Knowledge Production, Social Change

AND THE FUTURE OF RESEARCH UNIVERSITIES: TRENDS AND CHALLENGES*

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RESUMEN

Con el final de la guerra fría, la política económica neoliberal y los cambios sociales influenciados por el mercado a nivel mundial, las universidades de investigación han perdido la exclusividad de ser los únicos lugares de producción de conocimiento. Centros de investigación en el sector económico y otros grupos de la sociedad cada vez se involucran más en esta tarea para cumplir con los requisitos de la "nueva economía" y los objetivos de desarrollo de la sociedad. Más que nunca, los sectores de conocimiento emergentes van creando alianzas entre los gobiernos, la industria y la investigación en la universidad para producir conocimiento que genere competitividad, creación de riqueza y desarrollo científico-tecnológico. Estas alianzas, a su vez, han transformado las universidades y su relación con la sociedad. En este contexto, este artículo analiza las tendencias y retos de la universidad de investigación y las opciones que tiene para contribuir y cumplir con sus responsabilidades en la sociedad. Se presentan algunos asuntos y propuestas para abrir la discusión sobre el rol y el futuro de la creación de conocimiento académico, el cambio social y el desarrollo de las sociedades del conocimiento emergentes.

Palabras clave: contribución y responsabilidad para la sociedad, economía basada en el conocimiento y cambio social, producción de conocimiento e investigación, transformación de la universidad de investigación, desarrollo sustentable

* Revised paper, originally delivered at the UNESCO Chair Symposium, "La Universidad en discusión", University of Puerto Rico, Rio Piedras, March 2010.

ABSTRACT
With the end of the cold war, neoliberal economic policy, and market driven social change around the world, research universities have lost being the only site of knowledge production, where research centers in the economic sector and other groups of society are becoming more involved in creating and producing knowledge to meet the 'new economy' requirements and society's development goals. More than ever before emerging knowledge sectors are creating alliances between governments, industry and university research to produce knowledge for competitiveness, the creation of wealth and scientific-technological-development. At the same time, these alliances are transforming universities and their relations with society. Within this context, this paper analyzes the trends and challenges of the research university, and the options for its contribution and responsibilities to society. Some issues and proposals are put forward to open up the discussion about the role and future of academic knowledge creation, social change and development in the emerging 'knowledge societies'.

Keywords: contribution and responsibilities to society, knowledge-based economy and social change, research and knowledge production; research university transformation, sustainable development

RECIBIDO: 5 sep. 2014; **ACEPTADO:** 26 may. 2015.

Introduction

With the emergence of the knowledge sector, universities have lost being the only site of knowledge production, since research centers in the economic sector and other groups of society are becoming more involved in creating and producing different kinds of knowledge to meet the "new economy" requirements and society's development needs. In the university, concern about the growth and importance of professionalism and applied knowledge has mounted to the level of 'crisis,' as the academe's identity is being threatened by new governance resource allocation priorities and managerial reengineering, creating uneasiness about the future of this institution. The neoliberal political priority of 'competitiveness' supported by state funding, the economic interest stakeholders, accountability measures, and 'new social responsibilities' of the research university, has driven researchers and academe further into 'market' determinants upon the mission and functions of the university in the 21st century. Resistance without a comprehensive academic rationale as an alternative social

proposal for the university has paved the way for the ongoing trends in research, teaching and learning for technological development and modes of knowledge production, and the provision of services to community that are transforming the relationship between society, the university, academe, and other higher education institutions.

The purpose of this paper is to analyze the trends and issues revolving around the relationship between knowledge production and social change to advance the discussion about the future of the research university in the new context of the 'post-industrial knowledge-based economy' and the emerging 'knowledge societies'. The first part analyzes the dynamics between science systems and social change, state policy and economic restructuring, and the new knowledge production imperatives, their impact in academic identity, research culture, and transformation of the research university. The second discusses the trends and impact of the post-industrial economy in knowledge production in the research universities in terms of structure, organization and research function. In the third, some challenges about the relationship between science, technology, social needs, citizenship and scholarship are identified to develop an alternative scenario for intellectual reflexive-action within and beyond the research university, to enhance the academic community's capacity for action towards building sustainable learning-knowledge democratic societies.

Society, Science and the New Context of Knowledge Production

At the end of the 18th century, the university was on the brink of extinction. Though it appeared unable to cope with the demands of modernization, it was able to reinvent itself and become the embodiment of modernity, science[1] and political democracy. During the last half of the 20th century, ongoing trends in response to social change and pressing political demands —as in the past— evidences another transformation of the institution in late modernity (post industrialism), exacerbated by a new relationship between science, technology and society, fueled, in turn,

by new systems of knowledge production, and the emergence of 'knowledge societies'.

For the last three decades, contemporary societies have been undergoing rapid and profound changes in the economic, political and social structures. In the 1990's neoliberal economic policy and globalization exacerbated competitiveness and a rearrangement of a new world order. Although people were aware of these tendencies and could perceive the next step of knowledge production and its possible consequences, it was not clear what was going to happen inside and outside the universities. Yet, these processes provide the basis for identifying the emergent forces and trends, which are reshaping societies, their institutions and the world, as we know it. Higher education institutions and universities are essential for knowledge-based economies, not only for human resource development —for work—, but because they are important centers for research, science, innovation, technological development and citizenry (Stiglitz & Greenwald, 2014). They also participate in the international knowledge system and play a key role by providing policy research in issues and concerns about the global economy, development, and building sustainable democratic societies.

A group of researchers have documented significant changes in the evolution of the research university as an organization, and in the way scientific knowledge creation is being produced inside and outside the boundaries of institutions in the developed countries and the developing periphery (Drucker, 1993; Gibbons et al., 1994; Etzkowitz & Leydesdorff, 1997; Altbach & Salmi, 2011). These readjustments have been attributed to a structural shift in the economies of developed countries in transition to a post-industrial age, or a learning-knowledge phase of societal development (Stehr, 1994; Jarvis, 2001; Webster, 1995), in which knowledge becomes the prime factor of economic activity and reorganization in an upcoming age of emerging 'knowledge societies'. The preeminence of these developments in Europe and North America has precipitated an ongoing debate about the impact on the nature of scientific knowledge production and the role of the university in society in a context of 'fiscal crisis of the state' and finance, with changes of the criteria for supporting research,

increasing cutbacks in government funding of science and other institutional funding sources (Weingart, 1997; Nowotny, Scott & Gibbons, 2001; UNESCO, 2005).

From the perspective of social change, the transformation of modern society[2] is seen predominantly shaped by scientific and technological innovation (Polanyi, 2001), for which the *socialization of science* has been contingent on the *scientification* of society. In this new development, society has been permeated by science, and in the process, the culture of science —autonomous, reductive and self-referential— has been transformed into something different, a *culture of research* —that is populist, open and pluralistic— in which the social has been absorbed into the scientific. Hence, the relationship between science and society —that portrays the former as certainty, straight and detached, and interacts with *research,* which represents uncertainty, involvement and risk— has changed the interaction between them to become a collusive one, where the interplay becomes involving and an ever ending controversy (Latour, 1998; Nowotny et al., 2001).

The relationship between society and science is changing the context of science and research, which depends on a more radical notion of the articulation between them. The crucial issue is whether the idea of *contextualized science* —post academic science (Ziman, 2001)— is perceived as substantially different from previous ideas of science and consequently more threatening to the scientific method. The rigor and robustness of the scientific practice depends on how this context that is society is defined.[3] The argument put forward in society's transformation (Gibbons et al., 1994; Gibbons, 1998) is that the relationship of science and modern societies during the last century was determined by a research culture associated to a context of scientific and humanistic knowledge creation, transformation and production (mode of knowledge production I) in the universities (academic science), with the corresponding scholarly inquiry and academic formation practices (Ziman, 2001).

Thus, ongoing societal change, fueled by the dynamics of 'market-driven' research and development (R&D useful-applied knowledge), and in turn exacerbated by technology and communications innovations, are displacing, in funding priorities,

discipline-based and scientific research practice in the university. This is becoming a ubiquitous and institutionally de-contextualized activity (Ziman, 1996), known as mode II of knowledge production, which has accelerated changes in society beyond the categorizations of 'modernity' into discrete domains such as politics, culture, the market, and, particularly, science and society. Then, under conditions of the second mode of knowledge production, science and 'late modern society' (post-industrialism) have become transgressive arenas, co-mingling and subject to the same transformative trends (Nowotny et al., 2001; Linderstein-Walshock, 1995).

The climax of modernity's "industrialism," with the belief in planning in society and the predictability in science, is long past. This, together with evidence-based research, demonstrate the survival of the residues of the belief of predictability, as well as the simple cause-and-effect relationships embodying simple implicit assumptions about their linearity, instead of relationships that are not linear and subject to ever-changing patterns of unpredictability. In short, the coincidence between degree of order, control and the political world order is remarkable —the search for control and the belief in predictability that have guided the modernization project from the beginning. The clock and later the machine of industrialism became the guiding metaphors and dominant iconography of modernity's political order. Moreover, modernization was no longer attributed to the "hidden hand" of the market; instead, it was the affirmation of the human control over nature ad society.

Henceforth, science has developed faster in the context of a different knowledge production system and its relation to societal change. On the one hand, the development of open systems of knowledge production and, in the other, the growth of complexity in society, have increased 'uncertainty' in both the scientific and social systems. Therefore, a regularity that was limited—because the less predictable was regulated to the fringes of both systems, but also generalized (and because, apparently, it was governed by rational rules and universal laws)— has increasingly decayed. The context has been superseded by an unpredictability that is unconstrained (because the social is no longer confined to the

instrumental-rational arena). Science too has burst its positivistic bounds due to the intensity and pervasiveness of social and scientific change. Those have turned them into sensitive and susceptible 'local environments'. Thus, the categorization of human enterprise produced by the successive revolutions of modernity (scientific, political, industrial, urban and cultural) around which the contemporary world is organized, now appears to be in flux, eroded or socially contested, a trend in which it is difficult to distinguish between the domains of the state and the market, between culture and mass media, between public and private arenas. Science is increasingly challenged by forms of knowledge production, which are subsumed under the term 'research and development' (R&D), epitomizing its potential for innovation and exhibiting its seductive attraction to politicians and policymakers (Nowotny et al., 2001; Foray, 2004).

Regarding the state, the political formation is undergoing a series of transformations at least in five dimensions:

1. The nation-state, embodying ideals of bureaucratic rationality, undermined by the forces of individualization and globalization, making centralized bureaucratic rationality and state regulatory power dysfunctional.
2. The demarcation between the public and the private spheres, because of the privatization of public services and utilities, where the state redefines its role in 'market terms' as the purchaser of goods and in the provision of services.
3. Due to its relative power in relation to globalization and market determinants, the state has abandoned the responsibility of seeking full employment, to develop progressive social policies and to build technology infrastructures; it has taken on characteristics of the market norms as well as forms.
4. Under the recurrent fiscal crisis (O'Connor, 2001), the state has been pushed into arenas once reserved to the individual and the market; politicians are required to have views on almost everything, and to take appropriate actions.
5. The advance of science and technology has enlarged the domain of the 'political', creating the need for new regulations and regulatory frameworks (the new accountability—re-engineering and 'managerialism' of the public sphere),

regulations that are preceded by negotiation, mediation, consultation and contestation that take place in the public arena.

As a result of these trends, polity (state) and the economy (market) have become 'transgressive' arenas, penetrated by the market, social movements, individuals' responses by consumers and citizens, and fueled by the information-communication technologies and mass media (Hall, Held, Hubert, & Thompson, 1995; Nowotny et al., 2001). In short, the state has taken three forms: the erosion of the public service, ethics and its replacement by a "business" discourse still in search of an adequate instrumental ethic as it correlates to business performance. This reflects the 'new market roles' undertaken by the provision of health and higher education systems.

In the economic sector (labor, commodities and services):

1. The 'market' has become increasingly insubstantial of meaning, and a metaphorical wide range of social, political and cultural activities.
2. Market exchanges have accelerated and become instantaneous. Global brands, ephemeral images, and "virtual" products have become the dominant outputs and inputs of the market. At the micro level, exchange is deeply engaged with individuals' perceptions-preferences, while the overall allocation of resources and rewards takes place at the macro level.
3. The dynamics of 'instantaneity' is displacing previous demarcations between producer, supplier, distributer and user. It has broken down, and products can be redesigned and re-engineered to match consumer preferences-specifications, transforming the balance of social and economic relationships.
4. The market has invaded individual and groups intimacy with the 'commoditization' of family life and intimate relationships, eroding previous shared values, beliefs and social boundaries, for which the growth of new technologies plays an important role in making the 'market' global and personal.

Furthermore, culture has become a 'transgressive' domain. Individual creativity is bound together by creation and dissemination, and it no longer flourishes within a segregated territory; instead, it is now linked to the process of innovation. Symbolic objects and forms of communications become the staple material of the advertisement industry, as art arises in everyday life as powerful as in designated cultural arenas, where culture is contextualized, appropriated and disseminated. With the transformations in the state, market and culture, new dynamics of social change have emerged with categorizations that share similar trends, but lack clear boundaries (Gibbons, 1998; Power, 1999; Nowotny et al., 2001).

The dynamics of knowledge production systems, innovation and market-driven social change

The trends in the relationship between science-research and society are shaping the context of knowledge production in higher education institutions. Science has the capacity of creating novelty that, nowadays, receives more importance; society acknowledges it and is willing to exploit this function to pursue priority socio-economic goals (where combining capital and labor with knowledge production has strategic value and has become an intangible asset). *Innovation* has secured an urgent need for propelling a country, an industry, a company, a laboratory, a research field, a university or a national science system (Didriksson, 2009; Nowotny et al., 2001; Lindestein-Walshok, 1995; West, 2007). It is the connecting node that binds them together. This unrestrained belief in innovation has led to the notion of "without innovation, there is no future" (Atkinson & Ezell, 2012). The belief in creativity-innovation, which binds together the many interfaces between science, technology and society, and the world of finance, politics and the domain of everyday life, creates the conditions for shaping up the relationship between science, society and knowledge systems (Peters, 2013).

Within this context, 'research and knowledge production' are "valued more than science", and have become the new priority in funding —public and private— knowledge production systems. Its capacity to unfold unexpected novelty findings of research are

most valued by policy makers, researchers, media and the general public. Since research cannot exist without science, the university infrastructure, the academic formation of new researchers, as well as the creation, transformation, systematization and differentiation of knowledge, excel as a primary knowledge production system site. Among all these systems, universities are key institutions because they produce knowledge and form new home base of both science and research. They remain as the largest place for training scientists, and forming scholars, experts and professionals sufficient enough to sustain science, technology, medicine, and the communications system.

These trends, associated to the development of the mode of knowledge production II, are replacing the mode of organized modernity, and are characterized by the emergence of many knowledge producers working in the context of application, which is problem solving, oriented and specific. In this transformation context, the university is no longer the only site of knowledge production, having been challenged by knowledge producers' outside the institutions realm. Disciplinary boundaries are becoming blurred, as 'transdisciplinary' becomes the norm in late modernity (post-industrialism). As in the beginning of modernity, the relation between science and the social is transforming societies in an age of permanent learning and accelerated contextual knowledge creation, dissemination and use (Delanty, 2001; Ziman, 2001).

Knowledge production and the 'knowledge-based economy'

Knowledge has been at the core of economic growth and the rise in levels of science and social well being since the beginning of society. Nonetheless, 'knowledge-based economy' is a recently coined term (Machlup, 1962; Polanyi, 2001; Bell, 1974; OECD, 1996). Knowledge and innovation, as well as information and communication technology, have had a strong repercussions on many economic sectors, such as healthcare, transportation and finance. The emphasis on knowledge as a crucial driver of economic growth and development has set a new scenario for the education sector in all its levels. Education is a prerequisite of the knowledge-based economy, and has become essential because: i) the creation,

transformation, production and use of new knowledge requires a more educated (lifelong) citizen and workforce; ii) information and communications technologies have become a fundamental aspect of the education process; iii) it complements and induces innovative teaching and learning practices with different modes of engagement and cognitive structures (UNESCO, 2005).

More recently, disparities in the productivity and growth between countries have less to do with their abundance or lack of natural resources, than with the capacity to improve quality of human resources and other factors of production. Instead, it creates new cognitive structures for learning, for creating ideas and knowledge, and incorporates them in infrastructure and people. Since the second half of the last century, an associated characteristic of growth is the increasingly relative importance of intangible capital in total productive wealth, and the rising relative share of gross domestic product attributable to intangible capital. Investment is geared to the production and dissemination of knowledge —education, technical training and higher education—, research and development (R&D for patents, intellectual property), information and coordination. It is also allocated to sustain the physical state of human capital (health and welfare expenditure), which began to outweigh that of tangible capital (physical infrastructure and equipment, inventories, natural resources) by the end of the 1960's (Abramowitz & David, 1996; 2000; Pikety, 2014; Stiglitz & Greenwald, 2014).

The underlying trend must not be allowed to obscure the growing importance of activities related to science and technology. Knowledge economies are not restricted to the realm of high technology, but science and technology do tend to be central to the new sectors giving momentum to the upward growth of the economy as a whole over the past four decades. These developments are reflected in an ever-increasing proliferation of jobs in the production, processing and transfer of information and knowledge, i.e. lifelong learning-knowledge workforce. The tendency is not confined to the high technology, or the information and communication service sectors, as it has gradually spread across the entire economy. Hence, society as a whole is shifting to knowledge-intensive activities of permanent learning, accelerated

knowledge creation, dissemination and use in emerging 'knowledge societies'.

A distinction between *knowledge* and *information* must be drawn. The former empowers its possessors with the capacity for intellectual or physical action, to which knowledge fundamentally is a matter of 'cognitive capability', while the latter takes shape of structured and formatted data that remain passive and inert until used by those with the cognitive structures and knowledge needed to interpret and process them for different purposes and applications.

There are least four types of knowledge: know-why, know-what, know-how, and know-who (Lundvall & Bjorn, 1994; Malecki, 1997). These possibilities emerge from combining the dyads of form —codified or tacit— and structure, as residing in individuals or the collective. Know-why knowledge is codified and collective, while know-what knowledge is codified and individual, know-how is tacit and individual, and know-who is tacit and collective. Each type of knowledge has specific features. Know-why refers to scientific knowledge, which for the most part is undertaken globally in public funded universities and research institutes; it is subsequently codified and published. Know-what refers to knowledge about the facts and techniques, which can be codified and transferred through the commercial marketplace. Know-how refers to the combination of intellectual, educational, and physical dexterity, skills and analytical capacity to design a hypothesis-driven protocol with a set of expected outcomes, which involves the ability to combine the know-why and know-what to innovate. Finally, the know-who involves information about 'who knows what', and who 'knows how to do what'; it is becoming increasingly important nowadays, i.e. the cognitive, digital and knowledge gaps (OECD, 1996; UNESCO, 2005; Phillips, 2012).

Knowledge based activities (scientific, economic and social) emerge when people, supported by information and communication technologies, interact in concerted efforts to co-produce (create and exchange) new knowledge. This entails the combination of three elements: 1) a significant number of people to produce and reproduce knowledge with diffuses sources of innovation, 2) a group to create a 'public space' for exchanging and circulating

Table 1

The Post-industrial Trends: The 'Knowledge- Based' Economy and Neoliberal Market-Driven 'Knowledge-Societies'

Knowledge-Based Economy	Emerging Knowledge Societies
Production and services based on knowledge—intensive research activities that contribute to accelerate (an unprecedented) speed at which knowledge is created and accumulated; most probably, depreciates in terms of economic relevance and value.	Production and distribution of knowledge and information products.
Increase in knowledge production and users; creation of new ideas that are then embodied in products, processes and organizations.	Proliferation of jobs in the production, processing and transfer of information.
Increase of innovation policy (I&D) as a strategy for economic growth and development.	Greater reliance of knowledge on intellectual capabilities than physical inputs and natural resources.
Distribution of knowledge and of competencies required to generate it has an impact on the efficiency with which knowledge can be generated.	Information technology and the internet as knowledge infrastructure.
Broader scope and significance of intellectual property.	Internet-enabled explosion of learning by doing, tacit and codified knowledge.
Recognition of intangibles as sources of value and liability.	Knowledge production, appropriation and the competencies to generate it are not solely of individuals, but of institutional or collective groups.
Disaggregation of the enterprises and the emergence of 'global markets' for knowledge and technology.	Development of 'knowledge management' as a practical trans-disciplinary field.
Increasing of knowledge production and technology users —have 'spill-over' effects of knowledge distribution over other sectors of society and beyond.	Increasing movement, creating, sharing and using knowledge in networks, across boundaries and between country regions, and among sectors of societies.
Knowledge-based economies generate greater degrees of wealth than industrial economies.	Knowledge production-distribution depends more upon scientist, experts and researchers such as engineers, professionals, educators and innovators-inventors.

Sources: Castells, 1994; Power, 1999; Aponte, 2002; UNESCO, 2005; UN, 2005; David & Foray, 2007; Stiglitz & Freeman, 2014.

Table 2
Characteristics of Modes of Knowledge Production I and II

Mode I	Mode II
Homogenous and relatively autonomous; knowledge is created and disseminated within the university and peer community. Problems arise and are researched/solved within the disciplines and between them 'interdisciplinary'/governed by the interest of a specific community of scientist and academe. Disciplines have clear paradigms to work within; a linear relation is aimed at some instance between theory and practical problem solving, and between basic and applied research. There is a homogenous relation between conceptual experience, qualification and practical experience, i.e. the possibility of one to one relation between discipline and a profession. Structure and organization of authority is hierarchical. The notion of quality is internal and oriented towards the discipline and functions/responsibilities with peers. Technology is an applied science. Risk is understood as quantified 'uncertainty' and can be managed through insurance. Teaching and learning are united in the institution. Learning and knowledge production are different in nature; learning (academic formation) is 'transfer', and (research) knowledge production is 'discovery' or perception. Learning takes two forms in the economy, related to the division of labor: planning and professional performing tasks. Value creation takes place applying knowledge to processes and products.	Heterogeneous, reflexive and more socially accountable. Problems arise and are researched/solved in the context of application. Production of knowledge takes place within the trans-disciplinary applied research framework and fluid processes. The relation between theory, experience and qualification is heterogeneous. Communication and application of knowledge takes place in the context of production. Organization is transient and structure horizontal, flexible. The criteria of quality are more dependent on social relevance, utility and value, and improvement. Technology is an independent knowledge regime, instrumental, social and 'second order'. Uncertainty is a condition; risk is socially created, and crisis brings opportunity for inventiveness. Teaching and learning are fragmented-separated-distanced from the institution. Learning and knowledge production takes place on sites and are closely connected to having and developing a meaningful contextualized experience with new cognitive structures. Learning and knowledge production are connected to developing expert systems to transform tacit to explicit knowledge, to work with knowledge to solve problems. Value creation is related to the application and production of knowledge, and in the form of organizational learning.

Sources: Gibsons et al., 1994; Nowotny et al., 2002; Ziman, 2001.

knowledge, 3) a means where information and communication technologies are intensively used to codify and transmit the new knowledge. 'Codification' plays a central role in the diversified knowledge sector as it becomes the way for further memorization, communication and learning, which form a sound basis for the creation of new knowledge objects (David & Foray, 2007). Formal research may remain the cornerstone of knowledge production in many sectors (for the simple reason that it provides a more or less sheltered domain in which to carry out experiments that otherwise would not be possible in real life), while knowledge production is becoming more widely distributed across a host of new places and actors. Moreover, 'innovators' —users as a source of innovation— tend to be and are appearing in unexpected situations and lay people in the production of 'scientific knowledge', including such realms as health and the environment.

Rapidly changing technological and economic conditions make the before mentioned trends more complex and difficult to analyze. Knowledge has become more important, multifaceted, and multivalent than ever. In relative terms, less is known and less known about more, yet specific change trends demonstrate the growing significance and relevant policy perspectives on knowledge as can be summarized in Table 1.

Although mode I and II have coexisted for some time in the university, the latter has become more pervasive (market-driven) and is displacing the research orientation in funding and priorities in the institutions. The difference between both modes is shown in Table 2.

Knowledge production, relevance and the university

The new mode of knowledge production has implications for all the institutions of society, whether universities, government, or industrial laboratories that have a stake in the production of knowledge. Although there is no imperative to adopt relevance (context, norms and values) of the new mode, if institutional goals are to be achieved, the rules of organizing and governing research, teaching, professional development, and the social and technical determinants of competence will need to be modified to the extent that the new mode becomes established in a

particular context. This shift will be determined by the degree to which mode I institutions wish to adapt to the new situation. Some universities are already long way along the path of change in the research culture, moving from "publish or perish" to "partnership or perish". Some examples of these trends are 'triple helix', a nonlinear spiral strategy of knowledge production and innovation, with 'strategic alliances' between universities, industry and government (Lindestein-Walshok, 1995; Clark, 1998; Etzkowitz & Leydesdorff, 1997). A more recent one is the "corporate university" for enhancing knowledge production on site and the development of a world-class work force in "corporate universities" partnerships, among others (Meister, 1998). Hence, mode II is not supplanting mode I; rather, is coexisting and supplementing it with external funding. The former constitutes a distinct mode with its own set of cognitive and social norms, which are different from the first, making universities and other higher education institutions a colluding, more open space for 'reflexive' public debate and social change proposals.

Since knowledge production is becoming less and less a more contained activity, in the new context relevance is meant to be an array of things for universities. In its operational terms, relevance means, 1) being able to interact closely with other knowledge producers, and configuring resources around different problems according to the dynamics of the particular problem context; 2) become competent at creating a presence for themselves within that range of problem contexts that facilitate the attainment of the institutions goals, and 3) increase capacity to bring collaboration and the use of shared resources into the core of the institutions' value system. This transformation will require a substantial reorganization of universities (Gibbons, 1998) regarding research, teaching practices and collaboration; alliances, partnerships and networks; curriculum, allocation of resources and priorities; governance, internationalization, 'continuous quality improvement', provision of services, institutional accountability and social responsibilities (Neave, 2000; Delanty, 2001). The interrelationship and dynamics between the universities are shown in Table 3.

The interaction of both modes is being underpinned by the fiscal and financial crisis. Decisions at the institutional level are

Table 3
Interrelationships of Mode I and Mode II: Organizational Change and Research Practices in the University

Mode I	Mode II
Disciplinary knowledge specialized research practices and academic – disciplinary professional knowledge formation of 'why', for 'what,' and 'how' to do within the identity, mission and goals of the institution.	Trans-disciplinary specialized knowledge programs and research problem solving practices within the context application; academic-experts formation of 'why', 'how to do', 'when', and 'where' to create and apply knowledge with the corresponding competencies within the purpose of its application.
Knowledge creation-transformation and production within academic/professional programs; alliances with government/industry/services; structured programs with degrees.	Knowledge production in alliances-partnerships in the context of application with universities, industry, government, experts and other knowledge producers, users and systems; flexible programs certifying expertise and outcomes.
Academic knowledge/professional competencies for research, planning and work performance.	Applied knowledge and competencies for problem solving using information, data, networks and strategic communications systems within the context of application.
Autonomous institutions accredited and certified from outside by stake holders/interlocutors according to efficacy and mission accomplishment.	Validation and certification of responsiveness to society's demands for different knowledge production and application outcomes in relation to political, economic, social and cultural goals.
Research capacity to secure institutional and external funds for knowledge creation, transfer and dissemination.	Applied research capacity for integrating and using resources from different knowledge producers-users in different knowledge production-application sites.
Knowledge creation and transformation for forming scholars, researchers and professional practitioners for the continuity of academe, the university as an institution, and for providing expert services that will contribute to society's development aspirations.	Knowledge production capacity to sustain scientific, technological, communications, health, education and welfare systems according to society's development strategies and goals.
Knowledge production in terms of 'social value creation' and the contribution of the institution is seen more in the medium or long-term through contributions to problem solutions and the individual services spill-over-public good effects on societal development.	Knowledge production and application are short-term oriented; 'creating value' through innovations-problem solving applications is the central purpose and finality of a socially contextualized research activity.
Knowledge creation is seen as more autonomous 'detached' from society and less socially accountable.	Knowledge production is seen as "more accountable" and penetrated by 'market determinants', users' needs and social demands.

Sources: Gibbons et al., 1994; Nowotny et al. 2001; Aponte, 2002; Hessels & van Lente, 2007; Siggard, 2004.

being handle through 'managerialism' and budgeting 'accounting' measures, rather than promoting harmonious institutional change. This is creating greater uncertainty, more controversy, resistance and obstacles in the interaction between the six cultures of academic community (Deem, Hillyard, & Reed, 2007; Berquist & Parlak, 2007; Tierney & Hentschke, 2007), a scenario more open and a contested terrain for transforming the university that will determine its development in the future.

Knowledge production, society and the impact on the research university

The impact of knowledge production has shaped trends that are reflected in competing accounts of societal change because a mode II-oriented society can be conceptualized in different ways, two of which are: 'learning-knowledge societies' (Stehr, 1994; Aponte, 2002; UNESCO, 2005; UN, 2005; Aponte-Hernandez & Molina-Iturrondo, 2008) and 'risk societies' (Beck, 1992). Another label of this change, 'the information society' (Bell, 1974; Castells, 1994), which comprises discourses about the future of socio-economic development, derived from the political economy of information and communications technologies. The neoliberal 'knowledge society,' an OECD/World Bank conceptualization (OECD, 1996; IBRD, 2002, 2007), entails knowledge production as the scientific-technical-economic emphasis in post-industrial market-driven knowledge production (I&D), while the 'risk society' is conceptualized around the socio-cultural consequences and interaction of those who are affected as consumers and citizens, patients and clients, experts and lay people.

The theorization of mode II is characterized by reflexivity, transdisciplinarity, and heterogeneity. The essence of this theory of knowledge is that the university will not dominate the field of knowledge production as in previous times of modernity (mode I), and accordingly will go in decline. Although the argument supports the "trend", recently researchers are contesting the core facts on behalf of knowledge production mode II regarding 'science systems' and the social responsibilities of universities. However, the central point (Nowotny et al., 2001) is that, as a result of changes in the relation of the state to the economy, and to changes in the

relation of technology to the economy, the 'ethos' of knowledge is quite different from what it was in the enlightenment period (Nowotny et al., 2001). Knowledge then is seen as more democratic and socially accountable because users are increasingly becoming involved in the actual production of knowledge (mode II), thereby making it 'more relevant' to contextual applications. This leads to the end of the enlightenment conception of knowledge, instead of considering this process one of a major transformation. In that shift, there are continuities and discontinuities of the trends, in which the university can become an important mediator between 'producers' and 'users' of knowledge, thereby contributing to citizenship. As knowledge production moves out of the university, and a range number of users become involved in the nature of knowledge, the university is compelled to occupy the ground of 'public reflexivity' (Delanty, 2001), where the 'reflexivity' of market client-determinants, and not the 'public,' dominates (Nowotny et al., 2001).

Here, three developments of the relationship between knowledge, state and society have to be reconsidered. First, the nation state has entered a crisis (fiscal and resource allocation) during the economy's transition to post-industrial knowledge-based activity and the mobility of global financial capital. In this view, the nation state is no longer the primary site of economic management and integration. This is the result of economic restructuring (Castells, 1994; Wallerstein, 1991) and globalization, where these processes have challenged the logic of the prevailing nationalization, leading to a gradual 'denationalization of science' (Crawford, Shinn & Sörlin, 1993) and its effects —communications, capital mobility, and work— in the world knowledge order, and on the internationalization (Scott, 1995) of higher education. Second, the patterns in knowledge production has entered a 'crisis' for reasons extending to the role of the state, with its retreat as the primary provider and financier of knowledge, and an increase in new providers (universities, culture centers, medical institutes, heath centers, among others). This presents a new context where knowledge production is shifting away from the university to a range of locations, such as specialized research centers, industrial laboratories, 'think-tanks', consultancies, and so forth. Lastly, there are new links between

society and knowledge, in which the latter is becoming a terrain of conflict in late modernity—post-industrialism.

This is a scenario where knowledge and higher education are being democratized since they have become accessible to more people, turning into a major place of contestation. This development can be understood as the 'reflexivility' of knowledge, or the reflection of knowledge upon itself and its conditions of existence, i.e. the epistemological core of mode II (Delanty, 2001). Underlying these developments is a dual process of globalization and fragmentation. Knowledge is increased, globalized (Stiglitz, 1999; UNESCO, 1998, 2009) and detached from its traditional reliance on the nation state and its custodians-academe; in the other, it is fragmented, losing its ability to provide a sense of direction to society and breaking up into specialist discourses that arise in the context of application by 'market' and social determinants. Reflexivility in science is mirrored in growing 'reflexiveness' in society, which in turn grows distrustful as organized science. Science has entered public discourse as a critical force in the crisis of the 'risk society' (Beck, 1992), as a result of its rationality. This reflexive moment refers to 'the articulation of crisis' and social construction by processes that are far from being under the control of any social actor, and in which the university occupies the space in the production and dissemination of knowledge. As the university loses the exclusive role in the production of knowledge, it increases its role in the communication of knowledge. Thus, its future lies in preserving this relatively non-institutional space.

As a result of the weakening of the self-legitimatization of 'academic science' with the erosion of the notion of unquestionability of knowledge, it is no longer credible where more social actors are involved in defining the problems and the applications of solutions (Ziman, 1996, 2001). What these trends mean is that the 'end of knowledge' (Barnett & Griffin, 1997) is associated to the enlightenment in which the autonomy of knowledge has an emancipator role to play—as coherent, autonomous, transcendent, self-referential—conferred upon the idea of 'modern university' (Newman, 1996). A notion where the intellectuals were the custodians and institutional holders of universalistic notions of truth, morality, reason and humanity, defined the fields of

knowledge, which is not coming to an end, but changing and transforming into another emerging 'new idea of the university' and of the institution in late modernity, i.e. post-industrialism. Hence, knowledge nowadays has ceased to be outside of society, and is being shaped by many social actors—beyond multiversity—under the essential, contestability of truth in the public sphere of postindustrial society (Neave, 2000, 2002; Delanty, 2001).

Nonetheless, the theories about the university suggest that nowadays it is in a better position than before to resist and handle some of the more 'instrumentalizing aspects' of the transgressive mode of production II. Despite some of the claims about the mode II of knowledge production for the university, it has not only survived, but also expanded. While the argument of mode II is becoming an increasing phenomenon, the university i) still is the most important knowledge dispenser of credentials and, ii) is arbiter of cultural capital (Bourdieu, 1988), such as social status. The issue is whether mode II within the university can be a sound basis of the technological citizenship, and whether embracing the user will allow technological innovation to be shaped by the demands of citizenship. Universities are more equipped for this task than other organizations.

The emergence of 'learning-knowledge societies' in developed countries signals, first and foremost, a transformation in the structure of the economy and society. Change in the economic structure represents a shift away from an economy driven and governed by material inputs into the productive process and its organization, towards an economy in which the transformations of productive and distributive systems are increasingly determined by learning-knowledge-based inputs. This process includes the dematerialization of production that represents diminished constraints on supply, lower and still declining cost, a redefinition of the social functions of time, place, and the increasing acceleration of change.

The structural change of the economy and its dynamics increasingly reflects that knowledge is the leading dimension in the productive process, as well as the primary condition for its expansion and for a change in the limits of economic growth in the developed countries. In this context, the research university

produces four kinds of knowledge, to which correspond four knowledge producers: 1) research that pertains to basic research (mode I) and the accumulation of information; 2) education which relates to human experience and the formation of personality (known as Bildung); 3) vocational training and accreditation for professional life, and 4) the intellectualization of society (known as Ausbildung). Corresponding to each of these are the roles of the research-expert, the teacher, the professional and the intellectual. With respect to citizenship, the domains of education, intellectual inquiry and critique relate to 'cultural citizenship', while the domains of research and professional training relate to technological citizenship (Delanty, 2001; Phillips, 2012). The fulfillment of these two kinds of citizenships constitutes the social responsibilities of the research university (Neave, 2000).

Thus, in the emergent learning-knowledge societies, most of the wealth of an institution or enterprise is embodied in its creativity, innovation and knowledge creation capacity. In the prevailing scenario, this transition can be summarized in the following trends (Stehr, 1994; Gibbons et al., 1994; Lindestein-Walshok, 1995; Nowotny et al., 2001; Aponte, 2002, 2015; UNESCO, 2005; Stiglitz & Greenwald, 2014):

- Development of a learning-knowledge based-economy, research and intense application of knowledge, and intensive use of new technologies in economic activities.
- Penetration of scientific applied-knowledge not only to production, but also into most spheres of citizen social interaction.
- Increasing number of industries involved in knowledge creation, development and application outputs—ideas, marketing concepts, computers, etc.—and growth of occupations involved in activities to assist knowledge generation and application—such as designers, engineers, lawyers, accountants, among many others.
- The increase of research in leadership and management issues, and the significant experience-based, action-centered problem-solving and decision-making in economic activities, social institutions and everyday life.

- The transformation of the political system by an increasing population of knowledgeable professional-experts, and citizens.
- The rise of specific areas of expertise and changes in the corresponding institutions based on deployment of specialized and contextualized knowledge production based on creativity, innovation and organizational learning.
- The increase of open interaction at real time with global reach communication networks between social, cultural, religious, ethnic, plural interest groups.
- The increase of learning-knowledge network production, distribution and users of information technologies and communication networks in society, between sectors, among diverse social actors, and beyond boundaries.
- The increasing involvement of diverse stakeholders, exclusion of some social groups and lack of participation of others as a result of 'competitiveness' and accelerated 'marked driven' social change; asymmetrical relations between countries widening of cognitive and knowledge gaps, digital divide and marginalization of some population groups, regions and countries.
- The emergence of uncertainty, risk, vulnerability, pervasive inequality and social fragility as basic attributes of neoliberal economic policy, the rise of complex organizations such as government, industry, and international organizations.
- A shift in the nature of social conflict from struggles about poverty, the allocation of income, and property to generalized human needs, environment, sustainability, inclusion and social justice movements.
- Increase of the 'social responsibility movement' in universities, industry, business, government institutions, civil society and the international community.

In this complex scenario of opposing trends, far from being two independent phases of knowledge production, mode I and mode II regularly are interdependently-connected creation forms of knowledge production coexisting in the university with outreach to the economy and others actors of the emerging 'knowledge sector' in society. The 'new relations' of knowledge

production bears several important similarities to those that are obtained in other parts of the industrial economy and not necessarily shown only in postindustrial societies, and to some extent in the periphery of core-center economies (Europe, Asia, North America, and in regions such as Mexico, Brazil, Chile, Argentina, Puerto Rico, Cuba[4], among others). Some characteristics are being seen in developing countries where the globalization process is shaping up local economies, impacting population groups, institutional configuration and citizenship interaction.

The implication for the so-called "crisis in the university" has shown that the challenge posed to them by the increasing mode II of knowledge production will demand major adjustments to the present day structure, organization and research culture. What is unclear is who should be forging the visions, and whose interest these will serve under neoliberal or socially oriented policies. Nonetheless, if universities are to continue to make contribution to industrialized societies, they will have to participate more actively in achieving society's social and economic development goals while maintaining their strengths as centers of scholarship and research.

The Research University and Emerging 'learning-knowledge societies': The Challenge Ahead

In learning-knowledge societies, universities are not solely the only knowledge producers, for it is being produced or shaped by many other social actors. The research university still is one of the most important producers, but not its main user. The latter extends over a wide range of institutions and social groups. However, the institution still remains as the most important center for educating researchers and scholars for higher education and citizenship, as well as for training professionals, experts and artists in the global community.

Even in a mode II society, in most countries universities still retain a legal control of making academic rewards where formal certification remains important and associated with higher education degrees.

In terms of knowledge production and codification, universities are important as sites where knowledge gains can be

consolidated, stabilized, a task which assumes even greater importance in a volatile and risk society (Beck, 1992; Nowotny et al., 2001). Knowledge is central to the new economy, to the telecommunications systems, technological systems, politics and everyday life. Moreover, 'learning-knowledge society' is also characterized by the extension of knowledge into the cultural domain—where it is produced and used within publicly structured communication. Transformation of the cultural models is one of the university tasks, and it can only succeed if as many voices and groups representatives can be 'included'. This is an area of cultural contestation that is particularly relevant to the university as an institution concerned between knowledge and cognitive structures. The nature of 'learning-knowledge society' refers to a situation in which cognition and knowledge is being used to produce knowledge, and in which the knowledge production conditions are not controlled by the mode of knowledge itself. In this reflexive application of knowledge to itself, something else is also being generated—the creation of new cognitive fields to create new knowledge (Delanty, 2001; UNESCO, 2005;Stiglitz & Greenwald, 2014; Aponte-Hernández, 2014).

Moreover, the nature of learning-knowledge societies, cognitive processes and identities not only produce knowledge as context, but also give rise to new cognitive structures and identities. It is a more far reaching epistemic shift in horizons in which the role of the university is enhanced, since it occupies a space where different discourses interconnect different modes of knowledge embodied by a whole array of social actors, i.e. the theoretical basis of a communicative understanding of the university (that produce cultural models and knowledge, where the latter is becoming more reflexive) is so far a site more linked to communication and networks.

Thus, the challenge of the university is to have a critical and hermeneutic role in the orientation of cultural models with the capacity of giving post-industrial society cultural direction, as the church and the state did in previous periods of modernity. Its first and most important mission is the transformation of the cultural models, where the institution extends beyond knowledge production to participate in the broader creation of cultural production,

i.e. 'cultural citizenship'—the relation between 'self and others', that is the rule of governing membership of a cultural community. This is an area of cultural contestation relevant to the university concerning the encounter between knowledge and cognitive structures. Its second mission is to make a contribution to what has being called a new 'multidimensional citizenship,' in which the political and social citizenry now complement with 'cultural' and 'technological citizenship'. It relates to the dynamics of culture and forces unleashed by technological rationality in the media, the environment, the Internet and information technology; biotechnology, food, water, health and the accompanying discourses of creation-user-consumers rights. Many of these kinds of rights will increasingly depend on new technologies that will in turn shape the discourse of 'citizens rights' (Barnett, 2005; Castells, 1994; Delanty, 2001; Aponte-Hernández, 2014).

Hence, the challenge facing the university is to link cultural mission to the technological production. Its capability to establish zones of interconnectivity between the opposing domains of technology and culture, where the cosmopolitan forces of citizenship—that is, 'cultural' and 'technological citizenship'—are central to its mission—that is, the extension of knowledge creation beyond the realm of the ivory tower to the social world, where the university now inhabits a 'post scientific' research culture (Ziman, 2001; Peters, 2013) and faces a new role.

The elusive struggle for inclusion will make the university more representative of its social milieu, and with globalization, the cosmopolitan challenge remains to be fulfilled. Neither knowledge capitalism market-driven determinants, nor post-disciplinary 'managerialism,' will provide the solution to the challenges that technology poses. The solution resides in linking the challenges of technology with the cultural discourses at the university, where they intersect and can be interconnected.

Henceforth, the university is the institution in society most capable of linking the requirements of the economy, technology and the market forces, with the demands of citizenship. The university was once defined by its cultural mission, but later was determined by the conflicting imperatives of system integration and social cohesion (Neave, 2000). At this point in history, the

institution stands between these scenarios, where its surroundings and the globalization forces are permeating it, where it can become more influential in the construction of emerging 'learning-knowledge sustainable democratic societies' (UNESCO. 2005, 2009).

Conclusion

The university was based on science (as a public good), which was applied to technology, and it in turn was driven by science. Nowadays, the relationship has become complicated: technology is no longer driven by science, and the university is caught up in the institutional academic coexistence of mode I (in which it is still contained) with market-driven mode II of applied knowledge production. In this transition, academic science is losing its capacity to legitimate itself in a new context of rising conflicts in the domain of authorship, intellectual property rights, patents, and the commoditization of teaching and learning services in a globalizing world of higher education (Scott, 1995; Delanty, 2001). In such a world, the internationalization of higher education is being led by elite and new world class 'ranked,' highly competitive universities (Altbach & Salmi, 2011; Palfreyman & Tapper, 2009). The great changes have come about in response to the state fiscal crisis, external forces (market-driven politics), and the institution's own contradictions and cultural conflicts (Berquist & Parlak, 2007).

Even though the university portrays to have lost its direction towards the learning-knowledge sustainable democratic society, it can still play a central role as an important place of public discourse, in which the institution can develop the capacity to become a 'transgressive cognitive zone' where the contradictions of the neoliberal market driven 'knowledge society' are most apparent. It can also become an important agent of the 'public sphere' (Habermas, 1989), initiating social change (instead of only responding to these forces) towards an alternative human sustainable development scenario (UNESCO, 2009; Aponte, 2012, 2015). If this line of argument holds, there are chances that the university (particularly the research institution) will evolve to a new institutional, more proactive role in the 21st century.

The university in the age of mass education has been a major site for the articulation of democratic values, such as gender, racial and ethnic equality, and social democracy. Thus, at this point in history, it stands at the crossroads between its cultural mission and the imperative of system and social integration; a transition process where the institution no longer reflects the social transformation of society, but is now the major site in which different social projects are articulated, as it is happening in some elite and world class universities. Finally, and most importantly, the university must recover the cosmopolitan project (beyond multiversity) that was central to its identity from the beginning.

REFERENCES

Abramowitz, M., & David, P A. (1996). *Technological change and the rise of intangible investments: The US economy growth path in the knowledge based economy*. Paris: OECD.

Altbach, P. G. (2011). *Leadership for world-class universities: Challenges for developing countries*. New York: Routledge.

Altbach, P., & Salmi, J. (Eds.). (2011). *The road to academic excellence: The making of world-class research universities*. Washington: The World Bank.

Aponte, E. (2002). Hacia la universidad de autogestión del conocimiento. *Cuaderno de Investigación en la Educación, 8*. Recuperado de http://cie.uprrp.edu/cuaderno/ediciones/18/pdfcuaderno18/c18art3.pdf

Aponte, E. (2012). La educación superior del futuro en la encrucijada: Entre lo público y privado ante los retos de la comercialización. In J. R. De la Fuente & A. Didriksson (Eds.), *Universidad, responsabilidad social y bien público*. México: Editorial Universidad de Guadalajara.

Aponte, E. (Ed.). (2015). La responsabilidad social de las universidades: Implicaciones para la América Latina y el Caribe. Caracas, Venezuela: IESALC UNESCO.

Aponte-Hernández, E. (2014). La Universidad en la masificación de la educación superior: Identidad, misión y funciones alteradas. *Kalathos: Revista Transdisciplinaria Metro-Inter*, 7(2). Retrieved from http://kalathos.metro.inter.edu/kalathos_mag/publications/La-Universidad-en-la-masificacion.pdf

Aponte-Hernández, E., & Molina-Iturrondo, A. (2008). Research and knowledge creation in the Caribbean for endogenous development and building autonomous knowledge societies: The University of Puerto Rico and beyond. In H. Vessuri & U. Teichler (Eds.), *Universities as centers of research and knowledge creation: An endangered species?* (pp. 81-89). Rotherdam: Sense Publishers.

Atkinson, R. D., & Ezell, S. J. (2012). *Innovation economics: The race for global advantage*. New Haven: Yale University Press.

Barnett, R. (2005) Reshaping the university: New relationships between research, scholarship and teaching.UK: Open University Press.

Barnett, R., & Griffin, A. (Eds.). (1997). *The end of knowledge in higher education*. London: Cassell.

Bauman, Z. (2002). *Society under siege*. Oxford: Polity Press.

Beck, U. (1992). *Risk society: Towards a new modernity*. London: Sage.

Bell, D. (1974). *The coming of postindustrial society*. London: Heinemann Publishers.

Berquist, W., & Parlak, K. (2007). *Engaging the six cultures of academe: Revised and expanded edition of the Four Cultures of Academe*. San Francisco, CA: Jossey-Bass Publishers.

Bourdieu, P. (1988). *Homo Academicus*. Cambridge, UK: Polity Press.

Castells, M. (1994). *The information age: economy, society and culture*. Oxford, Blackwell.

Clark, B. R. (1998). *Creating entrepreneurial universities: Organizational pathways of transformation*. Oxford: Published for the IAU Press by Pergamon Press.

Crawford, E. T., Shinn, T., & Sörlin, S. (1993). *Denationalizing science: The contexts of international scientific practice*. Dordrecht, Netherlands: Kluwer Academic Publishers.

David, P., & Foray, D. (2007). *Economic fundamentals of knowledge societies* (SIEPR Discussion Paper No. 01-14). Retrieved from http://www.stanford.edu/group/siepr/cgi-bin/siepr/?q=system/files/shared/pubs/papers/pdf/01-14.pdf

Deem, R., Hillyard, S., & Reed, M. (2007). *Knowledge, higher education and the new managerialism*. UK: Oxford University Press.

Delanty, G. (2001). *Challenging knowledge: The university in the knowledge society*. Buckingham: Society for Research into Higher Education & Open University Press.

Didriksson, A. (2009). *La universidad en la sociedad del conocimiento*. México: UNESCO.

Drucker, P. (1993). *The post-capitalist society*. New York: Harper Publishers.

Etzkowitz, H., & Leydesdorff, L. A. (1997). *Universities and the global knowledge economy: A triple helix of university-industry-government relations*. London: Pinter.

Foray, D. (2004). *Economics of knowledge*. Cambridge, MA: MIT Press.

Gibbons, M. (1998). *Higher education relevance in the 21st century*. Washington, D.C: The World Bank. Retrieved from http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2000/07/19/000094946_9912220532351/Rendered/PDF/multi_page.pdf

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: SAGE Publications.

Habermas, J. (1989). The idea of the university-learning processes. En J. Habermas & S. W. Nicholsen, *The new conservatism: Cultural criticism and the historians' debate*. (S. W. Nicholson, Trans.), (pp. 100-127). Cambridge, MA: MIT Press.

Hall, S., Held, D., Hubert, D., & Thompson, K. (Eds.). (1995). *Modernity: An introduction to modern societies*. Oxford: Blackwell Publishers.

Hessels, L. K., & van Lente, H. (2007). Re-thinking new knowledge production: A literature review and a research agenda. *Research Policy*, *37*(4), 740-760.

International Bank for Reconstruction and Development (IBRD). (2002). *Constructing knowledge societies: New challenges for tertiary education*. Washington, D.C.: World Bank Publications. Retrieved from http://siteresources.worldbank.org/INTAFRREGTOPTEIA/Resources/Constructing_Knowledge_Societies.pdf

International Bank for Reconstruction and Development (IBRD). (2007). *Building knowledge economies: Advanced strategies for development*. Washington, D.C.: World Bank Publications. Retrieved from http://siteresources.worldbank.org/KFDLP/Resources/461197-

Jarvis, P. (2001). *The age of learning: Education and the knowledge society*. London: Kogan Page.

Latour, B. (1998). From the World of Science to the World of Research? *Science, 280*(5361), 208-209. Retrieved from http://www.sciencemag.org/content/280/5361/208.full

Leindestein-Walshok, M. (1995). *Knowledge without boundaries: What America's research universities can do for the economy, the workplace, and the community*. San Francisco: Jossey-Bass.

Lundvall, B. A., & Bjorn, J. (1994). The learning economy. *Journal of Industry Studies, 1*(2), 23-42.

Machlup, F. (1962). *The production and distribution of knowledge in the United States*. Princeton, N.J.: Princeton University Press.

Malecki, J. E. (1997). *Technology and economic development: The dynamics of local, regional and national competitiveness*. Toronto: Longman.

Meister, J. (1998). *Corporate universities: Lessons in building a world-class* workforce. New York: McGraw-Hill.

Neave, G. (2002). *Research and research-training systems: Towards a typology* (UNESCO Forum Occasional Paper Series Paper no.1). Retrieved from http://portal.unesco.org/education/es/file_download.php/0378d533b2a6a7672d37b0c06a3658ddGuy+Neave.doc

Neave, G. R. (Ed.). (2000). *The universities' responsibilities to society: International perspectives*. New York: Pergamon.

Newman, J. H. (Ed.). (1996). *The idea of a university*. New Haven: Yale University Press.

Nowotny, H., Scott, P., & Gibbons, M. (2001). *Re-thinking science: Knowledge and the public in an age of uncertainty*. Cambridge, UK: Polity.

O'Connor, J. (2009). *The fiscal crisis of the state*. New Brunswick, NJ: Transaction Publishers.

Organisation for Economic Co-Operation and Development (OECD). (1996). *The Knowledge-Based Economy*. Retrieved from http://www.oecd.org/science/sci-tech/1913021.pdf

Palfreyman, D., & Tapper, T. (2009). Structuring mass higher education: Interpreting the process of change. In D. Palfreyman & T. Tapper (Eds.), *Structuring mass higher education: The role of elite institutions* (pp. 1-10). New York: Routledge.

Peters, M. A. (2013). *Education, science and knowledge capitalism: Creativity and the promise of openness*. New York: Peter Lang Publishing.

Phillips, P. W. B. (2012). Governing innovation in a knowledge society. In J. Dzisah & H. Eztkowitz (Eds.), *The age of knowledge: The dynamics of universities, knowledge and society* (pp. 167-191). Chicago: Haymarket Books.

Pikety, T. (2014). *Capital in the twenty first century.* Cambridge: The Pelkman Press of Harvard University Press.

Polanyi, K. (2001). *The great transformation: The political and economic origins of our time*. Boston, MA: Beacon Press.

Power, M. (1999). *The audit society: rituals of verification*. Oxford University Press.

Scott, P. (1995). *The globalization of higher education*. Brigham,UK: Open University Press.

Siggrard, J. (2004). *Mode I and Mode II of knowledge production. Denmark Learning Laboratory. The Danish University of Education* (Working Paper). Retrieved from http://edu.au.dk/fileadmin/www.dpu.dk/forskning/forskningsprogrammer/epoke/workingpapers/WP_14.pdf

Stehr, N. (1994). *Knowledge society*. London. UK: Sage.

Stiglitz, J. (1999). Knowledge as a global public good. In J. Kaul & J. Stern (Eds.), *Global public goods: International cooperation in the 21st century* (pp. 308-325). New York: Oxford University Press.

Stiglitz, J. E. & Greenwald, B. (2014). *Creating a learning society: A new approach to growth, development and social progress: Basic concepts*. New York: Columbia University Press.

Tierney, W. G., & Hentschke, G. C. (2007). *New players, different game: Understanding the rise of for-profit colleges and universities*. Baltimore: Johns Hopkins University Press.

UNESCO. (1998). *World Conference on Higher Education in the Twenty-first Century*. Paris: UNESCO. Retrieved from http://www.unesco.org/new/en/education/themes/strengthening-education-systems/higher-education/reform-and-innovation/1998-world-conference/

UNESCO. (2005). *Towards knowledge societies*. Paris: United Nations Educational, Scientific and Cultural Organization. Retrieved from http://unesdoc.unesco.org/images/0014/001418/141843e.pdf

UNESCO. (2009). World Conference on Higher Education. Paris: UNESCO. http://www.unesco.org/new/en/education/themes/strengthening-education-systems/higher-education/reform-and-innovation/world-conference-on-higher-education/

United Nations, Department of Economic and Social Affairs (UN). (2005). *Understanding knowledge societies: In twenty questions and answers with the Index of Knowledge Societies*. New York: United Nations. Retrieved from http://unpan1.un.org/intradoc/groups/public/documents/UN/UNPAN020643.pdf

Wallerstein, I. (1991). Can there be a 'world culture'? In *Geopolitics and geoculture: Essays on the changing world-system* (pp. 184-199). Cambridge: University Press.

Webster, F. (1995). *Theories of the information society*. London: Routledge.

Weingart, P. (1997). From finalization to Mode II: old wine in new bottles? *Social Science Information*, *36*(4), 591-613.

West, C. M. (2007). The American research university from World War II to Worldwide WEB: The private sector and the emerging MetaUniversity. California: University of California Press.

Ziman, J. (1996). *Reliable knowledge: An exploration of the grounds for believe in science*. New York: Cambridge University Press.

Ziman, J. (2001). *Real science: What it is, what it means*. Cambridge: University Press.

NOTES

1 Science, from Latin 'scientia', meaning 'episteme' in Ancient Greek, refers to the systematic pursuit that builds and organizes knowledge in the form of testable explanations and predictions about the universe and human behavior, and more recently, to a body of knowledge itself of the type that can be rationally explained and reliably applied (Ziman, 2001).

2 From the perspective of the sociology of knowledge, the cultural aspects of 'modern societies' are new ways of creating, transforming, producing and classifying knowledge as a result of the emergence of a new intellectual and cognitive world coming from the Reformation outside the church and religion, the Renaissance and of the scientific revolution of the 17th century, and the Enlightenment of the 18th century, that propelled the formation of early capitalism, the nation state, and the formation of early modern social analysis of the construction of cultural and social identities as part of the social processes.

3 During the second half of the 20th century, 'society' was under two transformation forces working in two fronts: the 'global frontier-land,' where old structures and rules of society do not hold and new ones are slow to take shape, and from the fluid undefined domain of life politics.

The space between these two forces was, until recently, ruled by the sovereign nation-state as an enclosed entity. This confronts the established wisdom of the social sciences with a new challenge: Sovereignty and power are becoming separated from the politics of territorial nation-state, but are not becoming institutionalized in a new space (Bauman, 2002), in which hybrid identities are being formed with no fixed sense of belonging, i.e. "global society" and "global citizenship'' (Aponte, 2007).

4 Cuba's research and development (R&D) state policy is socially oriented in biotechnology, applications in health and medicine, among others.