CHAPTER 6

Learning to Think Critically

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Learning without thought is labour lost; thought without learning is perilous. (Confucian Analects, Wei zheng [Ho Peng Yoke, 2012])

INTRODUCTION

Confucius explains to his students and scholars his ideas about how to gain knowledge. In doing so, he continues, "… shall I teach you what knowledge is? When you know a thing, to hold that you know it; and when you do not know a thing to allow that you do not know it — this is knowledge." (Ho Peng Yoke, 2012)

These ideas seem entirely reasonable. So, why should the acquisition and reflection of knowledge be questioned or even endangered?

Confucius taught in the 6th century BC, at the same time when classical Greek philosophy arose in Europe, times of elitist education where the transfer of wisdom was to only a few scholars in an "inner circle". Since then, higher education has completely changed, becoming a mass enterprise of knowledge transfer. Small discussion groups have been replaced within the modern (still Humboldtonian?) university with more and more face-to-face lectures, programmed doctoral studies and the (in)famous Bologna Process. The acquisition of credit points within the latter may serve as a metaphor for the establishment of tailored structures in higher education as a consequence of the "massification of scientific enterprise" (Trajtenberg, 2013). The resulting functional behaviour of students and professors, and the economic motivation of political institutions trying to manage the cost of higher education may lead to a utilitarian attitude based on a simplified paradigm of a knowledge-based economy. Is there a need to counter-act? Can it be done without falling back into traditional or even revisionist attitudes? The Critical

Thinking Initiative at ETH Zurich, the Swiss Federal Institute of Technology in Zurich, is an ambitious project that started in 2014 to analyse and, at the same time, to gather the criticism that weighs on current academic life.

ECONOMIZATION OF SCIENCE

Currently, on a global perspective, we find nearly 6 million people who claim to be scientists defined by their ability to publish in peer-reviewed journals. While this sounds like a modest number, it represents about 1 person out of every 1,200 of the global population making it a quite remarkable quantity. Never before in history has the world seen so many scientists. Roughly one million of them have emerged from the developing countries within the last decade. The scientific community produces approximately one million publications annually and, on average, for each paper accepted for publication at least one is rejected. Each manuscript requires two reviews as a prerequisite for publication, such that at least four million reviews are written annually. Bibliometrics indicate that more than 50% of the published papers may never actually be read. This is the output of some 25,000 peer-reviewed journals fed by scientists from 22,000 universities worldwide. In 1665, the first issue of the Royal Society's *Philosophical Transactions* appeared. Since then, the scientific community has produced some 50 million publications, (Trajtenberg, 2013; Folkers, 2013); the vast majority of which saw the light of the day after 1950. (Jinha, 2010)

Academic career success and, to a certain extent, promotions in science-based companies bear a direct correlation to the scientist's reputation — a value measured predominantly by the volume rather than the quality of a scientist's publications. This raises the question of whether or not the growth rate of "real talent," i.e., the future "Einsteins", is accurately reflected in the measured output. One of the most important tasks of leading universities is to provide a space to develop and foster talent for the benefit of society, but how can universities detect such talent in the vast "noise" generated by the publication frenzy?

THE POSSIBLE CONSEQUENCES OF THE ECONOMIZATION PROCESS

Career promotions and position appointments have always been a question of a signal-to-noise ratio. If an individual catches the attention of the community and/or decision-makers, his/her promotion or advancement is most assuredly on (tenure) track. The enormous expansion of players, however, has considerably sharpened the fight for attention. In order to get rid of the "old boy's networks" and render a more objective system of advancement, we have, for more than three decades, applied various types of rating and ranking systems, commonly known as bibliometrics. Consequently, such metrics correlate scientific reputation with paper output. For a deep analysis, it may be worthwhile to consult the musings of the Vienna-based architect Georg Franck, whom we quote here as follows, "*Scientific information is measured in terms of the attention it earns. Since scientists demand scientific information as a means of production, the attention that a theory attracts is a measure of its value as a capital good. On the other hand, the attention a scientist earns is capitalized into the asset called reputation*" (Franck, 2002). If an individual career is a function of the H-index (citation, impact-factor, etc.) and if the growth curve of the publication ratio becomes even steeper, it is quite comprehensible that scientists at all levels of advancement jump on the Scientific Bandwagon (Caulfield, 2012). What are the consequences of this behaviour?

Get More Specialized

The increasing specialization and segregation of disciplines seem to follow a natural trend. Drilling very deep holes generally requires a narrowing of the diameter. This is simply due to the nature of the scientific method. It yields the advantage for the individual scientist that he or she is eventually alone in his field and by that reduces competition. In the best case, the newly drilled hole can be established as a new area of research and promote the scientist as "first-in-class". Given this to be the desired outcome of an individual scientific endeavour, the question remains whether enough time and space are granted to the individual scientist to step back and reflect the new findings in respect to the neighbouring fields, to the discipline as a whole, and how to incorporate the novelties into the scientific system. Individual ambition may be different, though. Seduced by the fight for attention, the novelties may be used to establish hype and to advance the individual career.

Get More Efficient and Increase Your Output Qualitatively

Drilling deep holes is not a problem *per se*. It depends on the material, the method and the nature of the ground. When choosing soft ground, even not-so-sharp drill bits may yield quick results, (i.e., high publication frequencies). This is known as reaching for the low-hanging fruit in science. If "only" the number of novel findings and not their weight in terms of the knowledge already established is valued in gaining reputation, then there is a great temptation to act along these lines. This may result in an increasingly observed "publication bias", where broader reflection is avoided in favour of reporting single observations. Especially in the field of life sciences, where Ph.D. students are often obliged to finish their doctoral thesis with one or more "accepted" papers, the pressure exerted leads to the attitude of trade-offs such as, "Don't look beyond your own nose, but focus and publish." The same pressure is on the faculty. Funding related to annual reports of "always better" scientific achievements triggers a novelty-publication spiral and increases the pressure for productivity. Is this the right approach? Is detecting novelties relevant for the knowledge system? Some institutional leaders think that is not relevant, *"For some of our projects, we need people who aren't concerned about getting a publication out in two years to get a job because we're trying to work on a more challenging problem."* (Rubin, 2006a).

'Move the Food'

Leaders in higher education generally face a dilemma in terms of resource allocation when developing relevant strategies. Even the wealthiest universities cannot afford to do everything and the shotgun principle does not accumulate enough resources for costly research in particle physics, imaging technologies, genomics or clinical research. If, on the other hand, only hypothesis or curiosity-driven research following an idealistic model is the focus of a university, (Schleiermacher, 1808):

- Freedom of teaching and learning, radical break with any form of set curriculum
- The unity of teaching and research, learning as a collaborative enterprise (of students and professors)
- The unity of science and scholarship, co-equal status of sciences and humanities
- The primacy of "pure" science, over specialized professional training (Ash, 2008)

It will never cope with the challenges of modern higher education as a mass enterprise. It will struggle to compete with "entrepreneurial" and "research" universities for students and other resources from the state or the private sector.

Consider a mixed model where managers in higher education organize a university-wide or nationwide competition in special research areas considered important for society, the economic welfare of a nation or for knowledge procurement. In a competitive context, peer-review mechanisms would select appropriate topics. Generous research grants, awarded to the competition winners, provide the motivation for doctoral students to produce results, publish papers, increase attention for their work and elevate their reputation. A competitive model, like this one, may prompt scientists to think carefully — even critically — about their proposals before leaving the comfort of their traditional area of research. Ultimately, brains and talent follow money. With the competition at the front door, only a model that provides both excellent funding and infrastructure will attract the most promising young researchers.

The Chinese National Academy recently gave up on bibliometrics for the evaluation of their member institutes — noted around the globe as a remarkable and unexpected decision. The Chinese National Academy has introduced instead a "One-Three-Five System", where every institute has to come up with ONE research topic, within which THREE expected breakthroughs should be realized within a FIVE-year period. In such a system, the lack of research diversity will surely harm the institutes. How to evaluate "breakthroughs" remains open, but the manner in which the money is distributed seems clear: *Chinese scientists should do things that are useful for China first of all…* (Huang Kun, 2015).

In general, allocating resources or "moving the food" is a heavy load of responsibility on the shoulders of university managers. They have to fight two battles at the same time. The first, with scientists who feel their field is underfunded; and the second with those who provide funding — whether from the government or private sector — they come with their own perspectives, agendas, and incentives for moving the food (Folkers, 2012).

Put Disciplines at Stake

Discipline ranking precedes establishing incentives for research and creating competitions. The large project may be "interdisciplinary", but at the local level academic institutions, often only one research group, garner the money and the reputation. This may start a "chain reaction" going back to the last century known as "accumulated advantage". In science it is commonly called "The Matthew Effect". The term, first coined by sociologist Robert K. Merton in 1968, takes its name from a verse in the biblical Gospel of Matthew that pertains to Jesus' parable of the talents:

For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken even that which he hath. (Matthew 25: 29, King James Version.)

Academic administrators aim to distribute research funds — especially funding that comes from taxpayers — in a manner that poses the least risk and offers the highest potential for output. Risk avoidance creates a "winner takes all" strategy that contradicts basic economic logic that purports there are no gains without risk. However, in terms of the leverage philosophy in finance that aims to multiply gains (and losses), the attitude makes sense and partitions the "successful" research fields in a university from the less successful ones.

Teaching

Second only to "attention", "time" is among a scientist's most scarce capital good. When academic reputation is based solely on research output, teaching falls behind. Scientists restrict their "teaching load", keeping it to a minimum for the sake of efficiency, having deemed the ideal, "*the unity of teaching and research*" unattainable. The semantics of the term "teaching load" already reflects the general attitude. Not surprisingly, many universities offer a reduced teaching load in contractual negotiations to attract desired candidates. Hiring strategists at some universities even correlate a reduced teaching load with success in seeking external funding. This development leaves us with a somewhat unprincipled scenario.

If, in the present paradigm, the aim is for an academic education is to create insight, conceptual understanding and motivation in young scientists, then shouldn't the best scientist focus on teaching rather than knowledge transfer? This idea, however, runs counter to the current framing of a successful career in science. If follows that this dilemma may be solved by reintegrating teaching as a primary function of faculty members. This is the point where the ideal of Humboldtonian Education breaks down. In the real world, however, such ideals do not simply implode. At the beginning of the last century, many eminent German scientists — researchers of mainly basic science — found their main occupation at the Kaiser Wilhelm Institutes. The institutes provided an innovative research atmosphere leaving universities unaffected and thus, the Humboldtonian constitution of universities became a myth, at least for the sciences (Ash, 2008). This paper is not about re-introducing Humboldt, but rather it is about finding solutions that follow our deep convictions to provide the best education for young scientists and future leaders.

CRITICAL THINKING

Further critical reflection and creative thinking at all levels and in all units, as envisioned and initiated by the ETH Zurich leadership, may provide an onset for the future improvement of academic education and research. The overall objective must be to minimize the restraints imposed by the economical paradigm that prevents us from achieving our desired goals. (e.g., Quack, 2014; Spelsberg, 2015).

Three serious and tightly interwoven arguments are in favour of the initiative:

- Responsibility
- Sustainability
- Economy

Responsibility

Critical reflection of our own work is the cornerstone of the academic endeavour. Referring to Confucius, "*Learning without thought is labour lost;*

thought without learning is perilous", achievements, whether they be new findings, theories, teaching, or lab methodologies, should be: a) Continually scrutinized to align with the aims of sound and rigorous reasoning; and b) Placed in a larger context that demonstrates relevance. In principle, the scientific process provides the means to achieve this endeavour. Global conferences, publications, research proposals, lectures, lab meetings and bilateral discussions, as well as platforms for interdisciplinary exchange, are opportunities that could guarantee the reflection process, provided time and space are allocated.

If scientists take the process of critical reflection seriously and take time to focus on the most difficult challenges, rather than seek the low-hanging fruit that lead to the next incremental research publication, perhaps the process might inspire different or more relevant research questions. Both curiosity-driven basic researchers and problem-driven applied researchers are invited to pursue a reflective approach in order to avoid quick "symptomatic" problem-solving and, instead, foster a process that generates fundamental and even controversial new ideas. Positive examples may be found intrinsically in interdisciplinary fields such as brain research, material sciences or computational sciences.

Since career, publication and communication rituals vary tremendously among academic disciplines, a "one size fits all" strategy is neither possible nor necessary. The Critical Thinking Initiative strives for a more intense reflection in each discipline, taking into account the pecularities in each and every field of research. The success of the initiative relies upon the willingness of all stakeholders in an academic institution encompassing faculty, students, post-doctoral researchers, senior researchers, administrators and managers.

The overall goal is to have more fun, take calculated risks, show courage and ultimately achieve an increasingly higher standard of research and a greater sense of satisfaction in academic life.

The "three commandments" declared at the foundation of Janelia Farm, Howard Hughes Medical Institute's pioneering research centre in neuroscience, outline the expectations of this process in a nutshell:

1. The ability to define and the willingness to tackle difficult and important problems;
2. Originality, creativity, and diligence in the pursuit of solutions to those problems; and
3. Contributions to the overall intellectual life of the campus by offering constructive criticism, mentoring, technical advice and in some cases, collaborations with colleagues and visiting scientists. Such criteria are not readily assessed by simply looking at someone's resume or publication record. (Rubin, 2006b)

Sustainability

At the turn of the century many leading academic institutions initiated sustainability strategies. When one takes a closer look at these strategies, they seem to consist of a maze of projects and initiatives in sustainability research that seek quantitative rather than qualitative growth. Sustainability in research and teaching has to consider: "Why, what, how and who" (McGill, 2015). In serious sustainability, research and problem-oriented practice address these questions, but here, the main focus is on environmental topics, agriculture, waste management, food and general development. While the latter topics immediately relate to "serving society", we think that sustainability will also find its merits in basic sciences and humanities. In addition, research and teaching are all about the respectful use of resources. The well-established scientific approach requires one to think first and perform the experiments later. Often human behaviour acts differently. Daniel Kahneman points out this fact in his bestselling book, *Thinking, Fast and Slow* (Kahneman, 2011). Kahneman's key observations (the following reformulated from excerpts of his book) emerge from behavioural economics and psychology and among many others relate to: *planning fallacies*, *overconfidence*, *availability heuristic*, *sunk cost fallacies and loss aversion*.

In *planning fallacies*, benefits are consistently overestimated, while costs are underestimated. *Overconfidence* lacks sustainability by only taking into account the "Known Knowns" and forgetting about the "Unknown Knowns". Even worse, *Overconfidence* leads one to underestimate the complexity of a problem — the "Unknown Unknowns" — by seeking simple answers to complicated problems or superficially interpreting the results to align with the expectations. The *availability heuristic* is a mental bias that judges the probability of events with anecdotal knowledge of some examples. *Sunk cost fallacies* describe the tendency to continue to invest more funding in projects that exhibit poor results and have already consumed significant resources — a frequent practice seen in incremental research. The *loss aversion* finally stands for the psychological phenomenon that we fear the losses much more than we value the gains. Raising awareness and sensitivity for these attitudes may considerably improve the quality of research, increase relevance and reduce the publication frenzy. Qualitative growth rather than quantitative growth, in the long run, is more efficient and effective.

Economy

Evidence suggests that there are economic consequences for many of the aspects addressed in this paper for example: reducing incremental research publications, addressing scarce resources in terms of laboratory space and increased teaching time all bear an economic impact. In theory, one must remember that, at least for the moment, neither the internal character of academia nor external pressures of the economy favour change. Academic networks force universities to compete globally; therefore, "ivory tower" behaviour without accountability to the needs of society will certainly have an effect a university's ability to compete in an international market.

The economic reality of the status quo is that researchers will continue to face the inevitable uneven distribution of resources. The vast majority of grants and budgets, as well as individual promotions, are currently dependent on "counting papers", ratings and rankings. "Hype" projects and those with a sharp disciplinary focus will be favoured over unruly rebelliousness in the current epistemic. Change is not only necessary, it is inevitable.

THE QUEST FOR A NEW FORM OF QUALITY ASSESSMENT

It is a commonly accepted perception that citation frequency directly relates to the importance and the relevance of a scientific publication. The more provocative question is whether or not truly important papers are reliably recognized, as such, by peers? One may consider the *annus mirabilis* 1905, seeing three fundamental papers of Albert Einstein as a positive example, but he stood at the end of the era of classical physics, where many contemporaries had paved the ground for a transition for new and revolutionary concepts. We live in an era where the scientific community rarely questions the prevailing paradigm. Under these conditions, will the peer-review be able to recognize the relevance of a conceptual (not methodological) breakthrough?

The following editorial in one of the leading science journals may shed some light on the situation:

> *The most cited* Nature *paper from 2002-03 was the mouse genome, published in December 2002. That paper represents the culmination of a great enterprise, but is inevitably an important point of reference rather than an expression of unusually deep mechanistic insight. So far it has received more than 1,000 citations. Within the measurement year of 2004 alone, it received 522 citations. Our next most cited paper from 2002-03 (concerning the functional organization of the yeast proteome) received 351 citations that year. Only 50 out of the roughly 1,800 citable items published in those two years received more than 100 citations in 2004. The great majority of our papers received fewer than 20 citations.*
>
> *None of this would really matter very much, were it not for the unhealthy reliance on impact factors by administrators and researchers' employers worldwide to assess the scientific quality of nations and institutions, and often even to judge individuals. There is no doubt that impact factors are here to stay. But these figures illustrate why they should be handled with caution.* (Nature, 2005)

When valuing publications and their citations as a correlate for quality, exercise care ensuring an objective assessment of both the field of research and the individual cited. Reading a specific paper may help. Discussing it and explaining it to non-specialists may further clarify the quality and relevance of the citation. This raises another hot issue prompting the question: "Is the contemporary peer-review system still adequate?" In neuroscience, for example, several journals in the field have established a peer-review alliance that is striving to speed up the review process and grant a higher degree of "fairness" to the authors. This may address some initial issues of the peer-review review system, but does not answer the underlying problem. The heart of the problem does not lie in the creation of new structures or a change in administration, but rather the responsibility rests with reviewers and authors. The immediate response to the citation issue emphasized the responsibility as follows: "*Shoddy authorship, editorship or peer-review review pollute the scientific record, cause colleagues to waste time and money trying to replicate findings, and can do serious damage to public trust of science.*" (*Nature*, 2009). Since there is currently no better solution than peer-review review and given the fact that science cannot survive without self-government, scientists must avoid all of the "Kahneman fallacies" mentioned earlier in this paper. Peer-review requires time. Should scientists who choose to take the time to contribute careful, helpful (for the authors) and honest reviews merit the same credit for the review as for other publications? By initiating an ongoing (intramural) discussion, the Critical Thinking Initiative strives to raise awareness and positively contribute to the improvement of the peer-review system.

Hiring at all academic levels is a matter of quality judgment and, therefore, closely related to the arguments related to peer-review and citations. A rigorous quality assessment process with transparent methods and standards may add to the reputation and attractiveness of a university. Indeed, such standards and processes may attract the scientists who possess the types of qualities and character a university desires (i.e, highly motivated, innovative and independent-minded).

SPACES FOR EXPERIMENTATION

The Critical Thinking Initiative considers not only processes, but also how best to address infrastructure. Classical university settings with half-day, face-to-face lectures may need to give way to more innovative teaching formats in order to foster creative and constructive learning. Flipped classrooms, peer learning, cross-curricular seminars and service learning models support inter- and transdisciplinarity transfer of theory into practice. Massive Open Online Courses (MOOCs) and Small Private Online Courses (SPOCs) may tap the potential offered Information and Communication Technology (ICT) developments allowing for blended teaching and learning opportunities.

In the coming decade, the university will need to address the challenge of the overall cost of maintenance on the existing facilities and the scarcity of land. The rate of transformation and growth challenges university managers and campus architects. While new buildings at ETH Zurich have already adapted to the emerging challenges, the redesigning of existing buildings remains a huge task that looms on the horizon. Securing financing for an ambitious plan to expand and develop available space still remains a challenge. Therefore, an efficient use of scarce surface areas will be a necessity making flexible, multi-use and well-scheduled space allocation attractive considerations. The planned "Student Project House" at ETH Zurich may serve as an example of how to satisfy many of these requirements.

Last, but not least, time is at stake. Assuming that time management is a matter of individual preference, it is evident that scientists prefer choices that optimize their opportunities to build reputation. In simple terms, if the number of publications is the measure of reputation, it is not surprising that scientists favour research over other responsibilities such as: teaching, reviewing, public science, managing technology transfer and university administration. Therefore, a careful examination of both the scope of a scientist's activities, as well as the system for awarding reputation, may be necessary to create space for experimentation.

SETTING OFF ON A JOURNEY TO NEW FRONTIERS

In spring 2015, the management board of ETH Zurich met 200 invited faculty members to discuss three important topics to further develop the strategy of the university: Defining quality; finding, attracting and fostering talent; and minimizing the publication "frenzy". It is no surprise that the participants, from all disciplines of ETH Zurich, found themselves engaged in a fierce debate that revealed the urgency of these strategic topics. From the concerns raised during the meetings, a consensus emerged that fundamental changes are necessary and that scientists need to bear some of the responsibility for such changes. The meeting concluded with participants offering full support for the initiatives of the management board and yielded some visionary recommendations.

One of the most challenging gaps to bridge is the need to accommodate the individual trajectories of scientists, without losing the relationship to the ETH Zurich community. It became evident that students, faculty and staff at all levels and units need time and space to establish a common discussion culture, to continually improve the curricula, and to make room for experimentation in teaching and research.

As the community implements the Critical Thinking Initiative, a change has started to take place in the first phase that focuses on teaching. Various measures have been set in motion to initiate the processes of a more interdisciplinary and collaborative working culture at ETH Zurich. The following are examples of some of the concrete projects initiated:

- The Spring 2015 term saw a new course that paralleled the lectures in basic physics with physicists and philosophers teaching joint lectures and applying flipped classroom techniques (Schiltz, 2015).
- The Autumn 2015 term offered a large choice of educational training courses, seminars and lectures gathered under the umbrella of the Critical Thinking Initiative. All the departments contributed in setting up special student lectures, events to promote interdisciplinarity, and workshops to foster new teaching methods (Critical Thinking annual program, 2015).
- ETH Zurich organized for the very first time the ETH Week in autumn bringing together some 150 Bachelor and Master students from all departments with faculty members and external experts to jointly work on a topic of high societal relevance (ETH Week, 2015).
- It is projected that in 2018 the "Student Project House" will be realized. In the meantime, a core group of students, faculty and staff launched a pilot phase to gain experience with novel thinking, making, showing and connecting spaces. Ultimately, the university will establish a spacious laboratory for student projects in a former heating plant located near the ETH Zurich main building in the centre of Zurich. ETH Zurich envisions an interdisciplinary space in a collaborative "workshop-like atmosphere". More self-organized student projects have arisen along the way with the start of the initiative: "getBriefed" — a Zurich-based event series bringing together curious students, doctoral students and researchers from all disciplines to explore, share and revive the unconventional. "getBriefed" is both a community and source of inspiration and discovery. *(getBriefed, 2015)*.

This is just the beginning. Fundamental change takes time and has to go much deeper in order to be effective. In addition to teaching, the Critical Thinking Initiative hopes to influence and transform other major fields of activities at ETH Zurich. The ultimate goal is to pursue the noblest quest of every university: to empower the community of students and faculty and enable them to gain new and deep insights, to teach and to learn to think creatively and critically.

CONCLUSIONS

This paper explores the challenges of recognizing and developing talent within the current status quo where scientific reputation directly correlates to paper output. The pressure to build a successful academic career often tempts faculty to specialize in areas where there is less competition and to reach for the "low-hanging fruit" in order to build a reputation measured by the number rather than the value of research publications. The consequences are that broader or perhaps an interdisciplinary reflection is avoided in favour of reporting single observations and teaching is marginalized to allow time for research and publication.

Leaders in higher education face similar dilemmas in how to assess value when making budget allocations. Such dilemmas challenge leaders to think critically about the "publish or perish" model and whether such a model is effective in assessing and rewarding faculty and whether it serves our ultimate goals for teaching and learning. If, at the extremes, universities and their stakeholders retire into a "splendid isolation" or dwell in an arbitrary state, further academic education and research may be absorbed by a knowledge-based economy, resulting in either utilitarianism or ideological idealism, which reins those institutions.

ETH Zurich's Critical Thinking Initiative prepares the ground for a paradigm shift in academia — one that allows for space and time for experimentation. One consideration is a mixed model where managers in higher education organize a competition in special, even multi-disciplinary research areas considered important for society, the economic welfare of a nation, or for knowledge procurement.

Three arguments for the foundation to move forward: responsibility, sustainability and economy require a reflective approach. It was concluded that achievements need to be continually scrutinized in order to align with the aims of sound and rigorous reasoning that adopting a reflective approach avoids quick "symptomatic" problem solving ultimately leading to fundamental and even controversial new ideas. Sustainability research and teaching refer to the respectful use of resources requiring one to first think critically. Economic consequences of the peer-review system necessitate the question: "Is the contemporary peer-review system still adequate?"

The Critical Thinking Initiative strives to guarantee the future achievements of science for the increase of knowledge and ultimately the benefit of society. Inherent to change and true to the nature of academia, such ideas will most certainly spur controversial debate. Such discussions are welcome as they signify a community that is not only open to change, but to becoming leaders in the academic world.

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