



COMMENT

Received 24 Oct 2014 | Accepted 18 Dec 2014 | Published 20 Jan 2015

DOI: 10.1057/palcomms.2015.1

OPEN

Interdisciplinary trends in higher education

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ABSTRACT The knowledge economy requires an adept workforce and cadre of leaders to help address the many challenges and needs facing companies, governments and societies worldwide. Many of the challenges we face today are new and there will undoubtedly be others arise in the future that will require innovative approaches and solutions to overcome them. No longer are higher education institutions able to train graduates to address all of the current and emerging challenges from a singular disciplinary source. Interdisciplinary (ID) approaches to research and training are essential underpinnings to best meet the dynamic needs of today's higher education students. As the first in a series of forthcoming articles on ID research, this article examines ID trends in higher education research, instruction and degree offerings. It highlights how central ID solutions are in helping to address some of the most complex needs and challenges in higher education today, including how best to prepare higher education graduates for future employment and leadership positions.

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Introduction

This article is the first contribution in a series on interdisciplinary (ID) research that will be showcased on a regular basis within *Palgrave Communications*, an open access journal with a commitment to quality and publishing articles representing all theoretical and methodological perspectives. The *Interdisciplinary Research Series* will include article contributions on country case studies; trends in scholarly output and degree offerings by discipline; and other areas that influence ID research including pedagogy, technology and the contexts in which higher education research is conducted.

Higher education disciplinary approaches often tend to focus only on a set of trees within a great forest. While disciplinary experts are essential for understanding particular ways of knowing within specific fields of study, their perspectives in addressing larger and more complex issues is often limited. ID approaches take a much broader view of the entire landscape, first by surveying the forest and afterwards drawing upon various tree experts depending on the needs, contexts and circumstances. Societal, environmental, economic, and philosophical issues and challenges are often so complex that it is impossible to fully understand them from a single perspective or knowledge framework. Multiple viewpoints can help draw from and leverage synergistic team efforts within higher education circles to address these broad and complex issues and challenges. Integrated efforts of researchers from multiple backgrounds and areas of expertise show the advantage of an ID approach to problem solving, innovation, training next generation leaders, and advancing research and development.

The terms ID and *interdisciplinarity* are often used interchangeably in the literature.¹ The former is an adjective and the latter a noun. ID practices in higher education refers to the integration of two or more disciplines or fields of study in relation to research; instruction; and programme, certification and/or degree offerings. Interdisciplinarity can exist within a single higher education institution (HEI) or between two or more HEIs. There are many types of ID practices within the higher education literature, including critical interdisciplinarity² (Klein, 2005, 2010), distal interdisciplinarity³ (Chavarró *et al.*, 2014), eclectic interdisciplinarity,⁴ instrumental interdisciplinarity⁵ (Repko, 2011), ID capacity building (Lyall and Meagher, 2012), ID management, ID team work (Nancarrow *et al.*, 2013), multidisciplinary (Moran, 2010), participatory interdisciplinarity (O'Brien *et al.*, 2013) and transdisciplinary.

There have been consistent calls for an increase in ID activities in higher education, yet the traditional nature of the institutions have many barriers that in many ways discourage or prevent such activities from materializing. Higher education organizational cultures and structures often prevent researchers from collaborating. Funding streams and promotion and tenure criteria often perpetuate traditional cultural and structural norms within disciplinary departments and schools. The silo syndrome that permeates so many HEIs worldwide at the very least discourages ID practices and at the most eliminates them from happening all together. A paradigm shift is needed to help provide an ID enabling environment to encourage and facilitate ID research, pedagogy and degree offerings.⁶ In many instances higher education policies and management bureaucracies discourage or prevent ID practices.

While there are generalists, or interdisciplinarian scholars who may have expertise from multiple disciplines, the vast majority of ID activities are grounded by faculty members with expertise in a specific field of study. Combining two or more faculty members from at least two fields of study constitutes an ID team for research or instructional purposes. There are often tensions that exist when combining experts from multiple fields, and it always

helps to consider chemistry and fit in ID team building. This helps achieve collaborative or Tuckman's (1965) performing status much quicker than if a hodgepodge of scholars are randomly identified and brought together with little thought considering organizational fit and the various assignments each team member will play. Based largely on the work of Nancarrow *et al.* (2013: 6), the following list provides 10 key characteristics essential for successful ID teams:

1. Leadership and management
2. Effective communication
3. Personal rewards, training and development
4. Appropriate resources and procedures
5. Appropriate skills mix
6. Positive and enabling climate
7. Individual characteristics
8. Clarity of a shared vision
9. Quality and outcomes
10. Respecting and understanding roles

The lack of 1 or more of these 10 characteristics is what causes many higher education ID ventures to fail.

Among the most influential organizations that promote higher education ID activities are the Association for Interdisciplinary Studies, American Educational Research Association, Association for the Study of Higher Education (ASHE), National Academy of Sciences (2005), National Art Education Association, Association des États Généraux des Étudiants de l'Europe and Interdisciplinary Research Group in Organizational Communication at the University of Ottawa, Canada. While these organizations have specific structures in place to advance ID within higher education, the increase in ID research, instruction and degree programmes will undoubtedly lead to future support of ID higher education activities among other leading academic associations in virtually every discipline.

ID research trends

Being able to address the existing and emerging gaps in the literature is increasingly difficult when relying on a single theoretical perspective and research design and analytical approach. Examining the literature in a vast majority of all higher education disciplines highlights the trend "away from disciplinary hypothesis-based research to problem-based, interdisciplinary studies" (ASHE, 2005: 52; see also Rudall and Mann, 2010; Espejo and Rudall, 2011; Romolini *et al.*, 2013; Adams *et al.*, 2014). While single-authored and first-author publications are still relevant in many fields, especially when it comes to promotion and tenure, there is a trend towards co-authoring and collaborating in higher education research and publications. Reis (1997) rightly noted nearly two decades ago how administrators from some disciplines are encouraging emerging scholars to collaborate, and recognize that ID research ability is an important criteria to be considered in the tenure and promotion process. The number of co-authored and multi-discipline authored articles increased during this time period in every discipline according to statistics provided through the Thomson Reuters Web of Science database (Voosen, 2013). Bringing together scholars on a research project enables research teams to conduct a potentially higher order of research that is all inclusive and can offer diverse points of view (van Eeden, 2011).

In recent years, ID research has increased in Turkey across most disciplines according to Basal and Keskin (2013), who provide a cartography of ID trends in research competency by discipline in Turkey from 2007 to 2011. The fields of chemistry, engineering and medicine are identified by Basal and Keskin as particular research strengths for Turkey.

Some research topics can only be addressed through a collaborative ID response. Such is the case with many social, economic and political issues. One of the most notable issues that has transitioned from what was predominantly viewed as a health-only issue to one that is now considered mainstreamed and multisectoral is the global battle against the AIDS epidemic (Kher, 2010). Because of its global impact, the United Nations even established a joint agency (UNAIDS) in 1996 to help coordinate the international response to the pandemic. Governments the world over have followed suit by establishing national AIDS councils to help coordinate multisectoral prevention, care, treatment, mitigation and research efforts nationwide (Osewe, 2009). ID research in many areas enables stakeholders at all levels to draw on common synergies to provide optimal research and learning opportunities:

Increasing recognition that the future of learning is multi-disciplinary or cross disciplinary; campus cultures are trying to break down silos, crosspollinate as many efforts as possible (not only academic, but also physical planning), and encourage students [and other relevant stakeholders] to collaborate and work together across disciplines. (SCUP Academy Council, 2014: 8)

There is also a trend in the increased amount of ID research among graduate students in many fields of study (Fox *et al.*, 2014). Solutions to current and emerging challenges are often best answered through a talented and diverse team with strengths from multiple backgrounds (Morse *et al.*, 2007). Schmidt *et al.* (2012: 296) recognize that many research projects could benefit from “interdisciplinary, international and interorganizational” research partnerships. “Complex environmental problems inevitably require large teams to address them; graduate students must therefore be trained to work on such teams” (298). On the basis of the National Science Foundation’s Survey of Earned Doctorates from 2001 to 2008, 28.4% had dissertations which were considered ID (Millar and Dillman, 2012: 6).

Køppe (2011) and Kroos (2012) argue that the foundation of mixed methods research is “eclecticism”. I prefer the term eclectic interdisciplinarity in that it enables researchers to examine questions based on specific needs and contexts. It also emphasizes the need for researchers to be flexible and to draw from the most appropriate research design and analytical methods to best respond to the respective research questions. Because eclectic interdisciplinarity requires researchers to be flexible, it often requires differing sets of expertise and knowledge that can only be achieved through collaboration of individuals from multiple backgrounds.

Prominent funding agencies continue to advocate for and fund ID research initiatives. Funding agencies like the National Science Foundation and the National Institutes of Health (Lyll and Fletcher, 2013; Aslan *et al.*, 2014; Bloch and Sørensen, 2014; Hunt and Thornsbury, 2014) have long encouraged proposals include ID research team collaboration. Funding is a significant lifeline of innovative academic research and will continue to propel this higher education trend well into the future.

ID teaching trends

Among the most notable areas of interdisciplinarity on higher education campuses occurs within traditional and online classrooms. Teaching in teams and to students from various departments is commonplace at the undergraduate level. But increasingly there are needs to bring faculty members from various backgrounds to provide instruction and training within fields of study that were previously taught by their own faculty.

New and emerging technologies and business management skills are among the most sought after supplemental courses that are part of standard curricula in many disciplines today (Lorenzen-Huber *et al.*, 2010; Loewer, 2012). Technology shifts occur at such a rapid rate that it is virtually impossible to keep up with them through the traditional tenure stream faculty lines.

Many teaching subjects are by nature ID. Research methods, gender, international development, organizational management, ethics and values, and environmental studies are some examples of such courses that attract ID students. Cross-cutting course themes and instructional topics often require team teaching to help provide the necessary content and training to class members. One of the most obvious advantages from a student’s standpoint is the reality that multiple instructors enriches a student’s learning experience through diversity exposure and multiple points of view.

Technology teaching shifts have helped faculty members from different fields of study and even different universities collaborate through a variety of co-instruction approaches. Shifting some of the instruction to online and hybrid delivery mediums is quickly becoming the global standard of higher education course instruction (McCray, 2000; Howell *et al.*, 2003; Keengwe and Kidd, 2010; Ehrenberg, 2012; New Media Consortium, 2013). Massive open online courses (MOOCs) bring in a new dynamic in ID teaching, in that they often enrol students from many different majors as well as non-degree seeking students. People who want to develop a new skill or learn more about a certain subject often enrol in a MOOC. Instructors who have developed MOOCs are generally experts in their respective fields; however, often lack the technical skills to develop a highly interactive and effective online delivery (Santos *et al.*, 2014). This requires substantial institutional support or outsourcing the technical aspects of the course design and delivery to one of the major MOOC providers (for example, Coursera, Udacity, edX, Canvas and NovoED).

Increase in ID programmes and degree offerings

Evidence shows the increase in two or more discipline based degrees over the past 40 years (see, for instance, Brint *et al.*, 2009; Jacobs, 2014). The types of degree offerings vary substantially, but the list continues to grow. Among the most common ID fields include organizational behaviour, management, political science, public health, international studies, international development, human resource management, history, music, environmental studies, biomedical sciences, law, engineering, rural development, agro-physics, agro-chemistry and energy studies (see Humphrey *et al.*, 2005; Mirabella, 2007; Kurup and Arora, 2010). These degree programmes are best offered through an integrated team teaching approach that provides students with the necessary ID underpinnings required to perform well in both the private and public sectors (Abraham *et al.*, 2006). There is a need to draw from multiple disciplines to provide the necessary training required for many degrees, including at the master’s and doctoral levels (Gonzales *et al.*, 2012; Vale *et al.*, 2012).

The rationale for increased ID higher education training is clear. Employment demands are drastically different today than they were in the past. Many employers recognize the need to hire recent graduates who are equipped with sufficient competencies, skills and an ability to adapt to change and diverse settings. Employers understand how important it is for graduates to be able to work as a member of a team as well as being able to understand certain core disciplinary competencies. In the post-Enron Scandal Era, there is likewise a renewed emphasis that business, accountancy and law graduates should have training and commitment to sound business ethics and character values.

Liberal arts schools that provide a solid general education for one or more years, followed by a specialization in a specific

discipline highlights the role ID programmes play throughout many HEIs in the United States and across the globe (Baker *et al.*, 2012; Scott, 2014). Liberal arts schools have traditionally adapted to change and are continuing to do so today (Spellman, 2009; Bonvillian and Murphy, 2014). Those that do not adapt, however, are finding it difficult to remain competitive and are facing tough choices to discontinue certain majors and degree programmes (Smith II, 2014).

While some scholars and practitioners disagree with the treatise that technology by itself enhances pedagogical outreach, there is no question that technology has helped facilitate the trend towards increased ID programmes and degree offerings (Ertmer, 2005; Laurillard, 2009; Hoekstra and Mollborn, 2012).⁷ The advancement of instructional technology has brought wider participation potential from across higher education campuses, as well as unprecedented inter-campus collaboration potential. Thus, joint degree programmes and certificate offerings are viewed as more realistic or doable within today's technological frameworks compared with anything we have experienced in the past. This bodes well for those interested in advancing ID programmes and degree options for current and future students.

Universities of the future

Higher education literature trends indicate an increase in ID research, teaching and student degree offerings. In addition to ID increases within HEIs, there are also trends that lead to increased ID activities between two or more institutions. Competitive degree programmes in the future may follow the Universitas 21 network model or the Semester Online consortium model developed by 2U and 13 HEIs in Australia, Ireland, and the United States that jointly offered courses online to students from participating universities. University consortia exist at many levels, including in the areas of joint funding procurement, course offerings and degree offerings. While expansion of ID activities is inevitable, there are also cautions that quality should be continually examined and maintained. This is especially difficult when multiple governance structures are in place. Quality is of particular concern when expanding ID activities with partners overseas (Hockenos, 2014).

Sustainable ID higher education initiatives are those which require commitment from senior administrators, including the investment of personnel, time and physical space (see, for instance, McCoy and Gardner, 2012). This top-level administrative support includes reward structures for promotion and tenure, as well as for student advancement towards their degree. Higher education policies need to be established to encourage and facilitate ID activities. Capacity-building initiatives and human resource training is essential if HEIs are able to institutionalize ID as a core area of research, instruction and programme offerings.

This is the first of several articles that will appear on interdisciplinarity in higher education in this journal. Forthcoming articles will examine ID research activities from several multidisciplinary angles, including in neuroscience and media studies; sports, media and psychology; and sociology and culture studies. Other topics will examine trends in ID publishing in leading SCI and SSCI journals, the development of ID majors and degree programmes, and innovative ID programmes among world-class universities.

Notes

- 1 Slavicek (2012) provides a good history of the terms ID and interdisciplinarity.
- 2 Critical interdisciplinarity seeks to address dominant challenges and issues within society through transformation, revolution and long-term change.
- 3 This is defined as the tendency for higher education researchers from particularly different or disparate disciplines to come together for research or instructional purposes more frequently than those from more similar disciplines.

- 4 Eclectic interdisciplinarity leverages whatever higher education resources are necessary to help respond to a question, problem or need. It emphasizes the need to be adaptable and recognize that our approach to solving problems sometimes change with time and based on unique and differing circumstances and contexts.
- 5 Instrumental interdisciplinarity is defined as a pragmatic way of problem solving based on needs and circumstances.
- 6 The Consortium of National Arts Education Associations (2002: 5) suggests that higher education administrators need to focus on establishing the following conditions to help facilitate an ID enabling environment: (1) common planning time or sufficient opportunities to meet with other teachers; (2) access to local, state and national standards and curriculum in the disciplines; (3) flexible scheduling; (4) appropriate resources; (5) ongoing professional development; (6) curriculum development; (7) community support and involvement; and (8) administrative support and involvement.
- 7 Some scholars argue that geographic location and distance remain significant challenges for all teaching scenarios, including with ID-based curricula. On-site instruction technologies are difficult to replace or replicate online, regardless of the available technology. Many students continue to long for the face-to-face interaction that only exists in the traditional higher education classroom, so it is difficult to say that technology will entirely replace the traditional classroom.

References

- Abraham T *et al* (2006) IT workforce trends: Implications for IS programs. *Communications of the Association for Information Systems*; **17** (50): 1147–1170.
- Adams W C, Infeld D L, Minnichelli L F and Ruddell M W (2014) Policy journal trends and tensions: JPAM and PSJ. *Policy Studies Journal*; **42** (Supplement S1): S118–S137.
- Aslan C E, Pinsky M L, Ryan M E, Souther S and Terrell K A (2014) Cultivating creativity in conservation science. *Conservation Biology*; **28** (2): 345–353.
- Association for the Study of Higher Education (ASHE) (2005) Professionalizing science and engineering. *ASHE Higher Education Report*; **31** (4): 51–74.
- Baker V L, Baldwin R G and Makker S (2012) Where are they now? Revisiting Breneman's study of liberal arts colleges: Shared futures, difficult choices. *Liberal Education*; **98** (3): 48–53.
- Basal T and Keskin G (2013) Turkey's Scientific Research Output is Booming—But What about the Quality? Available online at: <http://www.elsevier.com>, accessed 17 December 2014.
- Bloch C and Sørensen M P (2014) The size of research funding: Trends and implications. *Science and Public Policy*. doi:10.1093/scipol/scu019.
- Bonvillian G and Murphy R (2014) *The Liberal Arts College Adapting to Change: The Survival of Small Schools*. Routledge: New York.
- Brint S G, Turk-Bicakci L, Proctor K and Murphy S P (2009) Expanding the social frame of knowledge: Interdisciplinary, degree-granting fields in American Colleges and Universities, 1975–2000. *Review of Higher Education*; **32** (2): 155–183.
- Chavarro D, Tang P and Rafols I (2014) Interdisciplinarity and research on local issues: Evidence from a developing country. *Research Evaluation*; **23** (3): 195–209.
- Consortium of National Arts Education Associations (2002) *Authentic Connections: Interdisciplinary Work in the Arts*. American Alliance for Theatre and Education, Music Educators National Conference, National Art Education Association, National Dance Education Organization: Tempe, AZ; Reston VA; Bethesda, MD.
- Ehrenberg R G (2012) American higher education in transition. *The Journal of Economic Perspectives*; **26** (1): 193–216.
- Ertmer P A (2005) Teacher pedagogical beliefs: The final frontier in our quest for technology integration?. *Educational Technology Research and Development*; **53** (4): 25–39.
- Espejo R and Rudall B H (2011) Research and development: Current impact and future potential. *Kybernetes*; **40** (3/4): 581–584.
- Fox J A, Baloy N and Sens A (2014) Mix and match: Promoting interdisciplinary teaching, learning, and community through classroom-level partnerships. *Collected Essays on Learning and Teaching*; **7** (2).
- Gonzales R, Handley M A, Ackerman S and O'sullivan P S (2012) A framework for training health professionals in implementation and dissemination science. *Academic Medicine: Journal of the Association of American Medical Colleges*; **87** (3): 271–278.
- Hockenos P (2014) Academic values often give way as universities expand overseas programs. *The Chronicle of Higher Education* 15 April.
- Hoekstra A and Mollborn S (2012) How clicker use facilitates existing pedagogical practices in higher education: Data from interdisciplinary research on student response systems. *Learning, Media and Technology*; **37** (3): 303–320.
- Howell S L, Williams P B and Lindsay N K (2003) Thirty-two trends affecting distance education: An informed foundation for strategic planning. *Online Journal of Distance Learning Administration*; **6** (3): 23–35.
- Humphrey J D, Coté G L, Walton J R, Meiningner G A and Laine G A (2005) A new paradigm for graduate research and training in the biomedical sciences and engineering. *Advances in Physiology Education*; **29** (2): 98–102.

- Hunt F and Thornsbury S (2014) Facilitating transdisciplinary research in an evolving approach to science. *Open Journal of Social Sciences*; **2** (4): 340–351.
- Jacobs J A (2014) *In Defense of Disciplines: Interdisciplinarity and Specialization in the Research University*. University of Chicago Press: Chicago, IL.
- Keengwe J and Kidd T T (2010) Towards best practices in online learning and teaching in higher education. *MERLOT Journal of Online Learning and Teaching*; **6** (2): 533–541.
- Kher U (2010) A call for collaboration. *Nature*; **466** (7304): S21–S22.
- Klein J T (2005) *Humanities, Culture, and Interdisciplinarity: The Changing American Academy*. University of New York Press: Albany, NY.
- Klein J T (2010) A taxonomy of interdisciplinarity. In: Klein J T and Mitcham C (eds) *The Oxford Handbook of Interdisciplinarity*. Oxford University Press: Oxford, UK.
- Køppe S (2011) A moderate eclecticism: Ontological and epistemological issues. *Integrative Psychological and Behavioral Science*; **46** (1): 1–19.
- Kroos K (2012) Eclecticism as the foundation of meta-theoretical, mixed methods and interdisciplinary research in social sciences. *Integrative Psychological & Behavioral Science*; **46** (1): 20–31.
- Kurup A and Arora J (2010) *Trends in Higher Education: Creation and Analysis of a Database of PhDs*. National Institute of Advanced Studies, Indian Institute of Science: Bangalore, India.
- Laurillard D (2009) The pedagogical challenges to collaborative technologies. *International Journal of Computer-Supported Collaborative Learning*; **4** (1): 5–20.
- Loewer O J (2012) Teaching the linkages among technology, economics and societal values to interdisciplinary graduate students. *International Journal of Science in Society*; **3** (4): 81–106.
- Lorenzen-Huber L, Allen P and Kennedy-Armbruster C (2010) Synergy and sensibility: A course on entrepreneurship in gerotechnologies. *Gerontology & Geriatrics Education*; **31** (2): 181–197.
- Lyall C and Fletcher I (2013) Experiments in interdisciplinary capacity-building: The successes and challenges of large-scale interdisciplinary investments. *Science and Public Policy*; **40** (1): 1–7.
- Lyall C and Meagher L R (2012) A masterclass in interdisciplinarity: Research into practice in training the next generation of interdisciplinary researchers. *Futures*; **44** (6): 608–617.
- McCoy S K and Gardner S K (2012) Interdisciplinary collaboration on campus: Five questions. *Change*; **44** (6): 44–49.
- McCray G E (2000) The hybrid course: Merging on-line instruction and the traditional classroom. *Information Technology & Management*; **1** (4): 307–327.
- Millar M M and Dillman D A (2012) *Trends in interdisciplinary dissertation research: An analysis of the survey of earned doctorates*. Working Paper NCSES 12-200. National Science Foundation, National Center for Science and Engineering Statistics: Arlington, VA.
- Mirabella R M (2007) University-based educational programs in nonprofit management and philanthropic studies: A 10-year review and projections of future trends. *Nonprofit & Voluntary Sector Quarterly*; **36** (4): 115–275.
- Moran J (2010) *Interdisciplinarity*, 2nd edn. Taylor & Francis: New York.
- Morse W C, Nielsen-Pincus M, Force J E and Wulfhorst J D (2007) Bridges and barriers to developing and conducting interdisciplinary graduate-student team research. *Ecology & Society*; **12** (2): 1–14.
- Nancarrow S A, Booth A, Ariss S, Smith T, Enderby P and Roots A (2013) Ten principles of good interdisciplinary team work. *Human Resources for Health*; **11** (1): 19.
- National Academy of Sciences (2005) *Facilitating Interdisciplinary Research*. National Academies Press: Washington DC.
- Near Media Consortium (NMC) (2013) *NMC Horizon Report: 2013 Higher Education Edition*. NMC: Austin, TX.
- O'Brien L, Marzano M and White R M (2013) “Participatory interdisciplinarity”: Towards the integration of disciplinary diversity with stakeholder engagement for new models of knowledge production. *Science & Public Policy*; **40** (1): 51–61.
- Osewe P L (2009) One National Response: Synergy Networks for Effective HIV Education among Government Agencies, Nongovernmental Organizations, and Development Partners. *Prospects: Quarterly Review of Comparative Education*; **39** (4): 399–412.
- Reis R M (1997) *Tomorrow's Professor: Preparing for Academic Careers in Science and Engineering*. John Wiley & Sons: New York.
- Repko A F (2011) *Interdisciplinary research: Process and theory*, 2nd edn. Sage Publications: London.
- Romolini M, Record S, Garvoille R, Marusenko Y and Stuart Geige R (2013) The Next Generation of Scientists: Examining the Experiences of Graduate Students in Network-Level Social-Ecological Science. *Ecology & Society*; **18** (3): 277–303.
- Rudall B H and Mann C J H (2010) Perceptions of interdisciplinary research and developments. *Kybernetes*; **39** (7): 1093–1096.
- Santos O C, Boticario J G and Pérez-Marín D (2014) Extending web-based educational systems with personalised support through user centred designed recommendations along the e-learning life cycle. *Science of Computer Programming*; **88**: 92–109.
- Schmidt A H *et al* (2012) A new model for training graduate students to conduct interdisciplinary, interorganizational, and international research. *BioScience*; **62** (3): 296–304.
- Scott R A (2014) The meaning of liberal education. *On The Horizon*; **22** (1): 23–34.
- SCUP Academy Council (2014) *Report on Trends in Higher Education Planning 2014*. Society for College and University Planning (SCUP): Ann Arbor, MI.
- Slavicek G (2012) Interdisciplinary—A historical reflection. *International Journal of Humanities and Social Science*; **2** (20): 107–113.
- Smith II, P HII (2014) American politics and the liberal arts college. *Polity*; **46** (1): 122–130.
- Spellman B (2009) *The Resilient Liberal Arts College*. Inside Higher Ed: Washington DC.
- Tuckman B W (1965) Developmental sequence in small groups. *Psychological Bulletin*; **63** (6): 384–399.
- Vale R D, DeRisi J, Phillips R, Dyche Mullins R, Waterman C and Mitchison T J (2012) Interdisciplinary graduate training in teaching labs. *Science*; **338** (6114): 1542–1543.
- van Eeden E S (2011) Environmental history within a revitalized integrative research methodology for today and tomorrow. *Interdisciplinary Science Reviews*; **36** (4): 314–329.
- Voosen P (2013) Microbiology leaves the solo author behind. *Chronicle of Higher Education*; **60** (11): A16.

Additional information

Competing interests: The author declares no competing financial interests.

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How to cite this article: Jacob W J (2015) Interdisciplinary trends in higher education. *Palgrave Communications* 1:15001 doi: 10.1057/palcomms.2015.1.



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