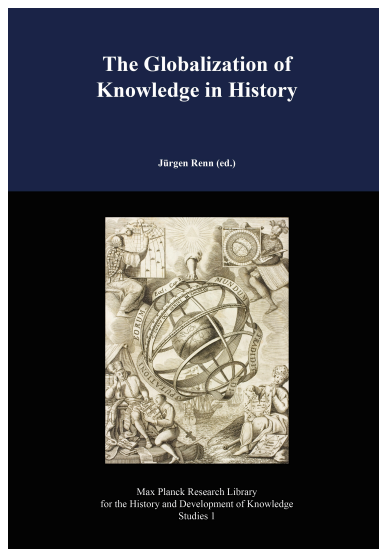


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Studies 1

Yehuda Elkana:

The University of the 21st Century: An Aspect of Globalization



In: Jürgen Renn (ed.): *The Globalization of Knowledge in History*

Online version at <http://edition-open-access.de/studies/1/>

ISBN 9783844222388

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Printed and distributed by:

Neopubli GmbH, Berlin

<http://www.epubli.de/shop/buch/17018>

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>

Chapter 25

The University of the 21st Century: An Aspect of Globalization

Yehuda Elkana

25.1 Introduction

“Globalization” has become a buzzword. When discussing it, the spectrum of views moves between seeing in every aspect of life an aspect of globalization and the view that there is nothing new about it: it was present in some form in all periods of history. In a way, both claims are true and we need some conceptual fine-structuring in order to make our point.

If we mean international trade or spread of inventions, of other types of new ideas or of knowledge in general, it existed from ancient times. On the other hand its scope and depth today is unprecedented and it is universal. In a very real sense the world has become one: political ideas, social institutions, universities have all become globalized as we shall see below.

While under “globalization” for a while mainly economic matters and new techniques of communication were meant, it soon became evident that many other aspects, like, for example, political ideologies, also became globalized. Democracy has become much more widespread in the last decades than ever before, but even more than actual democracy, it is the language—the political discourse—which became globalized. When listening to politicians representing genuine democracies, military dictatorships, communist one-party systems, fanatic theocracies, they all sound the same, evoking the same slogans, quasi the same ideals.

Yet, what was feared by many, of the world becoming an undifferentiated flatland, using a universal bad English as means of communication, has not materialized. On the contrary, all those aspects which did not fall under the aegis of economic interests, or were not part of a universal IT-system, became locally emphasized and cultivated more than before: local cultures, religions, languages, traditions and so forth.¹

Curiously, the university belongs to the first category: hundreds of new universities in the world, most of them in India and China, are mushrooming, all built on the model of the university as it has developed in the West in the last hundred years. By now, the fact that they were developed in the West has lost much of its meaning, or its political overtone, but the basic similarity of all of them

¹On this double nature of globalization, see Renn’s introduction to this volume (chapter 1).

remains. It is an interesting question—not to be explored here—what is actually being copied when universities are established on a given model. Is it full-scale copying of every detail, or is it some basic triggers or “stimulations” which then have to be developed locally? If the second, then it is a curious state of affairs that there is so little local influence on the curricula.²

The strongest proof of this development is the basic structure of the university: three faculties of the natural sciences, the social sciences and the humanities. It is still the way Francis Bacon conceived the division of what he called the “*globus intellectualis*” into disciplines. The worst aspect of this development is that there is very little attention being paid to the real core of the university, namely to the curricula being taught. The new universities copy what has already been developed elsewhere, where the “model” universities in America and Europe smugly leave their curricula mostly untouched and concentrate on structural reforms, and on the prevailing budgetary malaise.

There is international awareness of this uniformity of curricula. The Stanford sociologist John W. Meyer and his “school” have commented and documented this worldwide similarity. Their explanation is anti-functionalist and seeking the reason in a general cultural climate which, in their opinion, has become universal.³

In an important article (mentioned in the previous footnote), in this mode of argument, Frank and Meyer summarize:

Our overall argument here is that Modern and post-Modern societies rest on a central conceit [...] that the world is a unified and law-like place, comprehensible to everyday persons. Our argument helps explain why the university does not yield to technically superior competition. The university survives and flourishes over recent centuries as the locus of this conceit—the repository of universalized knowledge—not as the training ground for an increasingly complex role system [...]. The university’s isomorphism worldwide follows from the fact that universities spread in a top-down process—instantiating models institutionalized in world society—not from the bottom-up. And the university succeeds at certifying [...] much better than it succeeds in training because training is not the point. The university may be bad in teaching skills, but it is good at re-envisioning local particulars as global universals. (Frank and Meyer 2007, 28)

With all this the authors are quite happy. They find the real proof of their thesis in the fact that:

[...] it is often quite difficult, in examining university catalogues, to find much curricular material that directly indicates just what country, place and period the catalogue is covering [...]. Another indicator

²On the different types of knowledge transfer in different periods, see many of the other chapters in this volume.

³Two publications should be noted: (Frank and Gabler 2006; Frank and Meyer 2007, 19–44).

of universalism appears in the detailed contents of courses that initially appear to be immediately and obviously role-related. (Frank and Meyer 2007, 30)

The paper, and the book quoted above, are so meticulously researched that I do not doubt the exactness of what is described as the prevailing situation. Indeed, their criticism that most of the research is either about a single discipline, or a single country or even a university, is correct. Very rarely is research on higher education comparative.

My problem lies with the presupposition—the conceit as they call it—that the “world is a unified and law-like place, comprehensible to everyday persons.” The world is complex and messy, not at all unified and consisting of and exhibiting universally true phenomena, and it is precisely for this reason that the task of the twenty-first-century university is to prepare the students. All of them—hundreds of millions—are now entering higher education. This does not mean teaching skills—indeed I agree with the relatively low priority of “training”—but it is an epistemological task.

In his Foreword to the Frank and Gabler book (mentioned above), John Meyer talks of “a rather unified university” worldwide, “serving as a kind of church for post-modernity.” It is part of Meyer’s theory, which permeates this book, that this flat landscape is due to a universal culture, of being a knowledge society, and not a response to any functional needs of societies. As Frank and Gabler put it:

Most analysts adopt a loosely functionalist point of view, treating changes in the composition of teaching and research (more business, less botany, etc.) as adaptive responses to the shifting needs and interests of either society at large or of its dominant elites. (Frank and Gabler 2006, 7)

They review, and rebut, one-by-one organizational, economic and political forms of functionalism. Their theses are:

(1) that the university is definitionally committed to mapping reality and (2) that changes in the assumed features of reality thus reconstitute the academic core [...]. By cultural fiat and organizational rule, the university presents reality in objective and universal terms [...]. Violations of the standards of objectivity and universalism disqualify an organization from being a university.

Moreover,

The huge expansion of the rationalistic social sciences [...] provides the needed support for this explosion that Foucault called governmentality. And the relative decline of the humanities helps weaken the alternatives – the senses of the power of tradition, of local particularities, of the gods and spirits, or of natural human desires and needs. (Frank and Gabler 2006, xiv)

The universalism of the university is what stands out from the global purview. (Frank and Gabler 2006, 199)

The picture given here is precisely what must change. It is a correct description of a “conceit” which in my opinion is normatively wrong, relying on a historical interpretation, presupposing a cultural “flatland” all over the globe, which in my opinion is a fundamentally flawed interpretation.

Lest I be misunderstood, and risking redundancy, I wish to emphasize that I do not want change through the abolishment of teaching disciplines: we need them as a rigorous, methodologically rich foundation for all knowledge, and they must be the basis of undergraduate education from the beginning. The change must come—as we shall see in detail below—by accompanying those introductory, rigorous first-year courses by seminars, given parallel to these, discussing real-life situations, which are almost always interdisciplinary, which do show life as complex, messy and unpredictable, and find their mathematical expression in non-linear equations.

In order to make the redundancy somewhat less vexing, let me formulate the above thesis in a different language: if we distinguish between the body of language and the images of knowledge, which are statements about knowledge, by describing body of knowledge as first-order knowledge, and images of knowledge as second-order knowledge, then the conclusion is: teach introductory courses mainly on the level of first-order knowledge, and the more complex, more sophisticated, albeit, less rigorous courses in terms of second-order knowledge.⁴ Several of the chapters in this volume are also couched in this language.

By way of an epistemological caveat, I would like to remind the reader of another concept, which seems to be very relevant here: “Concepts in Flux”: in the creative formative stage when a new theory is being formulated by one or several scholars, the question arises whether the “discoverer,” while working on the details of the new theory, is speaking “newspeak” or “oldspeak”; when Einstein formulates his law $E=mc^2$ before having drawn all the consequences that will follow for classical Newtonian mechanics, what language does he think in? During this whole period the new concepts are not yet solidly settled—they are concepts in flux. At this stage the distinction between first-order and second-order thinking becomes blurred. I used this concept and relied on it in my historical analysis

⁴See (Elkana 1981, 1986, 1988).

of the new law of conservation of energy, formulated in 1847 by Hermann von Helmholtz (Elkana 1974).⁵ What is needed is a fundamental rethinking of the aims and tasks of the university in the twenty-first century, and the principles or guidelines for constructing curricula that follow from the rethought “aims and tasks.” This is the task for very many scholars, university administrators, but even on the policy level of politicians working together, and must be undertaken in all locally different social milieus. I shall come back to the curricular reform below.

But before that comes the challenge to create a general awareness of the acuteness of the problems of the world and the urgency for doing something about them. This is relevant here, because, as a clearly formulated task for the twenty-first-century university, it has not been often formulated. There exist specific research institutes, dedicated to solving well-formulated problems, such, however, that are couched in terms of existing disciplines, with well-known needs for support in manpower, financing and equipment. The most urgent world problems, like hunger, poverty, the spread of infectious diseases, the phenomenon of global warming, the scarcity of water and energy and many others, are distinguished by the fact that no one discipline can cope with them and often the kind of discipline that would be needed does not even exist: in these cases new disciplines have to be created like a new economics, which would integrate classical, mathematical, modeling main-stream economics with concepts stemming from anthropology, sociology, history, like norms, values and aspirations.

Similarly for understanding and coping with the spread of infectious diseases like HIV/AIDS, multi-drug-resistant tuberculosis, or malaria, a new discipline is needed which would integrate molecular biology and some of the relevant social sciences. On a different level, and not in the category of burning social problems, but still constituting phenomena for which our inherited theories of political science and sociology do not have the conceptual tools to study, are the phenomena of the spread of moderate religions almost everywhere in the world, and the emergence of new types of regimes which are neither fully totalitarian nor really democratic. To study these, the mentioned disciplines have to be rethought from the foundation. The university is the only social institution which in scope, depth and breadth could possibly be called upon to “invent” new disciplines or rethink old ones: this is indeed one of the unpredicted new tasks for the university of the twenty-first century.

What unites East and West, North and South—that is, world consciousness—is the growing crisis of the physical well being of our earth. The environmental, economic and public health crisis is a causally linked, unintended consequence of the very success of the scientific-technological-economic success of modern times. As Paul Collier pointed out, poverty in some parts of the world is simultaneous with the unprecedented accumulation of riches in other parts of the world (Collier

⁵See also (Elkana 1970a,b). More recently Mara Beller made good use of it in her important book (Beller 1999).

2007). At the same time, the gap between rich and poor in the richest, most successful countries is growing all the time.

Let me elaborate on this demand from the point of view I called previously a need to rethink the Enlightenment. Western capitalistic society gained its success by creating new knowledge in most areas and by accumulating material riches due to a series of values, which for almost two centuries guided thinking and research. These values were formulated during the Enlightenment and became centrally important in the nineteenth century when practical lessons were drawn from what was understood to be the message of the Enlightenment.

The university today, with its research agenda, its service function, its emphasis on social involvement, reflects the cluster of values that were received from the Enlightenment, mainly in the nineteenth century. I emphasize “received” because the great thinkers of the Enlightenment were much richer, broader, more controversial and more pluralistic, than what was received and internalized by the science, the politics, and the philosophy of the nineteenth century. These values are: objectivity, universal validity of theories, realism, rationality, context-independence, abhorrence of contradictions, non-linear thinking, determinism, predictability of the world in all its aspects, a belief in and craving for coherence of ideas and value-systems, anti-dialectical, and especially the newly developed social sciences concentrating only on what was measurable, which resulted in the cultivation of rational choice theories and methodological individualism.⁶

This cluster of values serves as a political guideline to most politicians in most democracies, but also as a cluster of research values to which most scientists/scholars adhere. The presently widespread undergraduate curriculum is based on these values and principles. It is precisely these values and principles which no longer fit the world we live in and the problems that our natural sciences and social sciences have to grapple with, that therefore have to be rethought. It will take an epistemological revolution to get used to thinking in terms of sets of values and concepts which, as Isaiah Berlin has tirelessly emphasized, do not constitute a coherent whole. Values do not ever form a coherent system; we must learn to live with contradictions (as an integral part of our world of knowledge).⁷

We should get used to the fact that all knowledge must be seen in context: not only when looking at its origin, but even when trying to establish its validity and even when looking for its possible application for solving burning problems. A concise way of putting the requirement for an epistemological need for rethinking our world in a metaphorical formulation is “From Local Universalism to Global Contextualism.”

One special aspect of global contextualism, to be discussed below, is the integration of parts of local knowledge with the universal general knowledge with which the culture confronts the two. In some areas local knowledge turns out to be extremely efficient, and even of high survival value. It took international agencies

⁶For more on this topic, see (Elkana 2000).

⁷See my paper on rethinking the doctorate (Elkana 2006).

many years until they realized the loss their efforts suffered when neglecting bodies of local knowledge.⁸ But let me enlarge a little on this new task for the universities, under the heading “Toward Global Contextualism.”

25.2 Toward Global Contextualism

I would like to argue that to a large extent universities are themselves to blame for their failure to respond adequately to the external pressures of the day. Barring the work of a few exceptional departments and individuals here and there, universities are incapable of addressing precisely those problems that most preoccupy our societies today.

Granted, universities rightly regard themselves as playing a key role in preserving intellectual, academic and cultural traditions. This, however, should not be taken to be an acceptable excuse for not dealing with fundamental social injustices and discrepancies—problems often deemed to lie outside the scope of a university’s legitimate interests. Since universities are by far the most important institutions in any modern society entrusted with the task of creating knowledge (whether the exclusivity of this knowledge-creating role is a good thing is another question), they should also strive to apply the knowledge created there to major social issues at any given time.

A few examples, some of them already mentioned above, will illustrate my thesis. It would be difficult to find a significant department of economics sponsoring a major research program focused on the nature of the public good, or poverty. As mentioned, there is almost no serious university department that would do research on the problem of combining sociological, anthropological, historical, and psychological knowledge with biology on the molecular level to help us deal with the spread of infectious diseases such as HIV/AIDS, multi-drug-resistant tuberculosis or malaria. Even if the Gates Foundation and others invest huge amounts of money in trying to develop a vaccine against AIDS, unless a new discipline is developed which integrates social sciences with biology at the molecular level, there will be no way to cope with the problem of how these diseases spread in whole societies. Until recently this was the case mainly in Africa, but today more and more countries are witnessing the vicious spread of the diseases.

As a last example, let us take up global warming. Even though by now there is almost universal consensus about the fact of global warming, we do not have the sought-after intellectual answers—beyond the political/economic—to this crisis, to the extent that leading experts disagree not only on possible solutions, but also on whether the catastrophe will take place in two years or two hundred years. The reason for this is partly political and partly epistemological, but both are rooted in the way we teach at our universities. The political: neither the scientists, nor the politicians are willing to admit publicly that science has no answer to this question.

⁸Part 3 of the present volume, especially the survey chapter 16, is an important reminder of this issue.

The problem is quasi technical: the number of parameters that one would have to consider for a credible prediction is so enormous that even with our modern computers, it would take ages to complete the calculations. Therefore the model-building scientists must make a choice of the parameters taken into account—each choice renders a different prediction, and these diverge widely. The epistemological is the fact that the phenomenon is a typical non-linear one: there are no linear equations, no solvable differential equations that would yield acceptable results. And our undergraduate curriculum—at least in most universities—does not involve teaching non-linear phenomena, or what is called, somewhat simplistically, non-linear thinking. This will come in naturally in those first and second-year seminars dedicated to real-life situations of an interdisciplinary nature, that we recommend here to be taught parallel to the introductory courses—rigorous and basic—which describe a predictable, easy-to-understand, “linear” world.

Paradoxically, by stretching the university’s functions and capacities to breaking point and by blurring its identity, globalization created the exact opposite of what we should expect of places of learning and scholarship today. To repeat: what we need is to move away in our teaching—and thus also in our thinking—from local universalism and work toward global contextualism.

In a nutshell, global contextualism is the idea that, whatever the academic discipline, every single universal or seemingly context-independent theory or idea rooted in the tradition of the Enlightenment should be rethought and reconsidered in every political or geographical context, different from the world as it used to be in the Age of Enlightenment in Europe, and in the nineteenth and twentieth centuries, also in America.

Global contextualism is one of the most important developments in world history since the Enlightenment and universities are uniquely placed to help us to understand it and to promote its growth. All the more regrettable that practically no university raises serious questions concerning the old structures which were then the relevant context for the disciplines as they were introduced.

Although it is hard to do justice to the complex issues of contextualism here, it is clear that to raise a question about context is first and foremost to raise a question about meaning. But it is precisely meaning—with all its flexibility, plasticity, ambiguities, and contradictions—that is neglected by universities for both systemic and intellectual reasons, and to which reasons I now turn. These reasons can probably be subsumed under the problem of academic freedom as it is understood today, and as it should be reinterpreted so as to fit the twenty-first century.

25.3 Academic Freedom

Academic freedom is severely limited for students, graduate students and scholars in the early stages of their career until, with tenure, they gain the freedom to research what they want. What results from the way an academic career is currently

structured is that young people are thrown into a groove that they can never leave if they ever want to remain successful in academe.

Let me again offer some examples. Consider, first, what is happening in economics departments. As mentioned above, the real challenge is to create an integrated discipline, a new body of economic theory, bringing together traditional interests of economists couched in advanced mathematical terms with a novel emphasis on norms, aspirations, values, and social ideals. Such a unified theory is a must if economics is to remain pertinent to today's needs and problems. Mainstream economics refuses even to consider this need: a combination of vested interest in the existing theory, of gatekeeper mentality, which is especially strong in economics, and the fact that economists are highly paid as consultants and experts—remained seemingly uninfluenced by the unpredicted and under-explained global financial crisis. Mainstream economic theory is wed to the idea that markets will revert to equilibrium when left alone—though the opposite seems to be the case. Serious economists, and financiers like George Soros, who have amply proven that they understand the crisis, its causes and its possible remedies much better than the great mainstream economists—some of them Nobel-Prize winners—have repeatedly pointed this out. Indeed there are some few attempts to found departments for the “new economics”: Columbia University, Oxford University, Cambridge University, the Central European University in Budapest are all supported by George Soros. For us the relevant point is that young economists who would like to explore new ground are strongly discouraged by their departments and by the leading mainstream economists, and it is made clear to them that if they do not follow the guideline their career is in danger. This applies even to more limited and less daring new directions like behavioral economics. But these new departments can become effective only if they do not only house a few, rebelling Nobel-Prize winners, but create new positions in a critical mass for young scholars whose careers will not be endangered by pressure from the mainstream.

Similarly, this is the case in departments of cognitive/experimental psychology: positivistic, reductionist approaches, no emphasis on context or meaning, and almost obsessive preoccupation with rational choice theory. And the same is happening in departments of political science. The rigid intellectual groove in which aspiring young academics move is fixed *a priori*.

Unfortunately the granting agencies and funding institutions and foundations follow the same pattern. But even more importantly, there is once more the epistemological consideration: mainstream economics does not study context—and therefore meaning—thus these are not central concepts in economic theory. The same holds for the other academic departments mentioned above. In the framework of the sweeping reforms advocated here, we must now turn to psychology and the theory of meaning.

25.4 Psychology and the Theory of Meaning

Jerome Bruner has convincingly argued on a number of occasions that psychology, cognitive science and other related disciplines systematically neglect meaning and ignore the fact that meaning is socially constructed. This failure is not just a coincidence or a fluke. It is perpetuated by well-entrenched systemic failures, incentives, or even expresses institutional prohibitions.

As a result, not only is the academic career of young scholars being influenced, but very often graduate students are not allowed to carry out research in other than mainstream areas, based on a paradigm different from the established and accepted one. Graduate students are not given the place, the infrastructure, the incentives and general wherewithal to do and publish innovative work on meaning. To be fair, this situation has changed somewhat owing in no small measure to Bruner's pioneering work on "narrative." It was Bruner's strategic decision to concentrate on the theory of narrative—borrowing much from literary theory—proposing the thesis that via a study of narrative in different disciplines, a study of meaning will be reintroduced. As a result, narrative was introduced into the curriculum of Columbia Law School where Bruner had been teaching for more than ten years.

Interestingly, this development has been paralleled, also at Columbia, by introducing "narrative medicine" into the medical school. These are laudable attempts to break with earlier practices to exclude the study of meaning from teaching and research at psychology and cognitive science departments, but they are not sufficient on their own.

In a way, more broadly than the need to study "meaning," there is a good case to be made that the exclusion of semantics (in the contextualized sense, not formal semantics) in many linguistics departments is largely due to the exclusive preoccupation and thus success of the Chomskyan syntax-centered research program. Although the criticism of this approach is growing rapidly,⁹ the very absence of a well-formulated alternative theory that can be presented to students as a coherent whole contributes to the persistence of the present state of affairs. I should make it clear, however, that I do not advocate here a return to the pre-Chomskyan era. Nor do I wish to underplay the enormous achievements of Chomskyan linguistics. Having said that, it is imperative that we develop in the universities areas beyond what has been achieved so far. In particular, comparative and historical studies of languages should be reintroduced. This is a considerable challenge, but it has to be tackled, and be tackled by the universities themselves.

When returning to historical and comparative linguistics, which had been neglected for some time under the influence of the Chomsky dogma, those universal characteristics of language that Chomsky had discovered must be taken into account, and the *differentiae* should be studied comparatively and historically beyond the universals.

⁹See the work of Guy Deutscher of the University of Manchester, or of Nicholas Evans and Stephen Levinson (2009).

Also the Sapir-Whorf hypothesis has to be reviewed taking the post-Chomsky findings into account. But beyond that, comparatively and historically one must study those elements of language which influence formatively the social and cultural differences between people—that is, languages.

The hypothesis developed by Edward Sapir and Benjamin Lee Whorf consists of two principles: (a) linguistic determinism, i.e. the principle that asserts that language determines the way we think, and (b) linguistic relativity, i.e. the principle that states that those that speak different languages conceive of the world differently. Chomsky and his followers, promoting a universal grammar—that is syntax—rejected the Sapir-Whorf hypothesis, and neglected a comparative, historical study of languages which could have thrown light on this complicated and important question. If we now reintroduce comparative-historical linguistics, based however on the achievements of Chomskyan theory, we shall be able to study anew issues of meaning, translation, and cultural contexts.

Daniel Dor's theory of language as a socially-constructed communication technology is a new and ambitious attempt to walk in this direction: It rethinks the universality of language in social-functional (rather than cognitive) terms, positions social meaning (and its relationship with private, experiential meaning) at the center of the theory, and allows for a new interpretation of the Sapir-Whorf hypothesis (Dor and Jablonka 2010).

Cassirer's work on language, myth and science is of great help here, even though his formulations are outmoded and must be reformulated to fit the state of the art of our times. Similarly Fritz Mauthner's major work (1901)¹⁰ and even the pioneering early work of Otto Jespersen¹¹ are again becoming relevant.

Another important example is the ongoing struggle at many universities to separate the study of sociology from anthropology: "Sociology is about us, anthropology is about them." This is another old-fashioned distinction that needs to go.

These antiquated curricular practices are paralleled by the design of the grant system for funding academic research. Foundations, as already mentioned, often attune themselves to the research agenda and institutional organization of the universities. This is an unholy alliance that severely limits the academic freedom of the research community. In many countries, leading research foundations talk about embracing interdisciplinarity as an important priority. At the same time, they encounter enormous difficulties in evaluating truly interdisciplinary research. These are, I am wholly aware, controversial claims. But what I am proposing here are fundamental mutations in the institutional framework of academic research and urgently need to be addressed.

Discussions on curricula and institutional design often tend to concentrate exclusively on elite universities—that is, the great research universities of the United States and the handful of leading universities in Europe. However, this focus on a

¹⁰Mauthner was an Austrian linguist and a student of Ernst Mach.

¹¹Jespersen's works appeared from 1889 onward; he was a famous Danish linguist, specializing in English grammar. See, for example, (Jespersen 1889, 1894).

few outstanding institutions can easily mislead those thinking about the future of academic research and higher education.

We have so far—I believe correctly—discussed only epistemological issues, mainly contents and curricula. But needless to say, these are intricately involved with structural matters in the way academe is organized. Only in America and in Europe are there around one million faculty members who earn a living by teaching at universities, but who in fact publish research papers.

Witness the growing pressure to produce publications. This by now has become a *sine qua non* of academic success, indeed even of mere survival in academe. But it is perhaps the most important limitation on genuine academic freedom, a constraint that is all the more regrettable as all practicing academics are familiar with the inferior quality of arguably as much as 80–85% of published output. Universities in very many countries are places with overcrowded auditoria, overworked professors who teach not more than six to nine hours a week, who are pressured to spend every precious moment on research, have very little time to spend with the students or indulge in dialogues in small groups, participate in numerous committees and write grant proposals. Most of the teaching is in form of frontal lectures imparting information, which today is easily available on the internet. All this shows that the way universities are structured does not fit either the multiversities with tens and even hundreds of thousands of students, nor recent developments in the availability of information, and preaching principles which were fitting for very small elite groups dedicated to the creation of new knowledge by way of research, where the interaction between professors and students was almost one-to-one. This was the case in the early nineteenth-century German university, and in the American research universities emerging at the end of the nineteenth century, well-suited to small elite universities and small groups of outstanding researchers. It is only in the case of this select group that the teacher and the researcher must be one. Yet this requirement has by now spread to the huge “multiversities”: every faculty member has to be a researcher and, what is worse, author of an unending outpouring of publications.

As a matter of university policy, it would be worth investigating whether these two activities could be separated. The basic idea would be to offer different streams: (a) faculty (not more than 3–5% of the professors) whose lifestyle and abilities fit a more or less full-time research career, who work closely with the 3–5% of students, who by degree of curiosity, temper and ability will lead a life of advanced scholarship and research; to those who are going to combine teaching and research; (b) the rest of the faculty (in much smaller numbers than today), who will do the kind of research needed for good teaching, will be free from any publication pressure and will teach for sixteen to eighteen hours a week.

Not as lip-service, but by genuine conviction society has to learn to respect those faculty members, who by temper and talent can and want to dedicate most of their life to teaching. These are not less gifted or less intelligent members of the faculty than the full-time researchers, but individuals with different priorities and

temperament. They are not, nor should be treated or considered, as second-class citizens. They should have the same salaries, promotion conditions and enjoy the same academic “perks” as the researchers.

Actually this would amount to a new social contract between politics, society and the university administrations, faculty and students. This change is inescapable if the university is to become less expensive and at the same time not qualitatively worse, considering the fact that no government, especially in the welfare countries, will be able to spend for higher education what it needs to keep up the level of its present structure.

Against the background of this, now is the time to return to the principles for a new undergraduate curriculum.

25.5 Redesigning Undergraduate Curricula

In order to cope with the problems sketched above, we must concentrate on developing a new kind of undergraduate curriculum that responds to basic demands for the twenty-first century. These demands require our proposals to be clustered around the following three challenges: genuine interdisciplinarity, the education of concerned citizens, and the fostering of nonlinear thought. I will address each one of these.

One cannot emphasize enough that we should not abandon teaching disciplines; it would lead to the loss of intellectual responsibility. However, it is time we took note of the fact that a young person, after completing three or four years of university studies, will typically face problems “out there” that are interdisciplinary in nature. This is irrespective of whether he or she goes on to do research, joins an NGO, goes into politics, or chooses some other profession.

When a problem is interdisciplinary in this sense, no existing discipline on its own will be able to provide the intellectual tools to deal with it. But how can young people be trained for such a situation? Higher education today lacks the resources, both institutionally and intellectually speaking, to prepare young graduates for these real life situations posed by the exigencies of their profession or research.

Even when universities, research centers, or funding organizations do take on board the notion of interdisciplinarity, they usually commit what we can call the “interdisciplinary fallacy.” We see this fallacy at work when donors or university administrators act on the mistaken assumption that to solve a problem that goes beyond the scope of any given discipline, one merely has to convene representatives of various disciplines and “put them in a room” for a solution to emerge. What is fundamentally wrong with this approach is the failure to recognize that ten different mindsets sitting together will not come to much. Instead, we need scholars who in addition to knowing their own disciplines are capable of a genuinely interdisciplinary way of thinking.

In order to acquire this interdisciplinary way of thinking, rigorous and stimulating training is required from the early undergraduate level. I do not have the space here to describe in detail how such training ought to be designed, but I can offer a few examples. First, as already noted, in order to train a person to think in terms of disciplinary paradigms as well as beyond the limits of the disciplines, we will need to begin with first-year students and not with advanced students already seeking a doctoral degree. It is too late for someone writing a doctoral dissertation in physics to discover that, for example, quantum theory and the theory of relativity conflict conceptually in a most fundamental way.

It was for this reason that we proposed above to teach, in parallel, basic introductory undergraduate courses (in science, or economics, or in any other discipline) and seminars that will expose students to conceptual inconsistencies, to phenomena or situations where the basic theory does not work, or even to the basic incoherence or incompleteness of the basic theories as such. Such seminars would bring into focus the “real-life” situation. In an ideal world, one and the same professor would teach these parallel courses in the given discipline, although anybody familiar with higher education, and not naïve, knows that this suggestion would be hard to put into practice.

Our century-old resistance to such ideas stems from preconceptions concerning the needs of children and young people. Particularly popular and of detrimental influence has been the thought that what an aspiring and gifted young person really needs is intellectual certainty. What a young person really needs is emotional certainty, not intellectual certainty! Overseeing this basic truth has been responsible for the overwhelming ambition of most authors of university curricula not to expose young people to contradictory or conflicting ideas. This is an absurdity. Highlighting and even embracing contradictions is the right, and possibly, the only way to cope with the complexity and messiness of the world, and should in my view be a key element of higher education from the first-year level on.

The second fundamental objective in redesigning curricula is to foster the education of what I call concerned citizens. The term “concerned citizen,” as we shall analyze below, carries moral implications too. I am not so much concerned here with the ethical dimension, but rather with the underlying cognitive and intellectual content of this term.

Quite simply, educating concerned citizens is to educate young people—all of them—to understand the main problems of the world; one encounters these on the pages of any good daily newspaper. Why is it, we may want to ask, that we have so little understanding of how to fight poverty and how to help the “bottom billion” (to use Paul Collier’s term)? Why is it that we do not know how to come to grips with the medical, social and economic problems of worldwide epidemics? Problem-oriented thinking focusing on such issues must be introduced as early as the undergraduate level.

The concept of a “concerned citizen” has two dimensions: a moral/social and a cognitive. The moral/social is very often invoked: for example, a recent publi-

cation of LEAP (2007) (Liberal Education & America's Promise), called "College Learning for the New Global Century," formulates it as "Personal and Social Responsibility." This involves civic values and engagement, knowledge of the major social problems that plague the world and the fundamentals for social/political activism. At the same time university is not supposed to deal directly with political issues, and the teaching should not be politicized. Social skills are also subsumed here. One could also mention under this heading education for democracy—I deal with this in a special chapter of my forthcoming book because of its importance (Elkana, forthcoming).

On the other hand the cognitive dimension of being a concerned citizen is very rarely mentioned. By this I mean a training of young people which, after three or four years of undergraduate studies, should enable them to understand the major social problems of the world, what is being done to deal with them, what is not being done, and above all, what the epistemological gap is that prevents them from being dealt with. This last point is of greatest importance because it is not usually taught how to understand the limits of disciplines in order to deal with the problems. The tendency is to ascribe the lack of preoccupation with these issues exclusively to corruption, political interference and other such factors, as much as they are important and prevalent.

It was discussed above that the task of universities is to encourage the emergence of new disciplines and the rethinking of some of the older ones. The most glaring examples have already been mentioned, such as fighting poverty, the spread of infectious diseases, the issue of global warming.

Appended to this article is a Manifesto which in eleven bullet points outlines the principles for constructing undergraduate curricula. The background idea is that in order to consider contexts of various kinds—social, cultural, religious, disciplinary—different curricula have to be prepared for students who intend to go into research, teaching, the professions, business and so forth. Yet at the same time there are principles that should apply to all. The curriculum research that follows will then concentrate in translating the principles into the different specific curricula. Also in the appended Manifesto, point (4) says:

Use these challenges to demonstrate and rigorously practice interdisciplinarity avoiding the dangers of interdisciplinary dilettantism.

It seems so obvious that it is perhaps superfluous to make a point of it. Yet, it so often happens that when tackling a problem which spans many disciplines, it is forgotten that the relevant disciplines must be brought together in the most rigorous fashion, especially since it is expected that every participant in the work for the solution of an interdisciplinary problem is supposed to be a master of one or two disciplines, while being aware in a much more superficial way of the other disciplines relevant for the work they are doing. For an expert in one or two disciplines it is very daunting to remember that the other disciplines of which he/

she is not a master, but has superficial ideas about, must be as rigorously treated as the ones he or she is master of.

Finally, we need to understand and draw practical conclusions from the fact that almost all of these major problems society faces today are what can be termed colloquially nonlinear in terms of the mode of thinking and method they require. That is to say, they are non-predictable, nondeterministic and often resist reduction toward one, universal general theory. They are much more complex and ambiguous and rich in contradictions. This point is worth elaborating on in some greater detail.

The curriculum should make students in all areas acquainted with the principles of non-linear thinking or, in the words of George Cowan, founding director of the Santa Fe Institute for the Study of Complexity, introduce them to “the sciences of the twenty-first century.”

As a caveat, it should be mentioned that all of these “new” sciences and “new” concepts like non-linear dynamics, chaos, complexity, network theories, actually emerged, sometimes even in the very same terms, at the end of the nineteenth century in works of scientists like Poincaré, Boltzmann, Gibbs, and later Shannon and von Neumann. What is definitely new is the scope of their spread and relevance, and the successful attempt to show that the concepts and the mathematical formulations that involve them are identical for a broad array of disciplines in the natural, as well as in the social sciences. It brings back a new kind of “unity” of knowledge describing, however, a messy, complex, unpredictable, indeterministic world.

The presuppositions underlying such a course (or courses, or seminars, or discussion groups), repeating what was said above, are as follows: it is important at an early stage, parallel to rigorous introductory courses of basic science, to show where these rigorous, classical theories fail to explain phenomena and to give the best possible introductory course—non-rigorous as it may turn out—of interesting real-life phenomena which are not covered by the basic courses and for which the students are definitely technically not ready. However, socially, morally and in the extent of their curiosity, they are more than ready.

Introductory courses in the sciences and the social sciences are rigorous, systematic, reductionist, positivist and linear in mode, describing only the regular side of nature or society, of the economy or of the mind. Disorders in the atmosphere, turbulence in the clouds or in the sea, fluctuations in populations, oscillations in the brain or in the heart, non-equilibrium state of the economy, and most other phenomena known from daily life, are irregular phenomena, what is often called non-linear, and classical science or social science has no tools to deal with them.

It is here that a host of new emphases in knowledge become relevant: chaos, complexity, non-linear dynamics, emergence as a general phenomenon in nature or in society. A host of new concepts, indispensable for studying irregular phenomena, like attractors, fractals, bifurcations, nodes, hubs and many others have to be understood. They must become part of the basic literacy of every citizen of the

twenty-first century, irrespective of whether they will be professionally preoccupied with these concepts or areas of research.

It is my understanding of an undergraduate curriculum—or rather of undergraduate curricula—that an introductory course on such matters in the first or the year year has to be taught to all undergraduates, irrespective of whether they will continue in research, in the professions, in the economic/financial sector or in any of the services, or become teachers in elementary or secondary schools, or in community colleges.

To exemplify what I am suggesting, let me mention a few books which could be used in such courses. These are all well-written, introductory—not to say popular—books:

1. James Gleick: *Chaos*, Heinemann, 1988
2. M. Mitchell Waldrop: *Complexity*, Touchstone, 1993
3. Albert-Laszlo Barabasi: *Linked*, A Plume Book, 2003
4. Edward N. Lorenz: *The Essence of Chaos*, UCL Press, 1995
5. Philip Ball: *Critical Mass*, Arrow Books, 2005.

I am sure there are many other books, some even more recent than these, but a look at these will serve to make my arguments clear.

Much of classical science was built on the presupposition that systems can be understood in terms of their constituent parts; systems could be broken down to those ingredients and could be built up again from them. The idea was that the whole could be built up from the parts, and that the whole was neither more nor less than the sum of the parts. In the natural sciences this meant analyzing all kinds of bodies into atoms, nuclei, electrons, and in later developments, into quarks; live systems into chromosomes, genes, neurons. The processes of breaking down to constituent parts, or in building up the whole, was pure reductionism with no place for randomness. The eighteenth-century dream (Laplace and others) of deterministic probability no longer applies.

In a different formulation it could be said: Relativity Theory applies to the very large (way out of the human scale), like galaxies and universes; Quantum Mechanics applies to the very small (way below the human scale), like subatomic particles, while chaos theory, complexity theory (if they can be legitimately called “theories”), deal with objects on the human scale, what real life confronts us with. “Emergence” as a much-studied phenomenon in the life sciences, but also in phenomena that describe process in the physical world, is the prime example for phenomena where the sum is definitely more than just the sum of its parts. Time direction becomes a central concept to be taught at a very early stage, parallel with the Newtonian worldview, even if first introduced more on the intuitive than on the mathematically appropriate technical level.

Classical science viewed the natural world in terms of the second law of thermodynamics according to which all nature aims at ideal disorder; life—which is the most important phenomenon of order—remained unexplained in terms of classical,

Newtonian/Laplacian theory. Classical economic theory—mathematically sophisticated as it may be—deals with a world where the market aims at, and will reach, perfect equilibrium. But the market usually does not approximate equilibrium, as the recent financial crisis has taught us in a bitter lesson. (These examples can be skipped by those readers who are not keen on going into more detail at this stage.)

25.6 A New Introductory Seminar

In what follows I will try to illustrate, albeit superficially, what could be part of such an introductory seminar or discussion group, relying on what was stated above. An obvious beginning would be the so-called “butterfly effect” (also called “sensitive dependence on initial conditions”). Unlike what is presupposed in classical science, small differences in the initial conditions can make enormous differences in all those cases where deterministic numerical forecasting does not hold. Newtonian determinism seemingly works quite well for distant, huge, celestial objects. The closer we get to our daily experiences in life, the less deterministic our forecasting becomes: for stars and comets it works, for clouds and winds it does not. As an early researcher on chaos formulated: “Any physical system that behaved nonperiodically would be unpredictable” (Gleick 1988, 18).

In all model-making disciplines like biology or economics or politics, what usually happens is that if the model predicts absurd situations, the programmers revise the equations to fit the output to the expectations. Especially economic forecasts were blind to what the future would bring while the politicians, for want of anything better, tend to act on those predictions.

Complex behavior is described by non-linear equations:

[...] they were non-linear, meaning that they expressed relationships that were not strictly proportional. Linear relations can be captured with a straight line on a graph [...]. Linear equations are solvable, which makes them suitable for textbooks. (Gleick 1988, 23)

In one of the formulations: in linear systems the whole is precisely equal to the sum of its parts. When the whole amounts to much more than the sum of its parts—most nature is like that—the mathematical expression of this state is in non-linear equations (one whose graph is not a straight line but some kind of curve). (One could study the narrative of the Los Alamos Center for Nonlinear Systems.)

Phil Anderson’s classic paper could be an important source for discussion (Anderson 1972). Probably the strongest statement against reductionism with its claim that the idea of all physical laws, in the final account, can be reduced to one basic law. Raising the question: “how do we know that not all different levels of organization have different fundamental laws, not reducible to each other?” opened up totally new approaches to nature and life.

Stuart Kauffmann's latest book against reductionism might serve as recommended reading (Kauffmann 2008). His previous books (still imbued by a reductionist spirit), about life, the nature of complexity and self-organizing systems might be too technical for this kind of course (Kauffmann 1993, 1995).

The issue of "emergence" with examples from biology and physical systems is important to be studied in an introductory course like this, even if at a non-rigorous level.

Processes where the rules are changing during the process are described by non-linear equations. For example: friction depends on the speed, and vice versa.

Examples should be brought from fluid dynamics and the central equation of this domain, the non-linear Navier-Stokes equation should be explained as far as possible.

A typical course in classical physics will introduce oscillators. Non-linear oscillators are rarely mentioned at all. In such an introductory course they should not be omitted.

Students learn to solve differential equations "that represent reality as a continuum changing smoothly from place to place and from time to time" as one expert has formulated. It is rarely taught to students that most differential equations cannot be solved at all.

Non-technical, low-level explanations should follow the work of Benoit Mandelbrot and his fractals, and also the work of Bourbaki following the intuitions of Poincaré.

Turbulence: to be explained conceptually with as little mathematics as possible at this early stage of studies.

Phase transitions: liquid to gas; unmagnetized to magnetized. To be explained conceptually with as little mathematics as possible at this early stage.

Attractors: definition in an easy, understandable way for beginners; examples for attractors be it a point or a series of points or a line or whatever.

If at all possible, one should find a way to explain to first-year students the concepts of renormalization, scaling, ways to deal with non-linear equations, and so on.

The different definitions of complexity and of self-organization as they occur in the different disciplines should be mentioned, explaining the reasons why different disciplines use different definitions.

An extended narrative of classical vs. new economics—from Adam Smith and Keynes and Schumpeter to Brian Arthur, Joseph Stiglitz, Amartya Sen, Edmund Phelps. Discussion of the basic dogma of the stability of the marketplace and the market's unstoppable aim toward equilibrium, as against its apparent failure. One should not omit the introduction of positive feedback and Brian Arthur's theory of "increasing returns." Also mention should be made of the similarity between biological systems and the market through the concept of self-organization.

Brian Arthur's classic paper in *Scientific American* "Positive Feedback in the Economy" should be read by the students (Arthur 1989).

The narrative of the founding and functioning of the Santa Fe Institute.

Networks: how networks emerge, what they look like and how they evolve. Make the student realize that networks are present everywhere: nature, society, business and so forth.

A good introduction could be the story of Euler and the Koenigsberg bridges, as told by Barabási (2003, 9–13). This would already introduce the concepts of ‘graph,’ ‘node,’ ‘link,’ and ‘network.’

The difference between random networks and the search for organizing principles of networks to be introduced with examples from as many different disciplines as possible.

Introduce the concept of ‘six degrees of separation’ and use Duncan Watts’s book *Six Degrees* (Watts 2004).

In sociology, the students could be introduced to Mark Granovetter’s classic paper: “The Strength of Weak Ties” (Granovetter 1973). This will already show that society is structured into highly connected clusters—it is far from a random universe. Self-organization and nature’s urge to synchronize can be explained here with numerous examples.

The concepts of ‘connector’ and ‘hub’ may be introduced. The presence of connectors (nodes with an anomalously large number of links) shown to be present in all complex systems—economic, biological, social. In the World Wide Web, highly connected nodes are called ‘hubs.’

Introduce and explain with many examples the ‘bell-shaped curve’ (Gaussian distribution), the ‘power law,’ the ‘scale’ and ‘scale-free’ distributions.

Clearly these were a random collection of points to be included in the preparation of a course on non-linear thinking. It would need the expertise of the best scholars working in these areas to tell us how to make them into a coherent whole of an introductory, non-technical chapter to be used for students of the natural and social sciences as well for students of the humanities. The important point is to realize that such a thinking is a fundamental ingredient of any person’s intellectual repertoire if he or she is to get an understanding of our “complex and messy” world.

The greatest obstacle to adopting the approach advocated here is the arguable worry of many scholars that introducing all these important concepts and theories on a superficial level will result in cultivating half-baked ideas. The answer here is that if such “sources” are given parallel to the rigorous, technically sophisticated introductory courses, which however do not apply to most real-life situations, the balance between being serious and scholarly and being popular, relevant and urgent is addressed. On the even more positive side, students’ curiosity about real-life situations with which most of them enter university will be satisfied instead of postponed to graduate studies—a time by which many of the students will have dropped out—intellectually or physically—frustrated by irrelevance and boredom.

As mentioned, I will append to this article the text of a Manifesto on “Principles for Rethinking Undergraduate Curricula for the 21st Century” that were

developed by a group of scholars convening at the Wissenschaftskolleg zu Berlin in the academic year 2009/10 and which is now available on the Web, inviting widespread discussion.¹²

25.7 Curriculum Research and the Future of Higher Education

I will conclude by saying a few words about curriculum research. The notion of curriculum research is almost entirely unknown in most of continental Europe (or in Israel for that matter; notable exceptions are the Scandinavian countries and the Netherlands). It is typically confused with didactics. The United States and Great Britain are among the very few countries where serious attention is paid to curriculum research.

Curriculum research involves the epistemologically oriented study of the foundations of areas, disciplines, or clusters of disciplines, and the utilization of the results and findings of high-level research in teaching and the design of research programs. Without a serious commitment to curriculum research—a complex undertaking involving the concentrated effort of several teams over many years—no university reform can be successful.

The short-term prospects for such an intellectual enterprise are not optimistic. In the wake of the financial crisis, “the gatekeepers” are becoming stronger and stronger and more and more resistant to the idea of change. Therefore universities, by nature conservative, are unlikely to become easily partners for curriculum research and curriculum reform. On the other hand, one encounters in more and more universities and research groups brilliant young scholars who are socially aware, dissatisfied with the pace of change in their institutions, and ready to invest time and energy bringing about the desired changes. Financial support has to come from the outside: from independent foundations, strategic alliances with stakeholders in the private sector, intergovernmental research organizations, and more. At a later stage, the novel curricula will have to be tested at willing universities. Moreover, constructing a new curriculum has to be undertaken by a critical mass of scholars who will work hard preparing such a new type of curriculum and then be ready, each one of them, to teach what the curriculum needs and to give up the privilege, couched in terms of academic freedom, according to which each professor teaches what he/she feels like teaching. It may look superficially like an infringement of their academic freedom—that is why it must be done voluntarily and not top-down. Yet obviously the commitment of university administrations on the level of President, Rector/Provost, Deans and Heads of Departments is a must. This, I believe, is a formidable but worthwhile challenge for the years to come.

Let me end on an optimistic but, I hope, not irrationally optimistic note. Many of the problems I have outlined emerged because many of the “good” young people have tended not to go into politics or into academe for the last thirty

¹²See <http://curriculumreform.org>.

years, but preferred to make money. As a result, the world of academe has fewer doctoral students and gifted researchers and politics has very few genuine leaders and change-makers. Talent has preferred making money on Wall Street or in law firms instead. According to some recent estimates, as many as 60% of the most talented graduates have gone to Wall Street during the last few years. Seemingly and hopefully this bubble has burst.

And another optimistic thought: For the last decade, many thought wrongly that globalization would abolish the nation state and create a kind of cultural flatland using bad English. This has turned out to have been wrong.

Once again, we see national governments and national institutions acquiring new strength in the wake of the global economic and financial crisis. At the same time, the increasing influence of governments will predictably lead to a strengthening of the party system. As a result, many gifted young people who now have nowhere to go will once again choose academe and politics. This may well become the trend dominating the higher education sector in the coming years.

We have some reason to hope that the growing significance and intensity of political life will attract better people, who in turn will turn to the universities again for intellectual ammunition and knowledge better suited to handling today's problems. That could provide new incentives to change the university system and put pressure on the political domain to seriously engage with science, research and universities in a dialogue of equals. If the diagnosis I have sketched does justice to the facts on the ground, then such new incentives and such encouragement will be sorely needed for a brighter future in higher education.

25.8 Appendix: Principles for Rethinking Undergraduate Curricula for the 21st Century, A *Manifesto*

The current crisis of the university is intellectual. It is a crisis of purpose, focus and content, rooted in fundamental confusion about all three. As a consequence, curricula are largely separate from research, subjects are taught in disciplinary isolation, knowledge is conflated with information and is more often than not presented as static rather than dynamic. Furthermore, universities are largely reactive rather than providing clear forward-looking visions and critical perspectives. The crisis is all the more visible today, as the pace of social, intellectual and technological change inside and outside the universities is increasingly out of step. While universities worldwide are undergoing many, often radical, structural transformations, ranging from the Bologna Process in Europe and the Excellence Initiative (*Exzellenzinitiative*) in Germany to the rapid expansion of universities in India and China, the accelerating decline of public investments in universities in the United States and elsewhere and an ever growing demand for university access everywhere, much less attention has been paid to university curricula. But for the university as a community of scholars and students, that is its central function and the key to its internal renewal. Universities are embedded in multiple institu-

tional, economic, financial, political and research networks. All of these generate pressures and constraints as well as opportunities. The curriculum, however, is the core domain of the university itself.

Here we present a set of eleven overlapping principles designed to inform an international dialogue and to guide an experimental process of redesigning university undergraduate curricula worldwide. There can be no standard formula for implementation of these principles given the huge diversity of institutional structures and cultural differences amongst universities but these principles, we believe, provide the foundational concepts for what needs to be done.

1. As a central guideline teach disciplines rigorously in introductory courses together with a set of parallel seminars devoted to complex real life problems that transcend disciplinary boundaries.
2. Teach knowledge in its social, cultural and political contexts. Teach not just the factual subject matter, but highlight the challenges, open questions and uncertainties of each discipline.
3. Create awareness of the great problems humanity is facing (hunger, poverty, public health, sustainability, climate change, water resources, security and so forth) and show that no single discipline can adequately address any of them.
4. Use these challenges to demonstrate and rigorously practice interdisciplinarity, avoiding the dangers of interdisciplinary dilettantism.
5. Treat knowledge historically and examine critically how it is generated, acquired, and used. Emphasize that different cultures have their own traditions and different ways of knowing. Do not treat knowledge as static and embedded in a fixed canon.
6. Provide all students with a fundamental understanding of the basics of the natural and the social sciences, and the humanities. Emphasize and illustrate the connections between these traditions of knowledge.
7. Engage with the world's complexity and messiness. This applies to the sciences as much as to the social, political and cultural dimensions of the world. This will contribute to the education of concerned citizens.
8. Emphasize a broad and inclusive evolutionary mode of thinking in all areas of the curriculum.
9. Familiarize students with non-linear phenomena in all areas of knowledge.
10. Fuse theory and analytic rigor with practice and the application of knowledge to real-world problems.
11. Rethink the implications of modern communication and information technologies for education and the architecture of the university.

Curricular changes of this magnitude and significance both require and produce changes in the structural arrangements and institutional profiles of universities. This is true for matters of governance, leadership, and finance as well as for systems of institutional rewards, assessment, and incentives; it is bound to have

implications for the recruitment and evaluation of both professors and students as well as for the allocation of resources and the institutional practice of accountability. The experimental process of curriculum reform we hope to stimulate by offering these guiding principles will thus require the collaboration of scholars and educators willing to transform their scholarly and educational practices and of administrators willing to support experimentation and to provide the necessary structural conditions for it to succeed.

These principles are the conclusion of deliberations by a working group of scholars that met at the Wissenschaftskolleg zu Berlin during the academic year 2009/10. Some were fellows at the Kolleg, others joined the group because of their interest in these issues. The Wissenschaftskolleg supported the work of its fellows. In addition, these principles have already been adopted by a first group of institutions as a blueprint for local curriculum reform. The group involved in drafting these principles represented diverse disciplines (from the natural and social sciences to the humanities), geographical origins (Europe, North America, and India) as well as career stages (from former university presidents to students). They invite their colleagues around the world to join in this effort of re-thinking and re-shaping teaching and learning for the university of the future.

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