Ethiopian Academy of Sciences
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PROGRAM & BOOK OF ABSTRACTS

Re-envisioning Higher Education and Research in Ethiopia

2nd Science Congress of the Ethiopian Academy of Sciences
26 - 27 November 2015

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Re-envisioning Higher Education and Research in Ethiopia

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Ministry of Science and Technology

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Education Strategy Center

UNITY UNIVERSITY

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- Dr Heran Sereke-Brhan, Independent Researcher and U.S. Liaison of the Ethiopian Academy of Sciences, Washington D.C, USA

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Congress Dinner with Guest of Honour

BACKGROUND TO THE CONGRESS

Ethiopia is a country with a long tradition of higher education and scholarly investigation. Both Christian and Islamic centres of advanced learning had existed in different parts of the country for centuries. Modern higher education began with the founding of the University College of Addis Ababa in 1950, upgraded to Haile Sellassie I University (later renamed Addis Ababa University) in 1961. Subsequently, one of the colleges of Addis Ababa University (Alemaya/Haramaya) was also elevated to university status.

The Government of the Federal Democratic Republic of Ethiopia has placed great emphasis on expanding higher education as part of its developmental goals. As a result, the number of universities in the country has increased dramatically, old ones have been overhauled, new graduate programs have been opened and specialized institutes have been launched at different universities. The expansion of higher education in the past two decades, with the number of public universities alone rising from two to thirty-three, is almost unparalleled. In tandem with this growth in the public sector, private higher education institutions have also shown remarkable growth. Currently, there are three private universities and colleges. If this commendable trend continues, the number of university graduates in the country will increase markedly in a reasonably short time. Also the Government will have a high prospect of meeting its objective of providing equitable access to tertiary education.

However, it has become all too evident that increase in the number of higher education institutions by itself does not guarantee quality. Indeed, there is a serious concern over the quality of higher education in the country. One of the issues that higher education institutions should face up to is maintaining balance between the expansion that is essential to broaden access and quality assurance if the country is to improve its human capital and meet the requirements for the transition from an agriculture-led to industry-led economy, the basis of which is a knowledge-based and skilled workforce.

Ethiopia aspires to achieve middle income status by 2025. The vision of the Science, Technology and Innovation Policy of the country is to see Ethiopia establish the capabilities which enable rapid learning, adaptation and utilization of effective foreign technologies by the year 2022/23. This requires an educated and skilled workforce without which joining middle income countries by 2022/23 is unthinkable. An educated and skilled workforce is

the engine that propels sustainable economic, social, scientific, and human development. High-quality and relevant tertiary education is vital to stimulating innovation, developing human resource, building scientific and technological capability and facilitating progress toward reducing poverty and achieving national development objectives.

Universities are places where knowledge and scholarship and the pursuit of truth should progress unhindered. Currently, in many university campuses, cultivating critical thinking and intellectual curiosity does not seem to have a prime place. As a result many of them lack intellectual vibrancy characterized by sustained intellectual discussions. Universities should nurture the culture of the appreciation of knowledge as a value in itself.

Creating a consensus-building platform, where the governance and organization of higher education and research is discussed, and where the challenges of quality of education in higher education institutions is deliberated, debated and analyzed, is a matter of the highest priority.

After a period of retrenchment in the 1980s and 1990s, African higher education has shown remarkable expansion in recent decades. While commendable and expected to continue if Africa is to meet global standards, this expansion has been attended by a host of challenges. These include quality assurance, the diversification and differentiation of Higher Education (HE) institutions to address the varying needs of the country, effective leadership and shared governance, and the introduction of relevant curricula to ensure national impact and graduate employability. Just as it has partaken of the continental expansion process, Ethiopian higher education is also faced with its challenges. There is, therefore, an urgent need to organize an informed debate on the status and prospects of higher education in Ethiopia. The conference is envisaged to address the following sub-themes:

Inquiring Minds: The Role of Universities in Nurturing Critical Thinking among Students

Quality of education in higher education institutions is compromised due to shortage of highly qualified academic staff, limited/poor infrastructure, lack of equipment, and absence of centers of excellence for advanced studies. Universities need the resources to adapt to changing circumstances in order to address academic challenges and to support the country's development agenda.

There is a concern that compromising on the quality of education leads to passive learning and the production of an unskilled workforce. A university should be a place where skills for creating, analyzing, evaluating and synthesizing information/knowledge are developed. It is the setting where a highly skilled workforce - the driver of any economic and social development - is developed. The training of a scientifically minded manpower and knowledge accumulation are keys to a nation's development.

The goal of universities is to foster critical thinking, which is the basis of knowledge creation. Universities and higher learning institutions should be venues where critical thinking skills are developed among students to improve academic human capital and the creation of knowledge. One of the requirements for the development of critical thinking in the university setting is an increased teacher/student engagement since a university is the space where high calibre intellectuals are nurtured. A question that will be a major focus of the 2nd Science Congress will be how best can higher learning institutions enhance critical thinking among students?

Economic Development and Tertiary Education: Impact and Graduate Employability

Ethiopia's development agenda demands the creation of change agents to fully develop the human being and to promote economic growth. Universities have been incorporating development values and practices into their core activities of teaching. However, unless quality of education is ensured, these ideals cannot be fulfilled and universities in Ethiopia cannot achieve what they are set out to accomplish. Without competency in science and technology, a skilled workforce cannot be created and science-led development cannot be attained.

It has been established that knowledge production and the pursuit of higher education is good for a country's economic development. Some of the steps that need to be taken for a sustainable development are innovative teaching practices, good quality curriculum development and research. The relevant issues in this regard include:

- Tertiary education, economic development and global competitiveness and quality of education;

- Technological advances, innovation and higher education and sustainable economic growth;
- The formation of a highly literate middle-class - the engine of a sustainable development; and
- Student career success as the driving force of economic development.

Diversification and Differentiation: Towards Research-Intensive Universities

The expansion of higher education in Ethiopia has not been attended by a systematic planning of the differentiated roles that they can play in manpower training and national development. Almost all universities have a standard mandate combining undergraduate and graduate training and research. Yet, if universities in Ethiopia are to have maximum impact in the implementation of national development goals, they have to be differentiated into undergraduate training, vocational training and research.

One of the most important aspects of universities is research. Universities are expected to be major centers of knowledge production and utilization. Training of highly qualified scientists at PhD and Masters levels thus, developing national capacity for sustained research and development in critical issues is essential to the country's development. Research intensive universities are considered among the central institutions of the 21st century economies. No country has ever developed without having at least a few outstanding research universities that provide intellectual leadership and lay the foundation for the country's long-term economic growth and international competitiveness. Universities should provide evidence-based research to support the development needs of the country and need to cater for the research demands and needs of different Government and non-government organizations on different development issues.

The nation needs to address the paucity of the culture of research; lack of quality research outputs; the need for training qualified scientists who have the capacity for sustained research and development in critical issues; inadequate research capability; inadequate access to the publication of research findings in reputable journals; and academics undertaking research for purposes of academic promotion rather than the pursuit of excellence and remaining competent in their areas of specialization and solving national

development challenges. A major question that arises from this state of affairs is, therefore, whether in the strategic interest of ensuring national competitiveness, there is a need for identifying and supporting selected universities to evolve into research universities. It is expected that the Congress will deliberate on these critical issues and map the way forward for creating research-intensive universities in Ethiopia.

Effective Leadership and Participatory Governance

If Ethiopia is to avoid marginalization in the global economy, it needs to continuously innovate and expand its knowledge-base. Innovation and creation of knowledge depends on the unencumbered pursuit of research and of higher learning and independent scholarly pursuit which calls for a dynamic and quality leadership.

University leaders should focus on providing leadership rather than concentrating on established routines. Handling of routines stifles initiative, creativity and inspiration. Universities need visionary leaders who can enhance their intellectual bases and develop their resource needs. They should be leaders who can effectively forge international collaborations to facilitate technology and knowledge transfer, work with different stakeholders, ensure effective involvement of faculty and students, provide intellectual leadership, and promote effective governance structures.

Ensuring participatory governance plays a decisive role in the efficient functioning of a university. The prevalent bureaucratic mindset is a major handicap of higher education governance in Ethiopia. As a result, HEIs lack a competitive edge regionally and globally. Higher learning institutions need governance features that encourage effective, visionary and innovative leadership capable of making decisions and managing resources unencumbered by bureaucratic considerations. It is expected that the Congress will explore the dynamic relationship between governance, autonomy and the quality of higher education in Ethiopia.

Universities need to be optimally organized and staffed to mobilize their diverse knowledge resources to serve public needs. They also need to adapt to changing economic, demographic and market conditions by developing new management skills.

It was in light of these pertinent challenges and in line with its mandate that the Ethiopian Academy of Sciences chose higher education as the main theme for its Second Science Congress where the issues of higher education and research in Ethiopia are debated and appropriate policy recommendations made to the Government. It is expected that the recommendations made at the Congress will contribute to better quality of higher education, improvement of academic human capital, increased and improved research outputs and quality assurance, and better governance, organization and management of higher learning institutions in Ethiopia.

THE OBJECTIVES OF THE CONGRESS ARE:

- To assess the current state of higher education in Ethiopia;
- To stimulate discussion on the challenges that it is facing;
- To bring to the attention of Government and major stakeholders the need for change in the way universities are governed, organized and managed and help policy formulation for the way forward; and
- To help universities become hubs of excellence and centers of knowledge production.

EXPECTED OUTCOMES

- A shared understanding of the challenges and opportunities of higher education and research in Ethiopia among stakeholders;
- A shared vision about the future direction of higher education and research in Ethiopia;
- A framework for enhancing national competitiveness through identification and support of research-intensive universities; and
- A reorientation of the national policy on higher education and research.

ABSTRACTS

Strategic Approaches to Developing Research Leaders - A Continental Perspective

Professor Berhanu Abegaz

Executive Director, African Academy of Sciences
P.O. Box 24916
Nairobi, Kenya

It is important that each African country knows those areas in which it has leadership or potential for leadership. These must be either in areas where there are competitive advantages, or areas of significance to the well-being of its citizens. Achieving excellence and relevance requires good judgment and strategic choices and sustained commitment. This presentation is intended to fit in the theme: *The creation of inquiring and critical minds and the academic environments of universities* and will be based on the strategic thinking within the African Academy of Sciences that has led to some of the early-career centered programs. PhD programs are very critical for equipping the graduate with some degree of knowledge and technical competencies but it takes many more years of mentorship, experience and development to be recognized as a research leader.

Research leaders are those that conduct high quality and relevant research and serve as leaders or equals (not followers) during engagement in intra-African and international collaboration. Research leaders are able to advocate for priority areas of research locally and globally and are often able to influence the development of evidence-based policies. Africa does not have enough research leaders that effectively engage in technology/knowledge transfer - innovation, developing new products, improved services, etc. Malaysia has >1600 researchers per million population, Singapore >6000, Denmark, 6806, while Africa in general has about 79 researchers per million population. Strong capacity comes from strong research and teaching institutions that conduct good science. Such institutions should be identified, enabled, strengthened and nurtured to produce locally grounded but world-class researchers. This presentation is intended to provoke thinking along the lines of: how best to train and retain the talented early career specialists; the need to benchmark across national, regional and international institutions; whether to focus on people or institutions; and the need to have locally grounded programs as one aims for world-class excellence.

Can We Make Graduates both Useful and Thoughtful? A Personal View of the Present and the Future of University Education in Ethiopia

Dr Tekalign Wolde-Mariam

Former Academic Vice President
Addis Ababa University

In this presentation, I try to make a case for a system of university education in Ethiopia that puts a premium on critical thinking capacities of students and provides a more robust program of General Education at the undergraduate level of training than we have at present. I define critical thinking as intellectual capability to process information and seek objective knowledge, both of which are crucial for making sound decisions and solve problems in both the private and the public domains. By a robust program of General Education, I am referring to a regime of education that exposes all students to the widest possible range of ways in which knowledge is organized and continuously reorganized in the sciences, the humanities, and the arts, both nationally and globally, and aims at enabling them to see similarities and differences thereof and lay a firm foundation for their personal and intellectual growth. I argue that critical thinking and general education not only go hand in hand, but are also very much interdependent: the latter serves as the platform and the crucible in which the former is nurtured while the former creates abilities by which one selects and makes a good use of the knowledge and values mix of the latter.

I then outline the various national and global imperatives that should compel us, sooner rather than later, to transition to a system of broadly-based university education in which the building of critical thinking capabilities is the paramount idea and organizing principle. Among national imperatives, I highlight the felt need to produce graduates who can create jobs and employ themselves rather than look elsewhere for employment. I also touch upon increasingly urgent public concerns about the work universities do or fail to do to instill socially necessary values in their graduates. Among the global imperatives, I highlight the massive flow of information made possible by the internet revolution and the potentially catastrophic results that this could have if capacities to discriminate and evaluate information are poorly developed among users. I also outline what I believe will be the major advantages of the system that I advocate over the current system. I underscore, in

particular, that it would be a truly student-centered approach to education, rather than employer or industry-centered, and will be geared towards creating capacities that can be adaptable to a broad-range of work and life situations rather than towards creating specific capabilities to do specific jobs or tasks.

I conclude by outlining the implications of the shift that I advocate for the way in which education will have to be organized and delivered at our universities. Organizationally, I believe we might need to rethink the ways in which undergraduate education links with secondary education on the one hand and with graduate education on the other. Whether undergraduate education should be viewed as a tip of a pyramid whose base goes down to lower levels of the school system or whether it should itself form the base of another pyramid that narrows up in the upper echelons of graduate education is a question that I believe needs to be tackled sooner or later. Pedagogically, I argue that building capabilities for critical thinking might compel us to approach curriculum formulation as well as teaching more creatively than has been the case so far. Our curricula, I believe, might need to be more responsive to multi-disciplinary approaches to real-life problems than to subject area packages. Our teaching, likewise, should permit greater room for the presentation of alternative ways and views rather than for the transmission of received wisdom.

Repositioning Higher Education toward Fostering Competitiveness and Graduate Employability

Dr Teshome Yizengaw

Associate Vice President for International Research and Development
Director of the Office of International Development
Indiana University, USA

Ethiopia, and many sub-Saharan African countries, have committed to an ambitious roadmap of development for the coming decades. Ethiopia has made tremendous economic and social progress and has registered nearly 9% GDP growth in the last few years. The development strategy of the country, led by the Growth and Transformation Plan (GTP), recognizes the pivotal role of higher education.

Higher education expansion in Ethiopia, the last two decades, is unprecedented and unique in sub-Saharan Africa. The rapid expansions, however, have not been accompanied with equal emphasis on quality, and have led to a drop in quality and might further lead to a production of increasing numbers of poorly-prepared graduates. The situation is not that different in many other sub-Saharan African counties.

After two decades of successful expansion, Ethiopia is at a crossroads in relation to higher education development. What can the Ethiopian higher education sector do to meet goals of the GTP? I am a strong proponent of continued planned expansion of higher education in order to ensure equitable access, invigorate innovation, solve societal problems, and develop sustainable human capital. The overarching theme of this Congress is, therefore, critical as it tries to encourage informed dialogue and debate, among others, on "*what kind?*" of a university we should build in Ethiopia, and "*how should we prepare our graduates?*" to contribute to better employability and competitiveness.

Any plan to strengthen existing institutions and any future expansion should focus on key elements of quality offering and relevance. Higher education should produce graduates more likely to gain and create employment and be successful in their lives and the overall well-being of society. Revitalized models and roles of leadership and governance as well as internal and external quality assurance systems should be implemented. More needs to be

done by researchers in terms of providing policy makers and university leaders with compelling evidence on improving, and addressing quality and employability challenges.

Academic staff should be provided with relevant support and resources, in order to have informed knowledge of current industry practice and integrating these skills into curriculum and course design. Curricula need to be redesigned to incorporate key skills, such as communication, team-building, problem-solving and life-long learning. Institutions need to establish/strengthen careers and employment services to students, and facilitate structured mentoring and internship programs.

Quality of Training: Perspectives of University Graduates and Employers

Professor Tegegne Gebreegiziabher

Director
Institute of Development and Policy Research
Addis Ababa University

The Ethiopian Government recognizes the role of science and technology fields in ensuring sustainable economic growth and enhancing the country's competitiveness. This is clearly reflected in the Government's education and Science, Technology and Innovation (STI) policies. The national education and training system is responsible for delivering the needed expertise in the natural sciences and technological fields in adequate quantity and quality. The general assessment, however, is that the level of qualified human power, capable of transferring foreign technology is low. A study which looked at the future projection of the science and technology human resources was made in order to provide the bases for educational policy regarding the supply and demand of the science and technological human resources.

The methodology followed both quantitative and qualitative approaches with the quantitative part focusing on projection of science and technological human resources and the qualitative part focusing on the concerns of students, teachers and employers.

Students and teachers rated facilities in higher learning institutions (libraries, accommodations, laboratories, internet service, etc.), research management and administrative issues as low while program design and courses were rated to be fairly good. In relation to competence, both university and TVET students believed that they will have developed the required competence upon graduation. Lecturers of both universities and TVET institutions generally agreed that they did not have job satisfaction and felt that research was poorly incentivized by their respective institutions.

The employers' concern was sought regarding skills shortage, skills gap, recruitment process and skills requirement. Regarding skills shortage, employers revealed that there is limited availability of science and technology workforce in the market or there is skills shortage with the implication of constraining the technological progress of the country, hindering

investment and arresting overall development. Regarding skills gap, employers mentioned that graduates lack practical training, lack appropriate industrial work ethic, and are not ready to learn. Employers also mentioned that TVET graduates are better than higher-level Science & Technology labor force, i.e. trained at the BSc and MSc levels at shop floor production. Similarly, experts believe that most graduates do not possess the expertise demanded by the market or employers. In particular, experts believe that the major skills deficiency is in the areas of practical training such as machine operation, computer skills, usage of tools, and equipment, and in non-technical skills such as report writing, inter-personal communication, etc.

The recruitment process of employers revealed that many employers recruit from the market with no effort to approach training institutions for recruitment purposes. The factors most influential in the recruitment process were expertise and experience while level of education and training was considered as less influential.

The employers' perception on the skills requirement and industry needs revealed that the manufacturing sector requires a pool of talent that can generally work in the manufacturing sector (a pool of engineers and technologists) but also a specialized talent that can work in specific sectors.

The study recommended that employers' concern, that graduates lack practical training and necessary industry ethics and culture, need to be addressed properly by training institutions. One way will be to strengthen practical training in universities and TVETs by putting in place the necessary facilities, laboratories and industrial environment that can positively build the practical knowledge of graduates. In addition, industries' need for more technologists and sector-specific professions should be considered by training institutions in producing professionals. There should also be a joint recruitment process of both industries and training institutions as this will help both institutions and meet the demands properly.

Integrating Arts and Humanities into STEAM: Sparking Student Engagement and Imagination

Dr Heran Sereke-Brhan

Independent Researcher and U.S. Liaison of the Ethiopian Academy of Sciences
Washington D.C
USA

The Government of the Federal Democratic Republic of Ethiopia has placed expansion of higher education among its highest priorities in achieving development goals. The rapid increase in the number of public and private universities and colleges attests to immense efforts in building the necessary infrastructure to support these objectives. Despite this, concern about creating a critical balance between rapid expansion efforts and maintaining quality standard of education continues to prevail. Among other challenges, lack of qualified staff, limited academic resources and funding support for advanced research have hindered and compromised quality, especially at the level of tertiary education. In addition, there is a notable orientation in education policy that posits competency in science and technology as the determining tenet of creating a skilled workforce to achieving science-led development. This orientation is not unique to Ethiopia as is reflected in trends in the United States and elsewhere of promoting and prioritizing programs and research in the fields of science, technology, engineering, and math (also known as STEM disciplines). Immense government and private sector funding at state and national levels are earmarked for STEM education based on the assumption that American students, and by extension the country, is losing its competitive edge in the global economy. Scientific research continues to be a central factor in driving innovation, yet in the last decade, discussions in U.S. higher education have broadened to include knowledge and skills gained from the study of arts and humanities as a vital element of complementing STEM preparation and participation for success in today's global economy. Integrating the arts and humanities at all levels of education ((STEM vs. STEAM, with 'A' signifying Art) has resulted in students applying creative thinking and design skills to standard STEM fields and invigorating innovation through sparking student engagement and imagination.

As we contemplate the future of higher education and research in Ethiopia, we can glean useful insight from these debates on the importance of integrating the arts and humanities

(social science, religion, geography, history, philosophy, language and arts) in curriculum development and for broadening options of graduate employability. Along with competency in science and math, grounding in the liberal arts is vital in creating well-rounded citizens and a workforce with advanced scientific and technical knowledge and essential communication, problem-solving, and critical thinking skills to form an engaged Ethiopian citizenry that will spearhead progressive achievements in the 21st century.

Building Ethiopia's Research Universities: The Arduous but Indispensable Task

Professor Damtew Teferra

KwaZulu-Natal University
South Africa

Higher education has now been fully recognized as key to national development and global competitiveness by all major regional and international development stakeholders. Research universities lie at the core of these issues in the increasingly globalized knowledge system with massive need for skilled, competent and productive labor force. To be sure, building research universities is neither easy nor comes cheap and is compounded by a plethora of social, economic, political, cultural, and academic realities. This paper attempts to articulate the reasons for urgent need for designated research universities in Ethiopia in keeping with the global trends—and necessities. The paper will draw some notable experiences from other (comparable) countries and concludes with some recommendations for possible national consideration.

Vision of Wisdom 2025 - The Blue Book of Bahir Dar University to Become a Research University

Dr Baylie Damtie

President
Bahir Dar University

Ethiopia aspires to become a middle income country and a research university provides immense contribution towards fulfilling that goal. Taking this into account, in this presentation, the direction of Bahir Dar University towards becoming a research university and the critical steps that it needs to take are outlined. Some of the crucial factors that contribute to making a university the hub of excellent research and quality education are: a) top quality researchers and qualified faculty b) infrastructure that meets standards and has the necessary inputs; c) high calibre students and research-motivated students; and d) leadership with clear vision and strategy.

Some of the ways through which Bahir Dar University implements this vision are: enhancing capacity of current faculty, hiring top quality local and foreign faculty, increasing quality of education to produce top notch students and creating opportunities for them to acquire international experience, building information technology infrastructure, increasing financial resources etc.

Red Carpets for the Next Generation of Scholars? - The Initiative for Excellence in Germany (2005/2006-2017) and International Graduate Schools as Instruments for Research Training and Mentoring at the Doctorate Level

Dr Christine Scherer

Coordinator
Bayreuth International Graduate School of African Studies
University of Bayreuth
Germany

"Research on Africa is only possible with Africa" – this has been the credo of the Bayreuth International Graduate School of African Studies since it was inaugurated in 2007 within the German Initiative for Excellence. As a highly competitive initiative in a traditionally diverse national higher education landscape, the implementation of the 'ExIn' aimed at promoting internationally competitive top-level research at universities in Germany by generally improving the conditions for researchers. Three funding lines were initiated: the so-called 'future concepts,' the 'excellence clusters' and the 'international graduate schools.' The latter are particularly dedicated to fostering excellent conditions for young scholars at German universities in order to successfully conduct a doctoral dissertation and become more competitive in a global knowledge economy. Funding of approximately 2.7 billion euros was made available in 2012 for a second phase of the Initiative, 45 graduate schools, 43 excellence clusters and 11 institutional strategies will receive funding until 2017.

The paper sketches the short history of the Initiative for Excellence in Germany as an initially contested policy and idea and examines the debate between scholars and managers at universities and policy makers in higher education. By looking at the impact of the Excellence Initiative on the higher education landscape in Germany after one decade it then focuses mainly on the effects that are triggered today by the third funding line, the international graduate schools. Do graduate schools as academic structures offer an appropriate environment for the nurturing of critical reflection among postgraduates (graduates) in general and do they support inquiring minds? What are the biggest challenges for the international young academics during their doctoral studies and afterwards? And last but not least, what kind of impact can such an academic structure have on the university itself, on higher education and on the (immediate) society?

The Quest for Science Communication as an Instrument of Knowledge Transfer in Ethiopia

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The production, consumption and distribution of knowledge are among the core objectives of academic institutions. As Knowledge becomes the driving force of economic growth and development, the consumption and utilization of it for effective and efficient production processes also becomes imminent. Even though scientific findings and produced knowledge are widely circulating among scientific communities, it has always been a challenge to translate and communicate them to the general public so as to make them part of the policy processes impacting development and economic growth. Even though the concept of science communication has different connotations, the rudimentary understanding of it is the process of translating scientific findings into more understandable ways to the general public. It is communicating science and building bridges between the people involved in scientific research and different groups of the public including policy makers through inter-disciplinary synergies. Ethiopian higher education sector has passed through an impressive transformation in terms of expanding access to the general public but the synergy among the academic communities, the industry, policy makers and the general public in terms of science communications needs to be developed. This paper starts from the assumption that, the role of Ethiopian higher education trainings and scientific research in the process of transforming the economy of the country in the coming years will only be realized in the existence of an appropriate channel of science communication that feeds policy processes and impacts the daily lives of the people. Addressing the above assumption, the paper explains the relevance of Science Communication for the growth and transformation of the Ethiopian economy and provides some practical insights on how to go about it.

What Leadership and Governance Structures do Our Universities Need?

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Universities are institutions that engage in activities related to teaching, research and community service. They are hubs where different disciplinary and multi-disciplinary academic and research traditions meet and interact. Such convergence of a plethora of activities that take place in universities often leads to complementary and synergistic outcomes in the venture of knowledge production and application. Interaction between different knowledge systems that are ethically sound, socially acceptable, and self-critical taking place at universities is vital for ensuring a continuous process of generating knowledge that could be put to use for ensuring development of human power and societal well-being. Experiences of universities that successfully realized their stated goals, visions and missions reveal that their accomplishments are partly contingent on putting leadership and governance structures right. Hence, Ethiopian universities cannot be exceptions in this respect.

Ethiopian universities have embarked on several stages of transformation resulting from a plethora of reform measures introduced in the system of Ethiopian higher education since the 1980s. Changes that have occurred in the course of the transformation process during the period in question are multi-faceted: enacting of standalone regulatory regimes and frameworks, overhauling of institutional arrangements and curricula, broadening of access resulting from proliferation of public and private higher education institutions, expansion and diversification of undergraduate and postgraduate programs and enrolments, phenomenal increase in the numerical size of university graduates, and considerable budgetary allocations originating from the public coffer for covering recurrent and capital expenditures of universities, among others. To its credit, the Ethiopian Government should be commended for displaying a robust political will that led to the aforementioned occurrences.

The foregoing notwithstanding, however, there is still a lot to be desired in terms of entrenching sound leadership and governance systems that could boost performance of

universities in meeting their declared objectives, missions and visions. It is to be recalled that Proclamation 650/2009 and Council of Ministers Regulations Nos. 210/2011 and 214/2011 are the legal instruments that provide the basis for the establishment and operations of universities and other institutions of higher education in Ethiopia. These legal instruments extensively deliberate on leadership and governance structures, including institutional arrangements of universities. The fact that the Proclamation recognizes the need to exercise academic freedom and institutional autonomy (Articles 16-18) in the process of engagement of universities in teaching and research can be lauded as a move in the right direction. It should, however, be stated that translating these provisions into practice on the basis of responsibility and accountability calls for the existence of capable, credible and committed leadership and enabling governance structures. Studies, including government documents (HESO 2004), state that several deficits and shortcomings in leadership and governance underpinning the workings of several universities in Ethiopia abound.

In what follows, attempt is made to shed light on the entrenched inadequacies pertaining to leadership and governance militating against smooth and quality performance of universities:

- Overcrowding of governance structures whose mandates and functions overlap and at times appear to be conflicting and contradictory (e.g. Proclamation 650/2009, Article 43);
- Failure in strict application of criteria stipulated in the Proclamation (Articles 45 and 52) for appointing members of governing boards and chief executive officers (presidents) of universities;
- Vesting overwhelming powers on university presidents that are allowed to play decisive roles in spearheading and managing activities of major university governance bodies to the detriment of prospects for ensuring accountability and embedding fair balance and smooth interplay between collegial and managerial leadership that is characteristic of the distinct nature of operations of universities with proven best practices: Hence, prevalence of executive absolutism in several higher education institutions;

- Unabated persistence of the aforementioned unhealthy state of affairs could make Ethiopian universities vulnerable to impunity and abuse when controlled by self-serving wrong hands for which numerous instances could be cited with evidence; and
- The stated inadequacies could have the potential of leading to a situation of disengagement and alienation of students, academic and research faculty, and university communities at large, including other stakeholders if they are allowed to persist unabated.

Hence, there is a need to deal with inadequacies experienced so far that could nullify ongoing efforts aimed at realizing the Government's transformation agenda by capacitating universities that are entrusted with the responsibility of generating basic and applied knowledge and imparting skills. In the absence of the requisite will to ameliorate identified drawbacks on the basis of foresight and strategic vision, universities would be rendered ineffective and breeding grounds for disaffection, patron-client relations, mediocrity, and other undesirable outcomes in the long run.

Leadership in Ethiopian Higher Education: Challenges and Opportunities

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This study examines the leadership phenomena in Ethiopian Higher Education and projects, challenges and opportunities ahead. Literature on post-massification and/or post-reform phenomena of higher education institutions of other countries is used to anticipate similar scenarios in Ethiopian Higher Education System. Some questions are developed waiting for empirical investigations in the future. Based on the literature and documentary evidences, plus my own experiences, some hypotheses are advanced. Massification measures are used to respond to ever-increasing demand for higher education in Ethiopia. Reform measures are used to respond to growing demand for accountability and relevance. Leadership has been exercised during such changes to influence stakeholders through such mechanisms as legal, strategic planning, and change implementation tools. Post-massification/post-reform (post – 2015) challenges and opportunities require a different form of leadership – academic leadership. The paper discusses and makes some recommendations to create such leadership capabilities in Ethiopian higher education institutions.

Governance and Leadership in Ethiopian Public Higher Education an Opportunity for Academics Engagement or State Watch Dog Structures?

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Ethiopia has engaged in ambitious efforts to align higher education system with its national strategy for economic growth and development. The higher education reforms are grounded with the legislative ratification of Higher Education Proclamation by the year 2009. Based on the proclamation, the governance and leadership structures of the university have been operational. As per the new higher education reform, the university board members are organized from appointed government officials and politicians serving at federal or state levels. Efforts are not made to include the board composition from university partner such as business, industries, technology or research centers or think-tank institutions.

The autonomy and accountability of higher education institutions is granted as the dual responsibility of the board and the ministry of education. There is less or implicit engagement of academics in realizing institutional autonomy and discharging effective decentralized decision-making. The public higher education institutions have no mandate to establish, reorganize and dissolve their boards and senates or appoint their presidents. Any amendments on the board or the senate depend on the boards or ministry's intentions and aspirations. The university president is the only non-voting member of the board from the academics. Higher education boards engage much and closely oversee the internal academic operations, decisions. In addition, the board has a vested authority to change, modify the senate membership and terms of office. The president determines the governing bodies and structures of academic units up to the department levels.

After critically examining the major aspects of higher education proclamation, reports and pertinent literature, the current study argues that the governance and leadership of higher education in Ethiopia is skewed policy reform towards academics disengagement and more of state watch dog structures and operations scenario.

Inter-Disciplinary Educational and Research Programs for a Success of Research-Intensive Universities in Ethiopia

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People with inter-disciplinary training will be in great demand in the future to solve not only major national and global challenges but also to fit into the current complex work environment. The intellectual boundaries of today's research do not always map onto disciplinary frameworks that were developed and organized over centuries. The complex problems of the 21st century that include sustainable energy, improved health, air quality, food and water security, sustainable development, climate change, development of new materials require inter-disciplinary solutions only possible through the collaboration of physical, biological, and social scientists, and engineers (Edward G. Derrick, 2012; Foundation, 2008; Ledford, 2015; National Academy of Sciences, 2005). They demand graduates who can combine disciplinary depth with the ability to reach out, integrate knowledge, and understand jargon and approaches from many disciplines (NRC (Council, 2012; M.J Amey, 2006). Colleges and universities will need to figure out how to provide students with this training despite their largely disciplinary structures.

Inter-disciplinary research and education (IDRE) is behind many of today's scientific breakthroughs, including those that provide tangible benefits to society (Catherine Lyall, 2011; Rhoten, 2004). The complexity of nature and society compels researchers to break subject boundaries, drawing on insight and knowledge from a range of disciplines. IDRE links and integrates theoretical frameworks and analytical strengths from two or more disparate disciplines and employs methods and skills from them (Aboelela SW, 2007; Van Hartesveldt, 2008). IDRE promotes intellectual maturity by providing the differing perspectives of collaborating disciplines and preparing students for the complexity of the real world. IDRE allows for higher level cognitive processing by providing the motivation for deeper learning (Ivanitskaya, Clark, Montgomery, & Primeau, 2002).

Universities need to train graduates who can fit into the workforce, not only in universities' and colleges' disciplinary units. The modern workplace is highly inter-disciplinary and global. Graduates entering industry require a much higher level of skills across different disciplines. Over-specialization at any level creates barriers to employment. Opportunities to provide a broader skills base in student training, along with greater contact with industrial research, should be explored through applied and professional science programs (Bililign, 2013). It should be noted that inter-disciplinary training does not necessarily mean that a person becomes "inter-disciplinary," rather that he/she is able to work well with other disciplines, appreciates and has respect for them, and is able and willing to seek them out when there is a need for another discipline.

A number of universities across the world have realized the importance of inter-disciplinary research and have been in the forefront of the effort (Sa, 2008). Some examples in the US include: the Bio-X Program (Niiler, 1999) at Stanford University that supports, organizes, and facilitates inter-disciplinary research connected to biology and medicine. It brings ideas and methods from engineering, computer science, physics, chemistry, and other fields to bear on important challenges in bioscience, creating new collaborative teams, significant biomedical discoveries, and new opportunities in fields outside biology. Bio-X includes 44 faculty more than 400 faculties from across the university. The Beckman Institute at the University of Illinois ((Ledford, 2015), created 25 years ago, continues to attract distinguished faculty members and large team grants. More than 1,500 researchers from more than 40 different University of Illinois departments as diverse as psychology, computer science, electrical and computer engineering, and biochemistry work within and across four research themes (Biological Intelligence, Human-Computer Intelligent Interaction, Integrative Imaging research, and Molecular & Electronic Nanostructures) at the Institute.

The inter-disciplinary trend is also growing in Asia and Latin America and Australia. (Gandhi, 2014; Holton, 2004; Katrenko, 2015; Siedlok, 2009). A 2015 study by researchers with the publisher Elsevier defined inter-disciplinary papers as those that reference journals that are rarely cited together. The report looked only at countries that routinely publish more than 30,000 papers per year to find the 'most inter-disciplinary' countries for 2013. The countries on top in the list are the fast-growing economies, including China, India, Brazil, and South

Korea. Since the start of the 21st Century, national governments and funding bodies in China have put intensive effort into stimulating IDRE and universities in China have launched several cross-cutting centers over the past decade, including the Academy for Advanced Interdisciplinary Studies at Peking University in Beijing. Moreover, the importance of IDRE is recognized in China's National Guideline on Medium- and long-Term Program for Science and Technology Development 2006-2020.

In the US some private universities—for example Dartmouth and Olin— and public institutions like UC Merced are experimenting with inter-disciplinary organization that involves a non-traditional university structure. When University of California, Merced (UC Merced) was established in 2005, it eschewed traditional department silos and majors in favour of an inter-disciplinary organization (Kemsley, 2013). UC Merced features a unique academic structure that removes barriers to inter-disciplinary research common in traditional departments and fosters strong ties with physical sciences research to life sciences, materials science, and engineering. Olin College was established in 2001 with a generous endowment and hopes to break with tradition to produce technology-minded engineering entrepreneurs for the 21st century (Irving, 1998). The College **is not** organized with traditional academic departments. Instead the faculty operates as a single inter-disciplinary unit with offices assigned to faculty members without any regard to discipline. The College intends to develop a culture of innovation and continuous improvement (National Academy of Sciences, 2005). We can learn from the innovative approaches at Dartmouth, Olin, and UC Merced. They demonstrate that radical university structural changes are more easily accomplished with start-up colleges (e.g. Olin and UC Merced). These programs can serve as models for what is to be done in Higher Education and may serve well new emerging universities in the developing World.

Higher education in Ethiopia can learn from these world-wide experiences of countries that consciously decided to invest substantial government revenues in building world-class laboratories to support inter-disciplinary research education and research in science and technology. They have seen enormous returns as evidenced by the growth of their skilled and advanced workforce, undergirding their emergence as major players in the global science-based economy.

The new universities in Ethiopia have the opportunities to be innovative and be organized in a very different way to serve the needs of the country and facilitate economic development. In particular the new emerging universities can champion very innovative collaborative inter-disciplinary educational and research programs which are proving to be very difficult and challenging in older well-established universities due a huge inertia for change.

Successful inter-disciplinary programs can be built if some or all of the issues below are addressed.

1. Successful inter-disciplinary research can happen only when it is done by **disciplinary experts** who remain leaders in their field. Any advantages that inter-disciplinary research and education holds depend on the presence of experts with strong backgrounds in their disciplines. Creating inter-disciplinary programs should go hand in hand with strengthening the disciplines.
2. A clear vision, goals, and strategy are essential for inter-disciplinary research. This requires establishing broad research directions and specific research plans. Not all ideas are suited to inter-disciplinary research. The vision should be aligned with the long- and short-term national economic growth strategies.
3. To realize the vision there should be a clear strategy to help remove barriers that hinder inter-disciplinary research and education (university structure, reward system, disciplinary jargon, disciplinary pride, investment priority etc.) (Caruso, 2001; Naomi Jacobs, 2010) by helping to make institutions of higher learning interactive community of scholars who are not defined by the arbitrary boundaries of divisions and units (departments) but instead live in an intellectual environment defined by research goals where each member of the faculty is comfortable in collaborating with others to contribute and learn from others (D. Crane, 1972).
4. Successful inter-disciplinary research typically requires creating and sustaining an inter-disciplinary culture at universities (J. Klein, 2010; J. T. Klein, 2010). Inter-disciplinary culture is built by making the right decisions about the kinds of individuals to recruit into a program and making an intentional effort to attract people who can excel at inter-disciplinary research (Massey et al., 2006).

5. Individuals participating in IDRE need to understand the risk (Rhoten & Parker, 2004), associated with IDRE. It could be threatening on both a personal and an institutional level. Willingness to sacrifice some independence and autonomy in favor of interdependence and group identity and letting go of individual status and ego and to trust others is needed.
6. Inter-disciplinary programs, centers and institutes can be formed through a top-down (research centers and institutes built by government or university administration to address major scientific or social challenges) or a bottom-up (faculty coming together to solve a problem and seek funding to do it) process (Sa, 2008), but in either case, institutional leadership is critical. Leaders who are trusted and with integrity to bridge the differences between departments and can effectively negotiate with the departments are needed to make IDRE a success.
7. Centers and institutes should be independently funded and independently administered. These research units should be structured to overcome stagnation by continuous assessment of the programs and the workforce needs (Mansilla, Feller, & Gardner, 2006; Massey et al., 2006).
8. Research centers and institutes should work closely with their academic counterparts (departments) and be encouraged to use new knowledge developed through IDRE to be incorporated into new inter-disciplinary courses. Inter-disciplinary education must supplement disciplinary teaching and learning so that students can learn how to respond to challenges that transcend their specific disciplines, work at the interface of multiple disciplines, and develop research trajectories that do not conform to standard disciplinary paths. Inter-disciplinary programs should have opportunities to hire faculty that have expertise at the interface of disciplines and can be hired jointly by multiple departments. (For example a computational scientist or engineer can fit multiple departments).
9. The physical location of inter-disciplinary research can be an important factor in its success. This could either be a departmental building, in a building designated for inter-disciplinary research, or off-campus. Building common shared core facilities for research will encourage collaboration and is often very cost effective.

Integrating Research and Education and Recruiting and Training of Undergraduate Research Assistants

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One of the main challenges for academic institutions today is to remain the backbone of economic growth by being sources of new knowledge, innovative thinking and skilled personnel. Concern with workforce quality and technological innovation has moved higher education into the forefront of national and international debates with increasing pressures from business and political leaders who insist that colleges and universities help meet the challenges of a new economy. There is an increasing demand by universities on faculty to do research. There are also demands for increased public accountability on universities to strengthen the connection between research and teaching (Commission, 1998; Jenkins, 2005; Zubrick, 2001). Linkage of research and teaching in academic work makes university education distinctive, and most effective teachers are those engaged in research and scholarship that are able to transmit the excitement of science into the classroom.

It is often is difficult to bring current research results into the classroom in the physical sciences and engineering because the hierarchical knowledge structures in those disciplines put most research well over the heads of most undergraduates, and the rigidly constrained curricula limit opportunities to bring in new material (Colbeck, 1998). However, students' interest in science and engineering courses is enhanced when they see the applications of the course material in real life. Retention of students in science and engineering areas can be facilitated by education that integrates research, since students are strongly attracted to issues and findings with societal relevance (National Academy of Sciences, 2005) and show increased enthusiasm about problems of global importance that have practical consequences (Golding, 2009).

The integration of research and education could be promoted by creation of a research and education environment with research programs that provide multi-disciplinary, team-driven,

and system-oriented educational opportunities for students (Tranter, 2007). Complexity of the problem shouldn't be a reason not to integrate research into the classroom. In fact, it should be the very reason to do it. There is considerable education research evidence that shows that learning occurs when students are given challenging tasks beyond their comfort zone (Vygotsky, 1978). Authentic science engagement (i.e. via discovery-based research courses or independent research on faculty projects, as opposed to standard laboratory courses) encourages individual ownership of projects and provides "a direct way for students to experience real discovery and innovation and to be inspired by science, technology, engineering and mathematics (STEM) subjects" (PCAST, 2012).

Common misconceptions regarding education and research (Avila, 2003) are: (1) Instructors often assume that the way they learned is *the* way to learn. This attitude ignores the wealth of research in cognitive sciences. (2) Research faculty often think involving undergraduates is a distraction and believe undergraduates can't do research. (3) Scientists often don't think that they have the time to learn about what education experts have to offer. Avoiding these misconceptions and instead looking toward solutions would aid faculty in their efforts to integrate research and education.

Teaching should enhance the skills, knowledge, and competencies students will need to meet the quickly evolving demands of life, work, and global citizenship in the 21st century. Beyond passing exams and assigning grades, teaching and learning should focus on core transferable skills that include: (1) critical thinking and complex problem-solving, the key function of education is to teach students to think critically, creatively, and effectively (Fisher, 2003). It is precisely the capacity to think which enables students to acquire new knowledge and replace old knowledge by new (Hamers, 1997), (2) working collaboratively, (3) communicating effectively across disciplines and cultures, and (4) learning how to learn and wanting to learn. These are skills that would allow graduates to be effective employees in the labor force and are developed through the integration of research and education. The experience from Australia (Brew, 2010) suggests that once faculty members begin to base the design of curriculum on research and scholarship and engage students in a variety of research-based approaches, student experiences are seen to improve.

A number of conceptual models propose ways of bringing teaching and research together in the learning environment**.** Ron Griffith (Griffiths, 2004) proposed four models of the links between teaching and research:

1) *Research-led teaching* - In this approach the content of a course is selected based on the special research interests of the faculty member teaching the course with the emphasis on understanding research findings rather than research processes. Ways to optimize opportunities for students to actively engage in STEM are accomplished by direct experiences in research labs and field settings, asking questions, collecting data, making interpretations, and developing scientific skills (AAAS, 1989).

2) *Research-orientated teaching* – In this approach more emphasis is placed on understanding the processes by which knowledge is produced. Research and teaching can be integrated more effectively by introducing students in their classes to the research process and research skills.

3) *Research-based teaching* - In this approach courses are designed largely around inquiry-based activities, rather than on the acquisition of subject content. The experiences of faculty members in the processes of inquiry are highly integrated into the student's learning activities, and the division of roles between teachers and student is minimized. It has been hypothesized that students who learn by inquiry-based teaching strategies will show a greater understanding of content and concept acquisition than students learning through expository learning (Brown, 1997; Rutherford, 1964, 2005).

4) *Research-informed teaching* - This approach involves systematic inquiry into the teaching and learning process itself. Here the connection between faculty research and undergraduate teaching is broadened to include forms of scholarship other than conventional frontier research, such as research on teaching and learning (Bransford, 2000), motivations for student learning (Edelson, 2001), and exploring the non-cognitive aspects of learning such as growth mindset, goal-setting, persistence, and delayed gratification (C. S. Dweck, 1999; C.S Dweck, 2006; Carol S. Dweck, 2008; D. S. Yeager & Dweck, 2012; D. S. J. Yeager, Rebecca; Spitzer, Brian James; Trzesniewski, Kali H.; Powers, Joseph; Dweck, Carol S., 2014). If faculty members study innovative instructional methods, evaluate the extent to which the methods improve knowledge acquisition and skills development, apply the outcomes to their own courses, and publish relevant findings that can be used by other

instructors to improve their teaching, it is reasonable to hypothesize that improved learning should result.

Universities should place greater emphasis on pedagogies that are student-focused, treating students as participants with emphasis on research processes and problems. Research-led teaching is not just for high-performing students or just for elite institutions, but all students at all institutions need research-enhanced and research-led teaching and learning to be successful in the 21st century economy.

Engaging students in research projects is frequently cited as an effective way of linking faculty research and undergraduate teaching. Research experiences for undergraduates (REUs) have advantages for students, universities, and industry. Benefits of REUs for students that include improved skills in problem-solving, analysis, writing, communication, and managing time have been documented (EMERSON, 2007; Millspaugh & Millenbah, 2004; Russell, Hancock, & McCullough, 2007). Institutions benefit because recruitment and retention of good students is increased as a result of undergraduates having research opportunities (Lanza, 1988). Major corporations are also using REU experiences as hiring criteria (Karukstis, 2009).

Undergraduate student research involvement has correlated positively with students' attainment of the bachelor's degree, commitment to the goal of making a theoretical contribution to science, and self-reported growth in preparation for graduate or professional school (Astin, 1994; Heath, 1992). REU experiences promotes cognitive gains (Rauckworst, 2001), and intellectual development (Felder, 2005). Involving undergraduate students in research also promotes the acquisition of research-related skills (Kardash, 2000; Lopatto, 2004; Ryder, Leach, & Driver, 1999; Seymour, Hunter, Laursen, & DeAntoni, 2004; Zydney, 2002). Seymour et al. (Seymour et al., 2004) report student claims that research helped them "think like a scientist," and Lopatto (Lopatto, 2004) reports students' self-assessed gains in understanding the research process as a result of their own research experiences, lending substantial support to the proposition that undergraduate research is an educational and personal-growth experience with many transferable benefits.

Developing undergraduate research involves recruitment, setting clear goals for the students and faculty, mentoring, and proper design of the educational experience. The book *How to Get Started in STEM Research with Undergraduates* (Schuh, 2013) provides a general discussion of these special issues and discusses ways to deal with them. Examples of such issues include: setting up and managing a research laboratory, designing student research projects, working with administrators, writing successful grant proposals, integrating research into the classroom, dealing with information management, and making optimal use of the primary literature

***Quotations cited in this text are listed in REFERENCES, pages 45-47**

References for *Inter-Disciplinary Educational and Research Programs for a Success of Research-Intensive Universities in Ethiopia*

Aboelela SW, Larson E, Bakken S, Carrasquillo O, Formicola A, Glied SA, Haas J, Gebbie KM. (2007). Defining interdisciplinary research: conclusions from a critical review of the literature. *Health Serv Res. , 42*(1), 329-346.

Bililign, S. (2013). The Need for Interdisciplinary Research and Education for Sustainable Human Development to Deal with Global Challenges. *International Journal of African Development 1*(1).

Caruso, D.; Rhoten D. (2001). Lead, follow, get out of the way: sidestepping the barriers to effective practice of interdisciplinarity. The Hybrid Vigor Institute.

Catherine Lyall, Ann Bruce, Joyce Tait, Laura (2011). *Interdisciplinary Research Journeys: Practical Strategies for Capturing Creativity*. London: Bloomsbury Acadmeic.

Council, National Research. (2012). Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century. In J. W. P. a. M. L. Hilton (Ed.), *Committee on Defining Deeper Learning and 21st Century Skills*. Washington DC: The National Academies Press.

D. Crane. (1972). *Invisible Colleges: Diffusion of Knowledge in Scientific Communities* Chicago, IL: University of Chicago Press.

Edward G. Derrick, Holly J. Falk-Krzesinski, Melanie R. Roberts,. (2012). Facilitating Interdisciplinary Research and Education: A Practical Guide. http://www.aaas.org/report/facilitating-interdisciplinary-research-and-education-practical-guide.

Foundation, National Science. (2008). Integrative Graduate Education and Research Traineeship (IGERT): 2006-2007 Annual.

Report. Arlington VA: National Science Foundation.

Gandhi, Divya. (2014). Indian science should embrace an interdisciplinary approach, *The Hindu -SCI-TECH*.

Holton, J.R. (2004). *An Introduction to Dynamic Meteorology*. Grandview Heights, OH, U.S.A: Elsevier Acad. Press.

Irving, C. . (1998). Well-educated Bricklayers?Two new colleges hope to produce broadly trained engineers. *National Cross Talk*. http://www.highereducation.org/crosstalk/ct0198/news0198-bricklayers.shtml.

Ivanitskaya, Lana, Clark, Deborah, Montgomery, George, & Primeau, Ronald. (2002). Interdisciplinary Learning: Process and Outcomes. *Innovative Higher Education, 27*(2), 95-111. doi: 10.1023/A:1021105309984.

Katrenko, Lei Pan and Sophia. (2015). A review of UK's Interdisciplinary Research Using a Citation Based Approach : A Report to the UK HE Funding Bodies and MRC by Elsevier: Elsevier.

Kemsley, J. . (2013). UC Merced turns 10. *Chemical and Engineering News, 91,* 32-33.

Klein, J.. (2010). *Monitoring the Interdisciplinary Career. In Creating Interdisciplinary Campus Cultures*. San Francisco, CA: Jossey Bass and American Association of Colleges and Universities.

Klein, J.T. (2010). *Creating interdisciplinary campus cultures: a model for strength and sustainability* San Francisco, CA: Jossey-Bass.

Ledford, Heidi. (2015). How to solve the world's biggest problems. *Nature, 525, ,* 308–311.

M.J Amey, and D. F Brown. (2006). *Breaking Out of the Box: Interdisciplinary Collaboration and Faculty Work*. Greenwich, Connecticut: Information Age Publishing.

Mansilla, Veronica Boix, Feller, Irwin, & Gardner, Howard. (2006). Quality assessment in interdisciplinary research and education. *Research Evaluation, 15*(1), 69-74. doi: 10.3152/147154406781776057.

Massey, Claire, Alpass, Fiona, Flett, Ross, Lewis, Kate, Morriss, Stuart, & Sligo, Frank. (2006). Crossing fields: the case of a multi-disciplinary research team. *Qualitative Research, 6*(2), 131-147. doi: 10.1177/1468794106062706.

Naomi Jacobs, Martyn Amos. (2010). Removing Barriers to Interdisciplinary Research. *arXiv:1012.4170*.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2005). *Facilitating Interdisciplinary Research*. Washington,DC: National Academy Press.

Niiler, Eric. (1999). $150M for Stanford Bio-X center. *Nature Biotechnology 17,* 1148.

Rhoten, Diana. (2004). Interdisciplinary Research: Trend or Transition. *Items & Issues, 5*, 6-11.

Rhoten, Diana, & Parker, Andrew. (2004). Risks and Rewards of an Interdisciplinary Research Path. *Science, 306*(5704), 2046-2046. doi: 10.1126/science.1103628.

Sa, Creso M. (2008). University-Based Research Centers: Characteristics, Organization, and Administrative Implications. *Journal of Research Administration, 39*(1), 32-40.

Siedlok, F., & Hibbert, P. . (2009). *Interdisciplinary research: A review of contextual and process factors.* Paper presented at the Australia and New Zealand Academy of Management: Sustainable Management and Marketing, Melbourne, Australia.

Van Hartesveldt, C. & Giordan, J. . (2008). Impact of transformative interdisciplinary research and graduate education on academic institutions *NSF 09-33, IGERT Workshop Report* Arlington, VA: National Science Foundation.

References for *Integrating Research and Education and Recruiting and Training of Undergraduate Research Assistants*

AAAS. (1989). Project 2061 Science for All Americans. Washington DC: American Association for the Advancement of Science.

Astin, A.W. (1994). *What Matters in College? Four Critical Years Revisited*. San Francisco, CA: Jossey-Bass Inc., .

Avila, Bridget K.B. (2003). Integrating Research and Education: Biocomplexity Investigators Explore the Possibilities: Summary of a Workshop Planning Group for the Workshop on Integrating Education in Biocomplexity Research. Washington DC: National Academies Press.

Bransford, J., Brown, A. L., & Cocking, R. R. (Eds.) (2000). *How People Learn: Brain, Mind, Experience, and School*. Washington DC: National Academy Press.

Brew, Angela. (2010). Imperatives and challenges in integrating teaching and research. *Higher Education Research & Development, 29*(2), 139-150. doi: 10.1080/07294360903552451

Brown, Ann L. (1997). Transforming schools into communities of thinking and learning about serious matters. *American Psychologist, 52*(4), 399-413.

Colbeck, Carol L. (1998). Merging in a Seamless Blend: How Faculty Integrate Teaching and Research. *The Journal of Higher Education, 69*(6), 647-671. doi: 10.2307/2649212.

Commission, Boyer. (1998). *Reinventing Undergraduate Education: A Blueprint for America's Research Universities*. Stony Brook: Carnegie Foundation for the Advancement of Teaching.

Dweck, C. S. . (1999). *Self theories: Their role in motivation, personality, and development. Philadelphia, PA*: Psychology Press/Taylor and Francis.

Dweck, C.S. (2006). *Mindset: The New Psychology of Success*: Ballantine Books.

Dweck, Carol S. (2008). Can Personality Be Changed? The Role of Beliefs in Personality and Change. *Current Directions in Psychological Sciences, 17*(8), 391-394.

Edelson, Daniel C. (2001). Learning-for-use: A framework for the design of technology-supported inquiry activities. *Journal of Research in Science Teaching, 38*(3), 355-385. doi: 10.1002/1098-2736(200103)38:3<355::AID-TEA1010>3.0.CO;2-M.

EMERSON, Norlene R. (2007). ENGAGING INTRODUCTORY STUDENTS IN INDEPENDENT RESEARCH AT A TWO-YEAR COLLEGE. *Geological Society of America Abstracts with Programs, 39*(6), 252.

Felder, R.M., and R. Brent. (2005). Understanding Student Differences. *Journal of Engineering Education, 94*, 57–72.

Fisher, R. (2003). *Teaching Thinking: Philosophical Enquiry in the Classroom'*. London: Continuum.

Golding, C. (2009). *Integrating the Disciplines: Successful Interdisciplinary Subjects*. University of Melbourne: Centre for the Study of Higher Education.

Griffiths, Ron. (2004). Knowledge production and the research–teaching nexus: the case of the built environment disciplines. *Studies in Higher Education, 29*(6), 709-726. doi: 10.1080/0307507042000287212.

Hamers, JHM & Overtoom, MTh. (1997). Teaching Thinking in Europe: Inventory of European Programmes. Utrecht, The Netherlands: Sardes.

Heath, T. (1992). *Predicting the Educational Aspirations and Graduate Plans of Black and White College and University Students: When Do Dreams Become Realities*. Paper

presented at the Association for the Study of Higher Education Annual Meeting,, Minneapolis, MN.
Jenkins, A.H., and M. Healy. (2005). *Institutional Strategies to Link Teaching and Research*. York, UK: The Higher Education Academy.
Kardash, C.M. (2000). Evaluation of an Undergraduate Research Experience: Perceptions of Undergraduate Interns and Their Faculty Mentors. *Journal of Educational Psychology, 92*, 191–201.
Karukstis, David F. Brakke;Mary L. Crowe;Kerry. (2009). Perspective: Reasons Deans and Provosts (and Presidents) Should Value, Support, and Encourage Undergraduate Research. *CURFocus, 30*(1), 10.
Lanza, Janet. (1988). Whys and Hows of Undergraduate Research. *BioScience, 38*(2), 110-112.
Lopatto, David. (2004). Survey of Undergraduate Research Experiences (SURE): First Findings. *Cell Biology Education, 3*(4), 270-277. doi: 10.1187/cbe.04-07-0045.
Millspaugh, Joshua J., & Millenbah, Kelly F. (2004). Value and structure of research experiences for undergraduate wildlife students. *Wildlife Society Bulletin, 32*(4), 1185-1194. doi: 10.2193/0091-7648(2004)032[1185:VASORE]2.0.CO;2.
National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2005). *Facilitating Interdisciplinary Research*. Washington,DC: National Academy Press.
PCAST. (2012). Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics.
Rauckworst, W.H. (2001). *Measuring the Impact of the Undergraduate Research Experience on Student Intellectual Development*. Paper presented at the Project Kaleidoscope Summer Institute, Snowbird, UT.
Russell, Susan H., Hancock, Mary P., & McCullough, James. (2007). Benefits of Undergraduate Research Experiences. *Science, 316*(5824), 548-549. doi: 10.1126/science.1140384
Rutherford, F. James. (1964). The role of inquiry in science teaching. *Journal of Research in Science Teaching, 2*(2), 80-84. doi: 10.1002/tea.3660020204.
Rutherford, F. James. (2005). The 2005 Paul F-Brandwein Lecture: Is Our Past Our Future? Thoughts on the Next 50 Years of Science Education Reform in the Light of Judgments on the Past 50 Years. *Journal of Science Education and Technology, 14*(4), 367-386. doi: 10.1007/s10956-005-8082-3.
Ryder, Jim, Leach, John, & Driver, Rosalind. (1999). Undergraduate science students' images of science. *Journal of Research in Science Teaching, 36*(2), 201-219. doi: 10.1002/(SICI)1098-2736(199902)36:2<201::AID-TEA6>3.0.CO;2-H.
Schuh, Merle. (2013). *How To Get Started in STEM Research with Undergraduates*. Washington DC: Council of Undergraduate Education.
Seymour, Elaine, Hunter, Anne-Barrie, Laursen, Sandra L., & DeAntoni, Tracee. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: First findings from a three-year study. *Science Education, 88*(4), 493-534. doi: 10.1002/sce.10131.
Tranter, E.A. . (2007). *Integration of Research and Education in a Multi-Institutional Centre. .* Paper presented at the International Conference on Engineering Education – ICEE 2007, Coimbra, Portugal.
Vygotsky, L. . (1978). *Mind in Society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Yeager, David Scott, & Dweck, Carol S. (2012). Mindsets That Promote Resilience: When Students Believe That Personal Characteristics Can Be Developed. *Educational Psychologist, 47*(4), 302-314. doi: 10.1080/00461520.2012.722805.

Yeager, David Scott; Johnson, Rebecca; Spitzer, Brian James; Trzesniewski, Kali H.; Powers, Joseph; Dweck, Carol S. (2014). The far-reaching effects of believing people can change: Implicit theories of personality shape stress, health, and achievement during adolescence. *Journal of Personality and Social Psychology, 106*(6), 867-884.

Zubrick, A., I. Reid, and P. Rossiter. (2001). *Strengthening the Nexus between Teaching and Research*. Canberra, Australia: Commonwealth of Australia.

Zydney, A.L., J.S. Bennett, A. Shahid, and K.W. Bauer. (2002). Impact of Undergraduate Research Experience in Engineering. *Journal of Engineering Education, 91*, 151–157.

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