, are created?

Contents

1 Introduction

Zero energy ontology (ZEO) [L8] gives rise to quantum measurement theory, which naturally extends to a theory of consciousness. In this article also consciousness aspect is central and my sincere hope is that it would not expel those physicist readers for whom consciousness still remains an unscientific notion.

1.1 Zero energy ontology (ZEO) briefly

ZEO provides a new ontology solving the key problem of the standard quantum measurement theory and quantum theory itself. It must be emphasized that ZEO is not a new interpretation created to put under the rug the logical paradox due to the conflict between non-determinism of state function reduction (SFR) and the determinism of unitary time evolution. Also the problem about the scale in which quantum world becomes classical disappers: the Universe is quantal im all scales and ZEO view about quantum jump makes the Universe to look like classical.

1. At the level of space-time dynamics, the notion of preferred extremal (PE) as a space-time surface is central: PE is an extremal of an action principle, which by general coordinate invariance must be highly unique once its intersection with either boundary of causal CD $= cd \times CP_2$ (cd is the intersection of future and past directed light-cones of M^4) is given. In the ideal situation this implies holography. Space-time surface is an analog of Bohr orbit and classical theory is an exact part of quantum theory.

   There is probably a finite and discrete non-determinism analogous to that associated with soap films spanned by a frame: space-time is indeed a minimal surface as also soap films, and the 3-surfaces at its ends at boundaries of CD are part of the frame. Besides space-time surface is an extermal for Kähler action analogous to Maxwell action. The challenge is to interpret this finite non-determinism.

2. Quantum states, which I call zero energy states, can be interpreted as pairs of analogs of ordinary 3-D quantum states with positive energy. The members of the pair are at the opposite boundaries of CD. The convenient convention used also in quantum field theories (QFTs) is that the conserved quantum numbers at opposite boundaries sum up to zero classically: this brings in nothing new. At quantum level, 4-momenta are conserved only at the limit when CD has infinite size whereas classically the conservation holds true for all CD sizes: this reflects the Uncertainty Principle [L18]. Also in QFTs exact momentum conservation is obtained only at the limit of infinite quantization volume.

At the space-time level, zero energy states can be regarded also as superpositions of deterministic time evolutions: this is central for the interpretation.

3. SFRs are quantum jumps between zero energy states. SFR does not affect any deterministic time evolution but only replaces their superposition with a new one. This solves the paradox that was one of the key motivations for ZEO.

4. Zeno effect strongly suggests that there are 2 kinds of quantum measurements assignable to SFRs. For "weak measurements", "small" SFRs (SSFRs), the component of zero energy state at the either boundary of CD, to be called passive boundary (PB), is unaffected. Also the PB is unaffected apart from scaling. At the active boundary (AP) state changes and AP is scaled up (at least in statistical sense) and due to the scaling shifts to the geometric future.

   The unitary time evolution preceding each SSFR corresponds to a scaling of CD (or rather, its M^4 projection cd) rather than time translation as its counterpart in string models. In A unitary evolution B between two SSFRs a superposition of CDs with varying sizes is formed and SFR localizes CD to a fixed size, which means the measurement of geometric time identifiable as the distance between the tips of CD. This geometric time correlates with the subjective time defined by the sequences of SSFRs. Subjective and geometric times are not identical as in standard ontology but only correlated.

5. "Big" SFRs (BSFRs) are the counterparts of ordinary quantum measurements. In the BSFR the roles of AB and PB of CD change so that the arrow of time changes since CD increases in the opposite direction of time (at least in statistical sense). For an observer with an opposite arrow of time, BSFR looks like an average deterministic time evolution leading to the final state of BSFR as observed experimentally by Minev et al [L5] [L5]. This illusion makes BSFR look classical in all scales although the TGD based dynamics is quantal in all scales due to the hierarchy of Planck constants predicted by TGD.

   The possibility of time reversal forces a generalization of thermodynamics to allow both arrows of time: this kind of generalization was proposed long ago by Fantappie [?] with motivation coming from biology. Quite generally, self-organization processes seem to violate the arrow of time. External energy feed explains this partially but BSFR would be an important additional element of self-organization [?, L17], especially so in living matter.

   The assignment of "free will" to BSFR allows us to understand how free will can be consistent with the classical non-determinism of physics which would be exact.

ZEO based quantum measurement theory and therefore also physics naturally extends to a theory of consciousness, and one cannot avoid using this word, which is still a cursed word in the physicalistic camp.

1.2 Problems related to the mathematical realization of ZEO

There are several open questions related to ZEO and TGD inspired theory of consciousness and the existing view involves several working hypothesis which should be reduced to deeper principles or shown to be wrong.

At least the following questions related to physical interpretation of ZEO are still waiting for a detailed answer.

1. Preferred extremal (PE) property of space-time surfaces is central for quantum TGD [L12]. It follows from holography forced by general coordinate invariance (GCI), which however need not be ideal. How uniquely does the PE property of the space-time surface fix the space-time surface inside a given CD? The simplest situation is that the data at the end of the space-time surface at either boundary of the CD,fixes it completely. Space-time surface would be an analog of Bohr orbit.

   Full determinism would imply that WCW for CD effectively reduces to the space of 3-surfaces assignable to either end of CD. The dynamics of SSFRs would reduces to that in fermionic degrees of freedom assignable to Boolean cognition since WCW degrees of freedom assignable to sensory perception would be fixed.

   However, the dynamics of soap films spanned by frames suggests that this is not the case. The 3-D ends of the space-time surface define a frame and also dynamically generated portions of frame are allowed by

the variational principle defined by the sum of a volume term and Kähler action as an analog of Maxwell action. The coefficient of the volume term has an interpretation in terms of a length scale dependent cosmological constant Λ.

Outside the frame space-time surface would be at least for a very large portion of extremals an analog of complex surface and therefore a minimal surface [L19] and also an extremal of Kähler action. At the frames only the equations for the entire action (sum of volume term and Kähler action) would be satisfied. The divergences of the conserved isometry currents for the volume term and Kähler action would have delta function type singularities but they would cancel each other. The portions of the frame could be analogous to singularities of analytic functions such as cuts and poles.

2. Number theoretic universality [L3, L4] in turn suggests that the inherent non-determinism of p-adic differential equations [K2] [?] proposed to be a correlate of imagination could also relate to this non-determinism. How do the non-determinism of space-time surface, p-adic non-determinism, and non-determinism of the state function reduction relate to each other: could they be even one and the same thing?

ZEO based quantum measurement theory defines a theory of consciousness. How unique is the interpretation of zero energy ontology (ZEO) [L8]? Here 3 options suggest themselves corresponding to "western" and "eastern" world views and their hybrid.

1. For the western option, the space-time surface continues outside any CD as external world, in particular sub-CD and sub-CD is a correlate for the perceptive field of self.
2. For the eastern option, space-time ends at the boundary of any CD and sub-CD is not a correlate for the perceptive field of self and there is no constraint from the external world at boundaries of CD.
3. For the hybrid of these two options, conscious entity corresponds to a hierarchy of CD for which the highest level corresponds to CD for which space-time does not continue outside the CD. The highest level represents a God-like entity.

1.3 Problems related to ZEO based theory of consciousness

The new picture about sub-CDs at WCW level raises questions related to the TGD inspired theory of consciousness. This view involves several ad hoc assumptions related to the notions such as attention, mental image, memory, volition and intentions. Do these assumptions follow from more general assumptions or can some of them be simply wrong?

1. CD is a correlate for the perceptive field of self. Sub-CDs of CD define perceptive fields of subselves identified as mental images. What is the precise definition of sub-CD? Can one say that a sub-CD is created when a mental image is created. How does this happen? What determines the

position and size of the sub-CD?

The sub-CD is defined by the restriction of zero energy state to sub-CDs so that sub-CDs are induced by CD. This condition is analogous to boundary condition in classical physics and freezes WCW degrees of freedom of sub-CD at the passive boundary (PB) but the failure of determinism leaves discrete degrees of freedom at the active boundary (AB) so that the dynamics of SSFRs is restricted to these sub-WCW degrees of freedom and fermionic degrees of freedom.

2. Where sub-CDs and subselves are located? The natural location for a minimal sub-CD and mental images is around 3-surface at which the classical non-determinism fails: the frames of the soap film in soap film analogy. One can develop a rather detailed picture about frames [L19] based on number theoretic vision realized in terms of $M^8 - H$ duality [L10, L11, L14].

3. How sub-selves (sub-CDs) are created? Can they disappear? The notion of attention as generation of sub-CD achieved by a location of WCW ("world of classical worlds") spinor field at spacetime surfaces having their intersection with the PB of CD in a fixed set of 3-surfaces defining the sub-WCW is highly suggestive. This also affects the WCW spinor field of CD.

   The attention can be directed in several manners. Redirection of attention means a movement of the region defining the content of mental images in the interior of a CD. Entanglement and classical communications would be naturally associated with attention defined in this manner. If minimal subselves are associated with the frames as loci of classical non-determinism, the set of targets of attention is discrete and finite.

   This view about attention makes it possible to see also memory, anticipation, and intentions as special cases of attention.

4. The time evolution of CD itself would correspond to a scaling of CD (rather than translation), which by the failure of strict determinism brings in new discrete degrees of freedom related to the new frames becoming into the daylight as space-time surfaces increase. In the new picture, the sub-WCW property poses strong restrictions to the earlier picture about the development of sub-CD. The idea about silent wisdom as mental images preserved from the previous life after BSFR is not lost but is considerably modified.

In this picture, the small failure of classical determinism would be an absolutely essential element in that it makes possible a non-trivial theory of consciousness at the level of CD and at space-time level. Otherwise would have only fermionic degrees of freedom forgiven sub-CD. What is intriguing is that everything would be finite. SFRs would involve choices between finitely many alternatives and in this respect the theory would be analogous to the computationalistic approach: in fact, preferred extremals are analogous to computer programs.

2 Some background

In the sequel, some understanding of the basic ideas and notions of TGD proper [L12] is needed. Also ZEO as the target of critical discussion is briefly summarized.

2.1 TGD view briefly

Very concisely, TGD emerges as fusion of special and general relativities and has Poincare invariance of special relativity and General Coordinate Invariance (GCI) and Equivalence Principle (EP) as basic principles. Also the interpretation as a generalization of string models is possible: point-like particles are replaced by 3-surfaces instead of strings and world lines become space-time surfaces.

The notion of induction makes it possible to eliminate classical boson fields as primary dynamical variables and reduce them to the sub-manifold geometry of the space-time surface. For the simplest option, free second quantized quark fields of the embedding space $H = M^4 \times CP_2$ induced to the space-time surface remain as fundamental fermion fields and quarks serve as basic building bricks of both bosons and fermions as elementary particles [L9, L15].

Some understanding of notions such as the "world of classical worlds" (WCW) [K3], preferred extremal (PE) [K4], and various variants of holography [L10, L11] implied by general coordinate invariance (GCI) in TGD framework is assumed. Inclusions of hyperfinite factors of type II_1 (HFFs) [K10, K9] are central elements of quantum TGD proper.

Adelic physics [L4, L3] replacing real number based with number theoretical universal physics based on the hierarchy of adeles defined by extensions of rationals (EQs) and $M^8 - H$ duality allowing number theoretic and geometric views about physics dual to each other is also assumed as the background.

Hierarchy of Planck constants $h_{eff} = n \times h_0$, with n identified as dimension of EQ, is the basic implication of adelic physics and central for quantum TGD. The phases labelled by h_{eff} behave like dark matter [K5, K6, K7, K8]. This hierarchy serves as a correlate for quantum criticality in arbitrarily long length scales.

Cognitive representations identified as points of space-time surface for which preferred coordinates of embedding space are in an extension of rationals are also central for the construction of the theory using $M^8 - H$ duality [L10, L11].Galois group of EQ becomes number theoretical symmetry and is central in the description of quantum variants of cognitive representations [L1, L13].

Zero energy ontology (ZEO) [L8] is a key notion of quantum measurement theory. The basic prediction is that time reversal occurs in the ordinary state function reduction (SFR). This has profound implications for the interpretation of the quantum measurement theory [L5].

TGD inspired theory of consciousness can be seen as an extension of quantum measurement theory and relies on Negentropy Maximization Principle (NMP) as a basic dynamical principle [K1] [?] implying second law for ordinary entanglement entropy.

2.2 $M^8 - H$ duality as it is towards the end of 2021

The view of $M^8 - H$ duality has changed considerably towards the end 2021 [L18] after the realization that this duality is the TGD counterpart of momentum position duality of wave mechanics, which is lost in QFTs. Therefore M^8 and also space-time surface is analogous to momentum space. This forced us to give up the original simple identification of the points $M^4 \subset M^4 \times E^4 = M^8$ and of $M^4 \times CP_2$ so that it respects Uncertainty Principle (UP).

The first improved guess for the duality map was the replacement with the inversion $p^k \to m^k = \hbar_{eff} p^k/p^2$ conforming in spirit with UP but turned out to be too naive.

The improved form [L18] of the $M^8 - H$ duality map takes mass shells $p^2 = m^2$ of $M^4 \subset M^8$ to cds with size $L(m) = \hbar_{eff}/m$ with a common center. The slicing by mass shells is mapped to a Russian doll like slicing by cds. Therefore would be no CDs in M^8 contrary to what I believed first.

Quantum classical correspondence (QCC) inspires the proposal that the point $p^k \in M^8$ is mapped to a geodesic line corresponding to momentum p^k starting from the common center of cds. Its intersection with the opposite boundary of cd with size $L(m)$ defines the image point. This is not yet quite enough to satisfy UP but the additional details [L18] are not needed in the sequel.

The 6-D brane-like special solutions in M^8 are of special interest in the TGD inspired theory of consciousness. They have an M^4 projection which is $E = E_n$ 3-ball. Here E_n is a root of the real polynomial P defining $X^4 \subset M_c^8$ (M^8 is complexified to M_c^8) as a "root" of its octonionic continuation [L10, L11]. E_n has an interpretation as energy, which can be complex. The original interpretation was as moment of time. For this interpretation, $M^8 - H$ duality would be a linear identification and these hyper planes would be mapped to hyperplanes in $M^4 \subset H$. This motivated the term "very special moment in the life of self" for the image of the $E = E_n$ section of $X^4 \subset M^8$ [L6]. This notion does not make sense at the level M^8 anymore.

The modified $M^8 - H$ duality forces us to modify the original interpretation [L18]. The point $(E_n, p = 0)$ is mapped $(t_n = \hbar_{eff}/E_n, 0)$. The momenta (E_n, p) in $E = E_n$ plane are mapped to the boundary of cd and correspond to a continuous time interval at the boundary of CD: "very special moment" becomes a "very special time interval".

The quantum state however corresponds to a set of points corresponding to quark momenta, which belong to a cognitive representation and are therefore algebraic integers in the extension determined by the polynomial. These active points in E_n are mapped to a discrete set at the boundary of cd(m). A "very special moment" is replaced with a sequence of "very special moments".

So called Galois confinement [L14] forces the total momenta for bound states of quarks and antiquarks to be rational integers invariant under Galois group of extension of rationals determined by the polynomial P [L18]. These states correspond to states at boundaries of sub-CDs so that one obtains a hierarchy. Galois confinement provides a universal number theoretic mechanism for the formation of bound states.

2.3 ZEO

The TGD based view of consciousness relies on ZEO solving the basic paradox of quantum measurement theory. First, a brief summary of the recent view of ZEO [L8] is required. Some aspects of this view will be challenged in the sequel for sub-CDs.

1. The notion of a causal diamond (CD) (see **Fig.** ??) is a central concept. Its little cousin "cd" can be identified as a union of two half-cones of M^4 glued together along their bottoms (3-D balls). The half-cones are mirror images of each other. CD=$cd \times CP_2$ is the Cartesian product of cd with CP_2 and obtained by replacing the points of cd with CP_2. The notion of CD emerges naturally in the number theoretic vision of TGD (adelic physics [L3])via the $M^8 - H$ duality [L7, L10, L11].

2. In the ZEO, quantum states are not 3-dimensional if the classical determinism does not fail as it actually does, but superpositions of 4-dimensional deterministic time evolutions connecting ordinary 3-dimensional states. By holography forced by general coordinate invariance, time evolutions are equivalent to pairs of ordinary 3-D states identified as initial and final states of time evolution.

   Quantum jumps replace this state with a new one: a superposition of deterministic time evolutions is replaced by a new superposition. The classical determinism of individual time evolution is not violated. This solves the basic paradox of quantum measurement theory. There are two kinds of SFRs: BSFRs (counterparts of ordinary SFRs) changing the arrow of time (AT) and SSFRs (analogs of "weak" measurements) preserving the arrow of time that give rise to an analog of the Zeno effect (`https://cutt.ly/yl7oIUy`) [L8]. The findings of Minev et al [L5] provide strong support for ZEO [L5].

To avoid confusion, one may emphasize some aspects of ZEO.

1. ZEO does not mean that the physical states identified in standard quantum theory as 3-D time= constant snapshots - and assigned in ZEO to the opposite boundaries of a causal diamond (CD) - would have zero energy. Rather, these 3-D states have the same conserved quantities, such as energy. Conservation laws allow us to adopt the convention that the values of conserved quantities are opposite for these states so that their sum vanishes.

   This is not new: in quantum field theories (QFTs), one speaks, instead of incoming and outgoing particles, external particles arriving from the geometric past and future and having opposite signs of energy. That conserved quantities vanish in the *4-D* sense, expresses only the content of conservation laws. A weaker form of this condition [L16] states that the total conserved Poincare charges are opposite only at the limit of infinitely large CD. CD would be an analog of quantization volume in QFTs, whose finiteness implies a small conservation of momentum.

2. ZEO implies *two* times: subjective time as a sequence of quantum jumps and geometric time as a space-time coordinate: for instance, the proper time of the observer. Since subjective time does not correspond to a real continuum, these times are not identifiable but are strongly correlated. This correlation has led to their identification although they are different.

3 How uniquely PE property fixes the space-time surface?

How uniquely the PE property fixes the space-time surface if its 3-D intersections with the boundaries of CD are given? This is the key question in this section.

3.1 Various variants of holography

General coordinate invariance (GCI) forces holography in the TGD framework. One can however consider several variants of holography [L10, L11, ?].

1. Holography in the standard sense would fix the space-time surface from the data of its intersection with either boundary of CD or the data associated with the light-like 3-surfaces at which the signature of the induced metric changes.
2. Strong form of holography (SH) states that 2-D data at the intersections of the light-like 3-surfaces and boundary of CD are enough to determine the space-time surface.
3. The strongest form of holography inspired by $M^8 - H$ duality [L10, L11, L16] states that space-time region is determined by a rational value coefficients of a real polynomial extended to an octonionic polynomials, whose "root" is the space-time surface in M^8. The n roots of a real polynomial would determine a 4-D region in M^8 and its image in $H = M^4 \times CP_2$ would be interpreted as space-time surface.
4. There is a variant of holography, which gives up the full determinism of classical field equations and gives rise to what look like classical topological analogs of Feynman diagrams.

   (a) Consider first the particle level at the level of H. Particle lines generalized to 4-D orbits of 3-D surfaces representing particles. Particles as 4-D orbits of 3-surfaces contain light-line 3- D orbits of partonic 2-surfaces.

   (b) Partons as building bricks of particles in the information theoretic sense, and correspond to partonic 2-surfaces at which the orbits of partonic 2-surfaces meet. Their orbits are 3-D light-like surfaces at which the signature of the induced metric of the space-time surface changes.

   The partonic 2-D surfaces defining topological vertices belong to the 3-D sections of space-time surface with a constant value of M^4 time coordinate t to which one can map the 6-D brane-like entities of M^8 predicted by $M^8 - H$ duality [?]

   This picture suggests that, besides the data at the boundaries of CD, also the data at the partonic 2-surfaces in the interior of CD are needed. This failure of classical determinism brings in the failure of the strongest form of holography. There would be a large number of PEs connecting the 3-surfaces at the ends of CD and they would correspond to the analogs of Feynman diagrams.

Zero energy state as a scattering amplitude would be a superposition over these diagrams. This superposition would not be however predetermined as in the path integral but the zero energy state would define the superposition of paths in question.

3.2 Is the failure of classical determinism possible?

The possibility of classical non-determinism is suggested by the interpretation of space-time surfaces as generalized Feynman diagrams. These Feynman diagram entities would not however define an analog of path integral in TGD framework. Classical non-determinis would be a space-time correlate for the non-nondetermism at quantum level.

In this framework partonic 2-surfaces or equivalently the 3-D sections of the space-time surfaces with constant value of M^4 time would act as 3-surfaces at which the deterministic time evolution as a minimal surface would fail.

Another option is that light-like 3-surfaces containing the partonic 2-surfaces at very special moments of M^4 time define frames. These special values $t = t_n$ of M^4 time would be associated with 6-D branes predicted by M^8 picture as universal special solutions and their images in H would define "very special moments in the life of self" defined by the sequences of SSFRs defining the self.

1. The first hint comes from the dynamics of soap films. Soap films are minimal surfaces. The soap films spanned by 1-D frames consist of minimal surfaces glued together at the frames and this dynamics is non-deterministic in the sense that it allows several soap film configurations due to the different branchings at frames. At frames the minimal surface equations fail.

2. In TGD framework space-time surfaces as PEs are both minimal surfaces and extremals of Kähler action. In this case the 3-surfaces associated with "very special moments of time" $t = t_n$ could define an analog of a dynamically generated frame defining a 4-D soap film. The 3-surfaces at the ends of the CD would be fixed frames like those for soap films.

   This realizes quantum criticality in the sense that the field equations outside frame do not involve the parameters of the action which sum of volume term and Kähler action. The interpretation as a non-linear analog of massless free field theory outside the frame conforms with the basic spirit of quantum field theory. These solutions of field equations rely on a a generalization of holomorphy to 4-D situation so that field equations reduce to purely algebraic conditions involving only the first derivatives of embedding space coordinates. The analogy is defined by the solution of 2-D Laplacian equation in terms of real or imaginary part of an analytic function.

   Field equations consist of two terms, which are divergences for the conserved currents (4-momentum currents plus color currents) defined by the induced metric in the case of volume term. In the interior of the space-time surface these divergences vanish separately for the volume term and Kähler action but not at the frame.

3. The field equations must hold true also at the 3-D frame but this need not be true for both volume term and Kähler action separately. The

coupling parameters of the theory make themselves visible only via the frame. For the volume action the divergences of the conserved currents are orthogonal to the space-time surface. For K "ahler action, the divergences of the conserved currents contain to terms. The first term is proportional to the energy momentum tensor of Kähler action and orthogonal to the space-time surface.

Second term is not orthogonal to the space-time surface. For twistor lift the Kähler also has an M^4 part with a similar decomposition.

The sums of the parts of divergences orthogonal to the space-time surface and parallel to it must sum up to zero separately. This gives 8 conditions altogether so that the number of field equations is doubled at the frame.

4. Could it happen that the divergences of these two isometry currents are singular and proportional to 3-D delta function but that their sum vanishes and conservation laws are respected? The part of the frame in the space-time interior would be dynamically generated whereas the part of the frame at the ends of CD would be fixed.

5. The restriction to 3-D frames is not the most general option. The delta function singularities could be located also at 2-D partonic 2-surfaces, at light-like 3-surfaces at which the induced metric changes its signature, and at string world sheets which connect these light-like 3-surfaces and have 1-D light-like boundaries at them. The light-like 3-D surfaces would be analogs of the cuts for analytic functions. Partonic 2-surfaces at the ends of light-like 3-surfaces could be analogs for the ends of the cuts. String world sheets could serve as analogs of poles.

6. The non-determinism associated with the soap films and with frames suggests that there is a large number of 4-D "soap films with a given frame", which is fixed at the boundaries of CD but not in the interior of CD.

4 Questions related to the theory of consciousness

At the level of TGD inspired theory of consciousness theory, causal diamond (CD) defines a correlate of self or of its perceptive field. CD has sub-CDs which correspond to subselves experienced by self as mental images [L8, ?].

Concerning the evolution of self, the basic notions of "small" state function reduction (SSFR) as an analog of "weak measurement" and "big" SFR (BSFR) as an analog of ordinary SFR.

1. The first deviation from the standard ontology is that BSFR changes the arrow of time defined by the selection of PB of CD at which 3-D part of zero energy states remains unchaged during SSFRs.

2. The second deviation is that either boundary of CD and states at it remain unaffected in SSFRs whose sequence defines self as a conscious entity. This is the TGD counterpart for the Zeno effect of ordinary quantum theory in which repeated measurements of the same observable leave the state unaffected.

The details of the evolution of self are not fully understood and the proposed general view can be criticized.

1. How the constraint that sub-CD serves as a correlate for a classical perceptive field can be taken into account?
2. What is the precise definition of mental images as subselves? Are they at some special positions inside space-time surface?
3. What are the precise definitions of memories and conscious memory recall? The same question applies to the notions of intention, anticipation and attention.
4. Can the mental images be destroyed or do they only experience BSFR and continue to live with an opposite arrow of time and become unconscious to self? If a mental image can completely disappear, what could be the physical mechanism leading to its disappearance?
5. One can challenge the detailed picture of the notion of time evolution by SSFRs. The assumption about the drift of mental images towards future in the second half-cone of CD is ad hoc. Should it be replaced with a deeper assumption. Could one simply assume that they are stationary.

4.1 Three ontological options

The basic problem of ZEO is whether the causal diamond (CD) represents a perceptive field in the sense that the space-time surface continues outside the CD or whether CD is an independent entity in the sense that space-time surfaces do not continue outside CD. Conservation laws do not exclude either option.

ZEO allows 3 ontological options which might be called easter, western, and intermediate views.

Option I: Space-time surfaces are restricted inside CDs. Quantum universe is a collection of CDs containing space-time surfaces, which have ends at the boundaries of CD.

In this framework, space-time in cosmological scales is an idealization and could be perhaps explained in terms of the correlations between CDs. CDs do not form a fractal atlas of something unless one says that the atlas *is* the territory. CD is an independent entity rather than a perceptive field of sub-self.

One can argue that for sub-CDs this picture is problematic since it seems that one loses totally the notion of objective reality as something existing outside CD. There are no sensory perceptions. Could the overlaps with other CDs create the experience about the existence of the external world?

Cosmology would be a mental construct and correspond to a very large CD. One would have a multiverse but only at the level of conscious experience. Option I is consistent with the eastern view that only subjective experience exists but not with the western view.

Option II: Space-time surface continues always outside all CDs and CDs can be interpreted always as perceptive fields. Option II conforms with the westerm option and implies that cosmology is something real.

Option III: Self is a hierarchy of CDs such that for sub-CDs the space-time surfaces continue outside the CD but for the largest CD this would not be the case. Sub-CDs would represent perceptive fields but the largest CD would be a God-like entity experiencing itself as the entire cosmos.

Meditators report altered states of consciousness in which the separation to self and external world ceases and the mind is empty. Also the experience of timelessness is mentioned. Could these states correspond to experiences without mental images (sub-CDs) created by SFRs at this highest level?

Option III is roughly consistent with both western and eastern views about consciousness. If one requires the notion of the external world as objective reality and accepts the proposed explanation of altered states of consciousness, option III remains the only possible option.

4.2 A general picture about the dynamics of sub-CDs

The ZEO based view of quantum measurement theory and the theory of consciousness inspired by it have not been precisely formulated for sub-CDs. In particular, the question of how sub-CDs as mental images are created, has remained unanswered.

The following proposal provides such a formulation and is consistent with Options I and III.

1. CDs form a fractal atlas of conscious maps but the map would be the territory since in general the space-time surfaces need not continue outside the CD. There would be no external particles as 4-D lines for generalized Feynman diagrams outside CD.
2. Sub-CDs correspond to mental images of CD as a conscious entity. From the point of view of consciousness theory, there are only experiencers (CDs) which can have experiences as mental images (have sub-CDs), be mental images of experiencers (be sub-CDs) and share mental images (intersecting CDs with common sub-CDs).
3. Consistency conditions for the quantum dynamics of CDs and sub-CDs and for the overlapping CDs give rise to correlations between the regions of the map. The shared regions are geometrically analogs for the intersections of the intersections of a covering of a manifold by open sets.
4. For sub-CD the interpretation of sub-CD as a perceptive field would be natural.

The first question is what does one really mean with sub-CD at the level of space-time surfaces.

1. Do the space-time surfaces of sub-CD continue outside sub-CD as space-time surfaces of CD? Does this imply that the quantum dynamics of sub-CDs in ZEO is completely dictated by that of CD? This is certainly not the case. Fermionic zero energy states associated with the sub-CD are possible and are analogous to quantum fluctuations. Note that in the TGD framework all elementary particles can be constructed from fundamental fermions (quarks).
2. If the PE (PE) property fixes completely the space-time surface, its intersections with the boundary of CD, this seems to be the case. If the

classical dynamics is not completely deterministic, as suggested by the analogy with minimal surfaces spanned by frames, the situation changes.

Sub-CD defines a subsystem of CD with boundary conditions at the boundary of CD which do not completely fix the quantum dynamics of sub-CD. Quantum states as WCW spinor fields inside sub-CD could change in SFRs of sub-CD.

The tensor product of sub-CD with CD would not be ordinary tensor product but much more restricted one and Connes tensor product, related to inclusions of HFFs, would be a possible identification. A subsystem would be like an included hyper-finite factor of type II_1 (HFF).

Suppose that the classical dynamics is indeed non-deterministic and sub-CDs are defined in the proposed manner. How the view about WCW spinor fields changes as one restricts the consideration to sub-WCW.

1. The failure of the classical determinism forces to replace each 3-surface at PB with a discrete tree-like structure consisting of all PEs connecting it to AB. Sub-WCW as the space of PEs is larger than the space of 3-surfaces X^3 at PB. Zero energy states are defined in this sub-WCW and assign to a given X^3 a wave function in this discrete set allowing interpretation as wave function in a set of paths of the tree.

   One cannot avoid the association with cognitive representations of adelic physics involving the number theoretic degrees of freedom characterized by Galois group of the extension of rationals associated with the polynomial defining the space-time region [L2, L13].

2. The activation of sub-WCW would mean an SFR selecting in WCW of CD such sub-WCW for which the space-time surfaces are such that their ends at sub-CD are fixed. This would correspond to SFR creating a sub-CD and corresponding mental image. This would answer the long standing question whether and how mental images can appear as if from scratch. This SFR would also represent a third kind of SFR having interpretation as a partial localization in WCW associated with CD. This also suggest that mental images could disappear suddenly. This "activation" could be seen as a directed attention.

3. WCW degrees of freedom at the boundaries of sub-CD are fixed. Also sub-WCW spinor fields make sense. One can allow the tensor product of Fock spaces of many-fermion states associated with the boundaries of CD. One would have a QFT like picture with sub-WCW degrees of freedom fixed at boundaries of sub-CD.

4. The tensor product of fermionic state spaces at the boundaries of sub-WCW makes sense and one can define zero energy states in the same manner as proposed hitherto. The only difference is that WCW degrees of freedom are frozen at the boundaries of sub-CD. At the level of conscious experience this means that the subself experiences the external world as fixed. This would be by definition the meaning of being subself.

The fermionic Fock state basis has an interpretation as a Boolean algebra so that fermionic zero energy states have an interpretation as Boolean statements of form $A \rightarrow B$. This would mean that consciousness of the subself would be Boolean, cognitive consciousness, thinking. This conforms with the Eastern view that ordinary consciousness is essentially thinking and that the higher level of consciousness as that associated with the highest level of the CD hierarchy of self is pure consciousness. Thinking assignable to the fermionic degrees of freedom would be seen as an endless generation of illusions. "Reality" in this interpretation would correspond to WCW degrees of freedom.

What restrictions must one pose on the quantum dynamics of CDs in the case of sub-CDs? Does the subjective evolution of sub-CD states by SSFRs and BSFRs make sense for sub-CDs?

1. The increase of the size of sub-CD makes sense and the proposed subjective evolution by scalings and SSFRs makes sense. The time evolution is also now induced by the increase of the perceptive field of a subself defined by the WCW associated with increasing sub-CD bringing in new 4-surfaces due to the classical non-determinism.
2. What about the interaction between CD and sub-CDs. Does this time evolution respect the condition that the space-time surfaces meet the fixed 3-surfaces at boundaries of sub-CD or is it possible that the SSFRs of CD destroy the subself by delocalization so that sub-CD as a mental images must be regenerated by localization in WCW.
3. Also the interaction between overlapping CDs and the sharing of mental images can be understood in this framework.

5 Comparison of the revised view of self with the earlier one

The revised view about TGD inspired theory of consciousness relies on the definition of subself at the level of WCW unlike the older view. In the following the new view is compared with the old view.

5.1 The view about SSFRs

5.1.1 Earlier picture

The earlier view about SSFRs was inspired by the M^8 picture.

1. The dynamics was assumed to involve both scaling of CD with respect to either tip of CD. The lower half-cone was only scaled whereas the upper half-cone was also shifted as required by the stationarity of the passive boundary. Dynamics at PB was passive in the sense that only a portion of the space-time surface became visible making also new states visible at it (Zeno effect) in the sequence of SSFRs . The idea about scaling leads to a rather concrete proposal for the S-matrix characterizing the scalings of CD.
2. The surfaces inside CD (or sub-CD) were assumed to be mirror symmetric with respect to the middle plane of CD. This assumption does not conform with the assumption that these surfaces define a perceptive

   field in the sense that they are parts of large space-times and continue outside CD.

The old view had several ad hoc features.

1. The creation of mental images was implicitly assumed without specifying what this could mean mathematically. These mental images were assumed to be created in the upper half-cone just above the $t = T$ mid-plane of CD and shift to the geometric future with the upper half-cone of CD. The asymmetry between upper and half-cone could be seen as reflecting geometrically the future-past asymmetry but was ad hoc.
2. One can criticize the assumption that the memories about the events of the subjective past are located in the geometric future with respect to the mid-plane of CD.
3. Whether mental images can disappear or only die and reincarnate by BSFR, was not specified.

5.1.2 New picture

In the new picture the situation is the following.

1. Also in the new picture, the time evolution by SSFRs would be a sequence of scalings of CD. The assumption about reflection symmetry of space-time surfaces is given up since it is inconsistent with the identification of sub-CD as a perceptive field. Also now the time evolution is passive in the sense that only a new portion of the space-time surface extending outside sub-CD is revealed at each step.

2. As in the previous picture, new discrete WCW degrees of freedom appear during the sequence of SSFRs and complexity increases. For both options only fermionic degrees of freedom remain if full determinism is assumed and if QCC is required also at the level of SFRs.

3. In the new view both directed attention, memory, and intention correspond to a generation of sub-CD by a localization in WCW fixing a subset of 3-surfaces at the PB of CD. Redirecting of attention would allow apparent movement of the sub-CD in the interior of CD and as a special case shifting the mental images in the time direction assumed in the earlier picture.

4. In the new view the loci of mental images are naturally associated with the loci of classical non-determinism that is 3-surfaces at the 4-D minimal surface branches.

5. $M^8 - H$ duality suggests that the branchings occur at H image points of the M^8 cognitive representation defined by the quark momenta which are algebraic integers for the extension of rationals defined by the polynomial defining $X^4 \subset M^8$. The non-determinism at $X^4 \subset H$ point set would correspond to non-determinism assignable to a bound state of quarks at corresponding point of M^8.

   Note that physical states correspond to total quark momenta which are rational integers, one can speak of Galois confinement meaning that physical states are Galois singlets. This gives an infinite hierarchy of

bound states formed by a universal, purely number theoretical mechanism. All bound states could be formed in this manner.

The non-determinism at $X^4 \subset H$ point which corresponds to a subset of points as images of quark momenta composing the bound state would correspond to non-determinism assignable to a bound state of quarks at corresponding point of M^8. There would be a hierarchy of CDs within CDs and hierarchy of mental images corresponding to the hierarchy of bound states.

The bound state momenta are mapped to $X^4 \subset H$ by $M^8 - H$ duality already described. In particular, the positions of quarks contained in 6-branes X^6 with a constant energy $E = E_n$ are mapped to a sequence of points at the boundary of cd of the system by M^8-duality and it can be said to represent the positions of these quarks. These point sets define sequences of "very special moments in the life of self".

The targets of attention would therefore form a discrete set assignable to bound states of quarks and antiquarks. Note however that each 3-surface X^3 in the superposition defining the WCW spinor field at the PB of CD has its own discrete set loci of non-determinism. BSFRs can change the superposition of these 3-surfaces. The selection between branches is possible in BSFR but not in SSFRs.

6. An attractive idea motivated by ZEP is that volitional action could be interpreted in the new view as an SFR selecting one path at the node of a tree characterizing the non-determinism. Single deterministic time evolution analogous to a computer program would be selected rather than modifying the deterministic time evolution as in standard ontology. In the M^8 picture, the very special moments $t = r_n$ in the life of self correspond to the roots of a real polynomial. What happens when all roots have been experienced? Does NMP force the BSFR to occur since nothing new can be learned?

5.2 Comparison of the views about BSFR

Those aspects of BSFR in which old and new views differ are of special interest.

5.2.1 Earlier view

The fact that the notion of sub-CD and mental image were not properly formulated led to several ad hoc assumptions.

1. The possible failure of a strict determinism was realized. The failure of strict determinism was assigned to "very special moments in the life of self" associated with the images $E = E_n$ planes of $M^4 \subset M^8$ at which the partonic vertices as loci of non-determinism were assigned.
2. The mental images of previous life near the AB of CD were assumed to be inherited as "silent wisdom". Their contents was from the early period of life with opposite arrow of time and one can of course ask whether they were really "wisdom".
3. There were also assumptions about the change of the size scale of CD in BSFR. The idea that the reduction of the size scale guarantees that re-

   incarnate has childhood was considered. This assumption also prevents unlimited increase of the size scale of sub-CD.

5.2.2 New view

The new view makes it possible to develop a more detailed picture of what happens in BSFR.

1. The WCW localization at the AB of CD selects one of the branches of the space-time surface beginning at the PB. This selection of the branch happens to each 3-surface in the superposition of 3-surfaces at the PB defined by the WCW spinor field before BSFR.
2. The future directed tree becomes a past directed tree beginning from one particular branch at the AB. The initial and final space-time surface share a common space-time surface connecting the roots of the old and new trees. This is essential for having a non-trivial transition amplitude for BSFR at WCW level.

In the earlier view, the mental images interpreted as memory mental images and located near the boundary of CD were assumed to be inherited as "silent wisdom" by the time-reversed reincarnate. What happens now?

The notion of "silent wisdom" as inherited information still makes sense.

1. The new space-time surfaces originate from 3-surface which was selected by WCW localization in BSFR. Therefore the new space-time surfaces carry classical information about previous life.
2. The space-time surfaces originating from the new root are near to the space-time surface connecting the old and new roots. The WCW spinor field before and after BSFR musthave a strong overlap in order to make the transition amplitude large. This implies that information about previous life is transferred to the new life.
3. The nearness property could imply that they are easily re-created as perceptions by directed attention so that they would indeed be "silent" wisdom. These mental images are from the later part of the life cycle rather than from the early life as in the earlier picture. If aging means getting wisdom, then silent wisdom would be in question.

Does the notion of "silent wisdom" as mental images make sense?

1. Mental images - this includes both sensory and memory mental images and intentions) are naturally assignable to the loci of classical non-determinism at the images of the planes $E = E_n$ of the branched space-time surfaces associated with the new root ("very special moments in the life of self").

   For the special space-time surface connecting the roots of old and new space-time surface, the surfaces $E = E_n$ in M^8 would not change and the mental images would carry information about previous life. Could one talk about potentially conscious "silent wisdom".
2. What happens to the mental images of self in BSFR? Can they be preserved or do they disappear or do they reincarmate by BSFR? The idea about preservation makes sense only for space-time surfaces connecting the roots.

3. What can happen to the size scale of CD in BSFR? The extreme option that CD decreases in size by shift of the formerly PB such that the time evolutions are fully determinimistic in the superposition of 3-surfaces. There would be no inherited silent wisdom and the self would start from scratch, live a chilhood. Otherwise these loci would define candidate for inherited silent wistom.

In the earlier picture the mental images corresponding to sub-CD could not disappear although it could die by BSFR and reincarnate with a reversed arrow of time. Can the mental image disappear now? Creation of mental image require metabolic energy feed: this explains 7 ± 2rule for the number of simultaneous mental images. Could this happen when attention is redirected? Therefore one could argue that mental image must totally disappear when the attention is redirected.

On the other hand, time reversed mental image apparently feeds energy to the environment in the original arrow of time, i.e. apparently dissipates. Could this dissipation be interpreted as an energy feed for its time reversal.

Note that the total disappearance of the mental image means delocalization at the level of WCW and seems possible. The new view clearly challenges the idea about the Karma's cycle of self. This cycle appears in many applications of BSFR.

6 Conclusions

Also the article *Some comments related to Zero Energy Ontology (ZEO)*" [L8] written for few years ago challenged the basic assumptions of ZEO. One tends to forget the unpleasant questions but now it was clear that it is better to face the fear that there might be something badly wrong. ZEO however survived and several ad hoc assumptions were eliminated.

6.1 Progress at the level of basic TGD

The basic goal is to improve the understanding about quantum-classical correspondence. The dynamics of soap films serves as an intuitive starting point.

1. In TGD frame 3-surfaces at the boundaries of CD define the analog of frame for a 4-D soap film as a minimal surface outside frame. This minimal surface would be an analog of a holomorphic minimal surface and simultaneous exremal of Kähler action except at the frame where one would have delta function singularities analogous to sources for massless d'Alembert equation.
2. There is also a dynamically generated part of the frame since the action contains also Kähler action. The dynamically generated parts of the frame would mean a failure of mimimal surface property at frame and also the failure of complete determinism localized at these frames.
3. At the frame only the equations for the entire action containing both volume term and Kähler term would be satisfied. This guarantees conservation laws and gives very strong constraints to what can happen at frames.

The frame portions with various dimensions are analogous to the singularities of analytic functions at which the analyticity fails: cuts and poles are replaced with 3-, 2-, and 1-D singularities acting effectively as sources for volume term or equvavelently Kähler term. The sum of volume and Kähler singularities vanish by field equations. This gives rise to the interaction between volume and Kähler term at the loci of non-determinism.

4. H-picture suggests that the frames as singularities correspond to 1-D core for the deformations of CP_2 type extremals with light-like geodesic as M^4 projection, at partonic 2-surfaces and string world sheets, and at 3-D $t = t_n$ balls of CD as "very special moments in the life of self" which integrate to an analog of catastrophe. T

   Deformations of Euclidean CP_2 type extremals, the light-like 3-surfaces as partonic orbits at which the signature of the induced metric changes, string world sheets, and partonic 2-surfaces at $r = t_n$ balls taking the role of vertices give rise to an analog of Feynman (or twistor -) diagram. The external particles arriving the vertex correspond to different roots of the polynomial in M^8 picture co-inciding at the vertex.

The proposed picture at the level of $H = M^4 \times CP_2$ has dual at the level of (complexified) M^8 identifiable as complexified octonions. The parts of frame correspond to loci at which the space-time as a covering space with sheet defined by the roots of a polynomial becomes degenerate, i.e. touch each other.

Concerning the physical interpretation, a crucial step of progress was the interpretation of M^8 as analog of momentum space allowing to interpret $M^8 - H$ duality as an analog of momentum-position duality and of complementarity principle of wave mechanics [L18]. This forced to modify $M^8 - H$ duality in M^4 degrees of freedom to satify the constraints posed by UP.

There is a nice analogy with the catastrophe theory of Thom [A2, A1]. The catastrophe graph for cusp catastrophe serves as an intuitive guide line. embedding space coordinates serve as behaviour variables and space-time coordinates as control variables. One obtains a decomposition of space-time surface to regions of various dimension characterized by the degeneracy of the root.

6.2 Progress in the understanding of TGD inspired theory of consciousness

The improved view about ZEO makes it possible to define the basic notions like self, sub-self, BSFR and SSFR at the level of WCW. Also the WCW correlates for various aspects of consciousness like attention, volition, memory, memory recall, anticipation are proposed. Attention is the basic process: attention creates sub-CD and subself by a localization in WCW and projects WCW spinor field to a subset of WCW. This process is completely analogous to position measurement at the level of H. At the level of M^8 it is analogous to momentum measurement.

One can distinguish between the Boolean aspects of cognition assignable to WCW spinors as fermionic Fock states (WCW spinor field restricted to

given 3-surface). Fermionic consciousness is present even in absence of non-determinism. The non-determinism makes possible sensory perceptions and spatial consciousness.

A precise definition of sub-CD as a correlate of perceptive field at WCW level implies that the space-time surfaces associated with sub-CDs continue outside it. This gives powerful boundary conditions on the dynamics. For the largest CD in the hierarchy of CDs of a given self, this constraint is absent, and it is a God-like entity in ZEO. This leads to a connection between the western and eastern views about consciousness.

A connection with the minimal surface dynamics emerges [L19]. The sub-CDs to which mental image as subselves are assigned would be naturally associated with portions of dynamically generated frames as loci of non-determinism. If one identifies partonic 2-surfaces as vertices, one can interpret the collection of possible space-time surfaces for a fixed 3-surface at PB as a tree. All paths along the tree are possible time-evolutions of subself. The dynamics of consciousness for fixed 3-surface at PB becomes discrete and provides discrete correlate for a volitional action as selection of a path or a subset of paths in the tree. The reduction of dynamics of mental imagines to discrete dynamics would mean a huge simplification and conforms with the discreteness of cognitive representations.

6.3 Challenges

There are many challenges to be faced. The discrete dynamics of sub-self consciousness certainly correlates with the notion of cognitive representation based on adelic physics [L4, L3] and implying a discretization at both space-time level and WCW level. The Galois group for the extension of rationals acting on the roots of the polynomial plays a key role in this dynamics [L13, L14].

One teaser question remains. Localization requires energy quite generally and this conforms with the fact that mental images demand metabolic energy feed. It is possible to redirect attention and it remains unclear whether the mental image disappears totally or suffers BSFR.

This relates directly to the question whether consciousness continues after the physical death. If mental images (and corresponding sub-CDs) can disappear, the same can happen to us since we are mental images of some higher level self. If this cannot happen, BSFR means death and reincarnation with an opposite arrow of time in a completely universal sense. For instance, sleep period could correspond to a kind of death at some level of the personal self hierarchy generalizing the Id-ego-superego hierarchy of Freud. This would explain why we have no memories of the sleep period.

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Finnish Methodology Society 2021,

issue II

ISSN 2736-9641