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"Silos" in the Democratization of Science

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"Silos" in the Democratization of Science

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Abstract

Efforts aimed at democratizing science continue to emerge, but these many efforts remain isolated from each other. This article argues that the full impact of democratization efforts will not be felt until they are integrated with each other. Two strategies for integration are proposed: a typology approach and a generative strategy. Uses of such strategies in other areas have been successful and offer pathways for coordinating science efforts. The article ends with recommendations for how such strategies could be pursued to integrate promising but dispersed democratization of science efforts such as citizen science, community based participatory research, participatory action research, and public participation in scientific research.

Keywords: democratization of science, citizen science, community based participatory research, participatory action research, public participation in scientific research, boundary spanning, wicked problems

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"Compartimentos" en la Democratización de la Ciencia

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Resumen

Esfuerzos para democratizar la ciencia continúan emergiendo, pero a veces de manera aislada. Este artículo argumenta que el impacto de estos procesos democratizadores no será significativo si no son integrados entre sí. Para ello se proponen dos estrategias principales de integración: un acercamiento tipológico y una estrategia generativa. Los usos de esas estrategias en otras áreas han sido exitosos y ofrecen vías para conseguir esa integración. El artículo acaba con unas recomendaciones sobre cómo esas estrategias deberían ser llevadas a cabo y así poder integrar los prometedores pero dispersos intentos para democratizar la ciencia ejemplarizados con propuestas como ciudadano/a científico, participación de la comunidad en la investigación, investigación-acción participativa, y la participación pública en la ciencia en general.

Palabras clave: democratización de la ciencia, ciudadano/a científico, participación de la comunidad en la investigación, investigación-acción participativa, participación pública en la ciencia, superando fronteras, problemas complejos

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The democratization of science has become a major preoccupation of our time (Ezrahi, 1990). Efforts aimed at reforming science are occurring on multiple fronts under such names as public participation in scientific research, citizen science, science for the people, science shops, community-based participatory research, actionable science, knowledge co-production, and participatory action research. These separate efforts share a common concern with the need for science to become more democratic, less controlled by elites, and less aimed at research that perpetuates the status quo.

It is no accident, however, that these efforts are occurring under different names. The various efforts at the democratization of science remain siloed, and the varying names reflect the specific preoccupations of particular movements. The science shop movement, for example, has focused on the problem of science too often failing to serve the needs of ordinary people as opposed to large corporations. Actionable research is focused on the problem that the actions and policy implications of research are frequently unclear. Citizen science is focused on science democratizing the data collection process so that citizens play a more central role. Participatory action research is concerned with opening up science so that it is not just scientists who are driving the research agendas. And community-based participatory research is focused on reframing research approaches so that communities become the architects of rather than merely the objects of study.

Silos are also very much in evidence, as well, in the conceptual analyses that have startlingly reframed and moved forward individual science democratization efforts. For example, researchers working in policy arenas have tapped a novel "wicked problem" reconceptualization (Kreuter, DeRosa, Howze, & Baldwin, 2004) to challenge the fundamental research assumption that additional data will inevitably make clearer how to solve a problem. Yet, despite these productive conceptual reframings within individual movements, these paradigmatic shifts remain largely isolated within their particular science democratization efforts.

Future progress in the democratization of science will depend on these separate efforts coming together to overcome their siloes with all

of the attendant fragmentation and duplication. What might help with this integration? In looking for guidance on methods for cross-fertilization, one discovers strategies in other areas that have fostered cross-learning and integration. In the remainder of this paper, an examination of two such cross-learning strategies--a typology approach and a generative strategy--will be used to suggest how disparate efforts within the democratization of science might be brought together.

Typology Approaches to Integration

In the face of siloed efforts, the first step frequently has been to collate and systematize information. As a part of this step, matrices, tables, typologies, taxonomies, rubrics and the like are created to capture the similarities and differences among efforts. There has been a long and grand tradition of turning to such taxonomic approaches. The value of such an approach can be seen, for example, in efforts to make sense of the jumble of activities that proliferated under the umbrella term of university engagement (Brukardt, Holland, Percy, & Zimpher, 2006). Over the last several decades, university engagement activities have burgeoned, yet frequently there has been little cross conversation among these efforts and it has been increasingly unclear how the proliferating efforts relate to one another. Foundations such as Kellogg Foundation, organizations such as Campus Compact, and the Carnegie Classification systems leaders have all stepped into the fray to call for a clearer understanding of the heterogeneous engagement efforts. Holland (Brukardt, Holland, Percy & Zimpher, 2006; Holland, 2009) and others have pioneered efforts to develop typologies that categorize the engagement efforts in instructive ways.

Many positives have resulted. Organizing previously chaotic information has helped move toward greater clarity (e.g., clearer definitions of what is and is not engagement). This matrix approach has been a means of making similarities and differences across activities more evident and more easily grasped (e.g., how engagement practices vary inside and outside of the classroom). Matrices have helped to create the “yardsticks” for comparison and thus allow for integration of what otherwise might be deemed incommensurate activities (e.g.,

diverse faculty activities in very different disciplines). And the matrix analysis approach has been instrumental in identifying gaps: by submitting the different approaches to the same matrix analysis, it becomes more evident what is missing among extant efforts (e.g., the absence of community engagement in some majors).

Yet valuable as this matrix approach has been, it is not without its shortfalls. While creating taxonomies has been helpful in highlighting dimensions that are particularly salient or noticeable, such an approach may downplay less obvious features. Metafeatures such as causal variables are often not well represented. Contextual factors may be neglected. Nor does the matrix approach lend itself to highlighting "why" questions such that particular strategies were undertaken. Strategies are made visible but the reasons for their success remain a mystery. Perhaps even more problematic is that the matrix approach frequently edges from the merely descriptive into the prescriptive. A grid summarizing what exists can lead to conclusions about what should be. Thus, in engagement efforts, the taxonomic can edge toward prescriptions that "x" way of doing engagement is better than "y" way. Orthodoxies that are not suitable for all contexts are sometimes the result.

Finally, there is a problem if efforts at integration stop with the matrix approach. The matrix approach does not lend itself to providing guidance in how to move beyond what currently exists. The approach is not focused on generativity. Creative problem solving is not a core feature of this approach. As Gardner (2009) might note, the matrix approach focuses on the synthesis part of the problem but not the creative part. The matrix approach alone does not encourage the kind of inventiveness that will be needed if the disparate efforts at democratizing science are to be brought together.

The Possibility of Adding a Generative Strategy

A second strategy, what might be called the generative approach, has been gaining currency in many circles as a complement to a taxonomic focus. This generative approach has been found to be highly productive in moving fields forward when extant analyses have become ossified and a matrix focus has gone as far as it can. Under this generative

strategy, two bodies of literature articulating different perspectives might be brought together to reframe a problem. Consider the phrases 'environmental justice,' 'social capital,' 'built environment,' 'social cognition,' 'boundary spanning,' and 'violence as a public health issue.' Each of these phrases captures the productive bringing together of two previously disparate bodies of literature (e.g., environmental issues and justice issues), resulting in the generation of 'game changing' new insights and approaches. Under the social capital framing, communities are understood in new ways by reconceiving of the social connections as a form of unrecognized capital. In the built environment framing, urban areas are understood to be physical spaces that affect residents in ways that could be compared to natural environments. To illustrate why this generativity approach holds promise, we will consider two examples: reframing environmental problems as a justice issue and reframing violence as a public health issue.

Environmental Justice

For decades, environmental problems were examined largely from the science and policy perspective: what are the factors that are leading to the degradation of the environment and how can they be addressed? Thus, previous efforts looked at the problems wholly from within the framework of the environmental literature. A study by the United Church of Christ's Commission for Racial Justice changed this and brought a civil rights and justice perspective into the discussion (Bullard, 2000; Chavis, Goldman, & Lee, 1987). Rather than simply documenting a litany of environmental problems, these researchers made note of the fact that environmental problems were unevenly distributed. They were more common in poor communities and communities of colors than in white upscale communities; thus, these environmental issues were justice issues. This insight reframed the discussions of environmental problems to ones of justice. This helped reinterpret environmental issues: they were not merely about how to improve water quality and the like but about whose water quality was impaired and whether some people's access to a clean environment was particularly compromised. The reframing led to an outpouring of new ways of thinking about what needs to be done about environmental

problems. This approach drew on different perspectives, led to different questions, and brought together different partners. The reframing suggested different solutions to these problems. The policy analysis was shifted and new questions were raised about what regulatory agencies should do. By bringing justice framings to bear on environmental issues, the results were both integrative and generative.

Violence as a Public Health Issue

The same generative effects of reframing have been seen when public health analyses were brought into discussions of how to address violence in urban areas (Gellert, 2010). Until this reframing occurred, most attempts to understand urban violence drew just from the criminal justice perspective. Researchers and policy makers considered what the criminal justice literature has shown about propensities for violence and how these could be addressed. Bringing in the framing of public health introduced new perspectives. Public health analyses are particularly strong at focusing on systemic causes, which helped frame issues of urban violence in very different terms than had previously been the case. The focus moved from being on the perpetrators and the need to control their behavior to a concern with systemic causes that could be addressed in ways that would reduce the epidemic of violence. Causes, treatments, and solutions were all examined in a new light. As is typical of public health analysis, population factors were brought to the forefront. Consideration was given to what might be gained by understanding that violence might share properties with other health epidemics. By bringing in analogies from the public health perspective, new tools could be brought to the task, such as those used to measure impact of various interventions. And this approach has been successful in reshaping discussions of urban violence by bringing in analogies.

How Can These Two Approaches Be Used to Reduce "Silos" and the Fragmentation in the Democratization of Science?

These two approaches—the typology approach and the generative strategy—offer promise as we look for ways to "desilo" the democratization of science efforts. The challenge will be to tailor the approaches to science democratization's particular problems. A few

small starts have been made in this direction and in this final section we consider these fledgling efforts and how they might be built upon and advanced.

Typology Approaches as an Aid to Desiloing

Consider, first, the typology approach and some initial efforts within individual democratization movements to formulate categorization systems. Working within citizen science, for example, Shirk (et al., 2012) have developed a continuum to capture how citizen science initiatives vary in the steps at which citizens are brought into research. This continuum shows that citizens are sometimes asked to volunteer as data gatherers (e.g., carrying out bird counts or contributing to online data collection where the need is simply for many person hours) and other times to be involved in a much more substantial range of activities such as deciding which issues are to be studied and how they are to be investigated (e.g., Karubian (2012) work in ecology in Ecuador or Nichol's (2012) work with sea turtle hunters in the Baja Peninsula of Mexico). Shirk's et al continuum has stimulated discussions within citizen science circles about the value of various activities that fall at different points on the continuum. Working in actionable science, Hutchins et al. (2011) have used a typology or matrix approach in a different way to assess preferences among policy leaders for different types of involvement in actionable science. Building on previous literature, Hutchins et al. (2011) created a selection matrix through which stakeholders could express their preferences for levels of involvement (from stakeholders entirely directing the research and its use to researchers entirely controlling the agenda) that range along a democratization continuum. These findings are being used to design more democratic, less researcher-centric approaches to creating policy-informing science. Within community based participatory research, Silka and Renault-Caragianes (2007) developed a Research Cycle Framework that places different stages in community-based participatory research on a time-course continuum capturing when particular science democratization tasks emerge in the research process. The framework is designed to be a tool used jointly by researchers and community members for confronting the challenges of ensuring

democratic, collaborative processes at each of those stages.

Efforts at systematization have begun within individual movements (e.g., citizen science, actionable science, and community based participatory research), but an inclusive typology or matrix that brings together the different movements now needs to be created. A master matrix would make apparent what the similarities and differences are among various democratic science efforts such as actionable science, community based participatory research. But such a matrix or typology, to be productive, also needs to move beyond merely laying out the obvious differences to making apparent how those differences reflect history and context (such as CBPR emerging out of the ethical problems of poor community members being repeatedly the objects of investigation and having little choice over this, or PPSR originating in part out of the problem that more data needs to be collected than there are researchers to collect it). These different origins have colored the emphasis in the individual approaches and decoupling the foci from their histories reduces their prescriptive thrust and opens up considerations of how they can be brought together across the array of situations where science needs to be more democratic. And, the typology should not simply be created: it should be used as a guide much like the Silka and Renault-Caragianes's (2007) Research Cycle Approach has been used.

Generative Approaches as an Aid to Desiloing

To integrate the independent democratization of science efforts, it will be important to add the tools of the generative approach. Here, too, there have been initial starts. Consider the phrases 'citizen science' and 'actionable science' as examples of generative efforts that combine literatures that reframe the discussion. Both place emphasis on bringing ideas together. By combining 'citizen' and 'science' one naturally starts to think about how citizens have ownership claims over science, that science is not owned by scientists, and that the link between science and democracy is strong. By combining 'actionable' and 'science', the steps to creating science that is useful doesn't seem separate from the science itself. Action becomes integral to good science.

At the heart of these generative and integrative approaches is the

effective use of metaphors and analogies. Consider Cash, Borck, and Patt's (2006) loading dock analogy. This analogy is being widely used to help scientists see why it does not work to create science in ways that simply assume that someone will find a use for it. In the case of loading docks in factories, widgets are produced and then trundled out of the factory and on to the loading dock so that they can be picked up and taken away for use. Scientists implicitly assume that they are operating in a similar context: that there is someone at the loading dock who will pick up the results from studies and use them. In the case of widgets, we know that it is important to make certain beforehand that they are useful and that they been designed so that a market exists for them. By analogy, we need to ask whether our research is designed in ways that speak to problems as they are conceived of by key stakeholders and that garner solutions that as taken to be viable by those who would use the information.

Boundary Spanning

The generativity that could result from bringing different bodies of work together will be possible only when there are those adept at bridging the gap. The boundary spanning literature provides helpful guidance on what is needed to strengthen such cross conversations (Kimble, Grenier, & Goglio-Primard, 2010; Wenger, 1998). This literature, found within the sociology of science, tackles the recurrent problem of people from different backgrounds (researchers and the policy makers, for example) failing to achieve a common understanding because they are unable to span the boundaries separating their perspectives. Use of this concept of boundary spanning has turned out to be productive way to frame a problem that is plaguing many areas. And what makes it possible to span boundaries? One answer has been to understand the importance of boundary objects and their creation and use within and across groupings (Lee, 2005, 2007). Boundary objects have been described as physical objects or even activities that by their nature can be used within each territory but also can be used in both to bridge differences. Something as simple as a map has served as a boundary object (helping to span boundaries) in some science democratization projects. Marine researchers and the fishing community might come together to study

local fish depletion patterns. The researchers and stakeholders might experience trouble in communicating across their different ways of framing the problem but both rely on maps as a part of their work. Effective boundary spanners understand how both groups use maps and can envision ways to use maps as boundary objects so that they are helpful within the community but also across communities.

Boundary spanning has the potential to be helpful in reducing the silos in the democratization of science. What will be needed is individuals conversant with the different movements in science democratization who are also able to use that knowledge to innovatively create and use boundary objects. And part of what they need to ensure is that they carry out their facilitation of combinatory activities in ways that avoid making prescriptive recommendations but at the same time move things forward.

How will we know if we have succeeded in reducing the silos? There will be some important markers. Cross-learning will be evident in the integration, typologies, and generative analyses. Citations will regularly occur to each others' work and publishing within the same journals will be commonplace. Perhaps most importantly, our colleagues outside of academia will have a sense that the various democratization approaches are deeply linked: if stakeholders start with one kind of science democratization effort (getting involved in community based participatory research, for example), they will end up not at a dead end but will find a pathway to another (starting with community based participatory research can be directly tied to actionable science and vice versa). All of the efforts of doing science that matters will be understood to be related.

Conclusion

Current science democratization efforts differ. Some have been directed at looking at how the research is done while others on how the research is used. Some have focused on creating processes by which knowledge is jointly produced whereas others have focused on how knowledge, created by whatever means, can be made more widely available. Some are concerned with who decides on the focus for the research whereas others have focused on ensuring that the research, whatever the

emphasis, is done in ethical ways. The next step is to bring these various approaches together.

In all of the efforts to integrate the approaches, it will be important not to forget the extent to which calls for the democratization of science of any sort deeply challenge what is believed to set science apart and makes it special: rigor, reliability of data, objectivity, truth, and the like (Gieryn, 1999). The pushback among scientists to the democratization of science is not merely about inviting nonscientists into participation in various aspects of the science. Democratization efforts will continue to be seen as under mining the very underpinnings of what is believed to make science better than, stand apart from, and stand above other activities. The hybrid approach being recommended throughout this paper could provide the kind of united front that will help create robust democratization efforts that can move forward in the face of continued skepticism on the part of science traditionalists.

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Beyond Engagement: Universities within their Community

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Beyond Engagement: Universities within their Community

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Abstract

In the contemporary economic environment, universities both as sector and individually, are increasingly called to quantify their value. This is aggravated by the emergence of Massive Online Open Courses that promise all the content without either the costs incurred or the time commitment. While restructuring is necessary in many circumstances, this paper argues that the future of universities should be focused on the importance of building community engagement principles. In the contemporary world, universities and both the teaching and research scholars that reside within them can no longer afford to be isolated. Rather, what is required is the need to build closer, wider and deeper links with the various communities we serve. As such, any restructuring of the sector should be used to reassess the role universities play within broader society as well as promoting an active and engaged citizenry. As such, this paper is made up of three sections beginning with a discussion of the concept of community engagement. Following this, I move on to outline the pedagogical approach required and conclude by outlining how such an education is relevant within the emergence of a changing citizenry.

Keywords: university engagement, community engagement, active citizenship, innovative pedagogies

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Más allá de la Vinculación: Universidades dentro de sus Comunidades

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Resumen

En el actual contexto económico, las universidades deben cada vez más cuantificar su valor. Este proceso está siendo agravado por la emergencia de Cursos Abiertos Online y Masivos que prometen ofrecer todo el contenido de un curso sin tantos costos ni limitaciones de tiempo. Mientras la reestructuración es necesaria en bastantes circunstancias, este artículo defiende que el futuro de las universidades debería enfocarse en la importancia de la colaboración universitaria con la comunidad local. A día de hoy ni las universidades ni sus profesoras ni investigadores pueden permitirse estar aisladas de su entorno social. Lo que necesitan es establecer contactos más intensos con las diversas comunidades en las que están establecidas. Cualquier reestructuración del sector de educación superior debería usarse para reevaluar el rol que las universidades juegan dentro de la sociedad, así como promover una ciudadanía activa y más involucrada con ellas. Este artículo contiene tres secciones empezando con una discusión del concepto de vinculación ("engagement"). Seguidamente, muestro el estilo pedagógico necesario para conseguir esa vinculación, y concluyo, manifestando la importancia de la educación dentro de la aceleración actual de los cambios de la noción de ciudadanía.

Palabras clave: vinculación de la universidad, vinculación de la comunidad, participación activa de la ciudadanía, pedagogias innovadoras

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Universities across the world continue to feel the after effects of the Global Financial Crisis as they face budgetary cutbacks. The impacts for many parts of the university community have been devastating. For example, in the United Kingdom, it was reported that across the sector, there was a 12 percent funding reduction resulting in many universities being forced to cut courses and increase fees (Harrison, 2011)[1]. At one of Australia's most prestigious institutions, Melbourne University, it has been reported that plans to hire an additional 200 academics over a four-year period were abandoned because of cuts totalling more than $1 billion across the sector (Hall & Preiss, 2012)[2]. My own university, the University of Western Sydney, has not been immune to such cuts and has implemented a range of restructuring processes.

The challenges confronting universities are not unidirectional however. In addition to the tight budget environment, the sector is facing changes that are parallel to the traditional media industry including changing user patterns, delivery mechanisms and increased competition. This changing environment is epitomized by the introduction of Massive Online Open Courses (MOOCS), which have resulted in the very future of universities being questioned (Cadwalladr, 2012). The exact size of MOOCS is difficult to assess, but as Laura Pappano (2012) outlined in the *New York Times* recently, the for-profit online provider, *Coursera,* reported that within 18 months their course had gone from nowhere to reaching 1.7 million users, "growing 'faster than Facebook'"[3].

The consequences of the rise of such providers is almost impossible to predict. Some feel that these threaten the traditional universities while others see only certain sections vulnerable, such as second-tier universities (Cadwalladr, 2012)[4]. Regardless, the introduction of this new dimension to tertiary education provition will have significant effects across the sector: some positive (such as prompting the sector to innovate), some negative (resulting in restructuring and job losses) and some which we will only know by hindsight (for example, the changing pedagogical environment).

Furthermore, such changes and challenges have led many to reflect on the exact role of universities. Unsurprisingly, the

'business-orientated' approach has been to demand that universities become more focused on meeting the needs of industry. In Australia, a report by Ernst and Young (2012) titled *University of the future: A thousand year old industry on the cusp of profound change*, called on universities to better specialise by not only targeting certain student groups, but also working more closely with industry or risk being left behind. The report discusses the need for "research partnerships and commercialization" and argues that universities must "deepen their commercial skills and capability" (2012) of staff and graduating students.

The focus of the Ernst and Young Report, which has very much set the tone for the future of universities in Australia, is on commercialisation, speed to market, partnering with private service providers. Yet it only makes passing reference to "community engagement" (2012). While I do not oppose the imperative for universities to build closer links to the private sector, singular, commercial focus at the expense of community engagement is deeply flawed, and will place universities in an even more vulnerable position. This vulnerability emerges from two sources: firstly, it risks placing universities in a vulnerable position of producing graduates whose skills are focused on a specific point in time within a rapidly changing market; and even more importantly for the purposes of this paper, universities need to build closer strategic ties to the various communities we serve – with the for-profit private sector being only one of many.

The purpose of this paper, then, is to focus on the future of universities by discussing the importance of building community engagement principles. In the contemporary world, universities and the teaching and research scholars that reside within them, can no more afford to be isolated. Rather, what is required is the need to build closer, wider and deeper links with the various communities we serve. Restructuring of the university sector should be used to reassess the role that these important institutions play with a fundamental dimension of their mission being community engagement.

Such a strategic redirection will have many benefits: from the pedagogical to the re-positioning of universities at the center of debates about the type of societies we want to build, to the quality and relevance

of the research produced and the culture of citizenship which is established. The very essence of engagement should be built into the pedagogical approaches adapted with the broader goal being to promote an active and engaged citizenry, underscored by strong community links.

This paper is made up of three sections. To begin with, I discuss the concept of community engagement. Following this, I move on to outline the pedagogical approach required and how such an education is relevant within the emergence of a heterogeneous citizenry. Before continuing, however, it is important to establish the methodological framework that I will follow. In my research, teaching, and engagement activities, I am motivated by a desire for justice. It is from this position that the methodological approach developed has been employed. In designing and implementing teaching strategies, research projects and engagement activities, I utilise a participative research methodology, becoming directly involved as both a participant and observer (see for example, Arvanitakis & Boydell, 2012). Here I am inspired and informed by both feminist researchers such as Maria Mies (1991) and post-colonial authors including Edward Said (1979) and Ashis Nandy (1983). In this context, both the 'researcher' and the 'teacher' – who may or may not be the same person – actively participate and agitate rather than simply observing and reporting (Arvanitakis & Hodge, 2012).

This is an approach that rejects the claims of one objective form of inquiry or knowledge that shape much academic research (Stanfield, 1998). As I have argued elsewhere, a number of important benefits from this approach come: it creates a pluralism that is reflective of both a plurality of knowledge and the heterogeneous nature of the contemporary world. It also continually "reminds us that in seeking to change others, we are not above the need to change" (Arvanitakis & Hodge, 2012).

Engagement

In a recent article I co-authored, Professor Bob Hodge and I trace the etymology of the word 'engagement' (see Arvanitakis & Hodge, 2012).

Key here is the central aspect of the older meaning and practice of 'engagement', which is the *gage*: this was the pledge made between two participants in front of witnesses. The gage essentially made an indeterminate outcome more certain by commitment of the pledge-giver to fulfilling it (unless something happened to the pledge-giver to make the commitment impossible). Any pledge, however, is contextualized within the specific conditions, commitments and potential benefits – monetary and otherwise.

Importantly for the purposes of this paper, and the concept of engagement more broadly, is that the possibility of making a pledge and seeing it through is dependent on the strength of the social relations surrounding the participants as well as the witnesses. It is possible to draw parallels with the research revolving around gift economies (Mauss, 1990; Gudeman. 2001). Fundamental here is that with a pledge , as well as the act of receiving and accepting a gift, there is a sense of reciprocity: to respond to the gift or, at the very least, meet the commitments made. For those of us working with universities and often confronted with the demands of producing ‘outputs’ from our research projects, the relationship between the university and the community is a precarious one. Despite our desires for good research, career ambitions and deadlines, we must acknowledge that different sections of the community do not want to engage with us, or do so only in certain ways. As I have found in my own experience, community members may feel that the research process is a one-way commitment: for example, it has been rightfully pointed out that I may get my article and research grant, but they receive nothing in return.

This is not the essence of the aforementioned gage or the gift relationship that one aims to establish. As such, it is necessary to reflect on and negotiate the terms and expectations of the relationship, and how these can be strengthened. Without such an understanding, any relationship is fragile and prone to fracture.

From this perspective, the concept of a gage, 'pledge' and gift, potentially offer us ways of understanding the way the universities engage with communities. To begin with, the relationship must be understood as reciprocal with both parties experiencing agency. The university community – researchers, teachers and administrators –

as well as students and community members have agency and expectations when ‘engaging’. By acknowledging and encouraging this agency, we build an important sense of reciprocity. Agency and reciprocity come to rest on a complex network of commitments or ‘pledges’.

The second important insight is that such a commitment should be based on a sense of desire (Brent, 2004; Arvanitakis. 2009). Community development worker, Jeremy Brent, has argued that the basis of a community is a sense of desire: that is, each participant in the community must desire to remain involved. This conceptualization challenges the Hegelian conceptualization that communities are formed ‘naturally’ with those that we recognize (Fukuyama. 1992). Rather, Brent's position is that for communities to be formed and remain, there is a requirement for ongoing efforts to coexist and maintain this desire (Brent. 2004). In this way, communities can be formed beyond those we simply recognize as being ‘like us’ but also those with whom we establish a reciprocated sense of desire. On this view, the pledge will only be maintained if there is a desire to do so – and it is this desire that builds the complex bonds of a community.

The third insight is that the pledge, once established, should not be casually broken. If we continue to draw on gift theory, then we must see the bonds that are established through exchanges as the very foundations of an authentic community (Mauss. 1990). When pledges are broken, community bonds are frctured or even broken. Universities should not make promises of engagement with a sense of indifference, or there will be adverse long-term consequences when the commitments are not maintained.

While this background may provide insights into the concept and importance of ‘engagement’, it is also essential to understand what is meant by community engagement. University engagement is an ambiguous term with no broadly accepted definition and can mean everything from speaking at a local school about ‘university life’, taking part in public debates, and bridging the “gap between the laboratory discovery and practice” in the medical sciences (Doberneck, Glass & Schweitzer. 2010).

Despite this, a number of general themes emerge when investigating

the 'engaged university' (Watson et al., 2011). In their quest for a broad definition, Doberneck (et al., 2010) quote Michigan State University's discussion of engagement as a "scholarly endeavour that cross-cuts teaching, research and service... generating, transmitting, applying, and preserving knowledge for the direct benefit of external audiences ... that are consistent with university and unit missions". In my own research, I have reviewed the websites of each of the 41 universities in Australia and identified that each refers to 'engagement' in some way – with the most frequent being a reference to 'mutual benefit'. My university, which is one of the case studies featured in the research of Watson (et al., 2011), describes 'engagement' in similar terms: as a "partnership, for mutual benefit, between the University and its communities, be they regional, national or global ... a distinctive way of carrying out research, teaching, learning and service"[5].

Cynics may feel that this simply pays lip service in a time when neoliberalism has come to grip the university sector, yet only a generation ago, it was unlikely that university management would have mentioned the term 'engagement'. For those of us who pursue an 'engagement' agenda in our research and teaching activities, these descriptions do not necessarily establish a clear direction. For example, how do we define and judge 'mutual benefit'? Further, how do we manage the incompatibilities of engagement; such as when our engagement pursuit brings different communities into conflict?

Such definitions fail to acknowledge the significant power imbalances between institutions such as universities and the communities we 'engage'. Centuries of cultural development have placed universities as the source of knowledge with a one-way relationship with the community. In this relationship, the central figure is the university who benefits others by producing knowledge that it believes they need. Yet those others who never seem to "be involved in deciding what benefits they most want, and in what form" (Arvanitakis & Hodge, 2012).

This leads us back to the question that began this section: what do we mean by engagement? Only a contextualised response can suffice. One principle which should guide the development of 'engagement practices' is that the mutual benefit should describe a

two-way process in both knowledge production and the development of the *civus*. That is, engagement should be about making a pledge towards strategic involvement and intervention not only through our teaching and research, but also by working with the broader citizenry to promote a sense of agency and active citizenship.

It is at this nexus that engagement provides the most important potential into the future of universities: that is, the university community more generally should see our role as not just about promoting education but working with citizens to identify and promote what is important to them. This should be the pledge (or gift) we offer to the community. To make such a pledge requires us to challenge and break down (at least some) knowledge hierarchies. This does not mean that all knowledge should be considered equal – as the debates about the causes of climate change have shown us – for it is not. Rather, this is a position that argues it is the community that should guide us, not simply scholars setting the priorities based on our own believes.

Such a position has important pedagogical implications and directions; and it is here that I turn to next.

Pedagogical Approach

The unifying pedagogical principles that ought to drive the project of the 'engaged university', I argue, should draw on the ideas of Brazilian theorist Paolo Freire (1972). While illiterate peasants from 1940s Brazil may seem a long way from many of the communities we deal with marginalized, privileged or otherwise – Freire's ideas have repeatedly proven powerful agents of change for many different places and times (Thomas, 2005).

Freire worked on literacy programs that had a double intention: instilling practical skills while simultaneously raising levels of understanding and knowledge. For Freire, these aims are complementary rather competing: that is, one does not have to be the focus at the expense of another. Freire criticized the idea of 'deficit' as applied to uneducated peasants seeing it as a static model that saw students as passive containers to be filled by teachers who monopolized knowledge. Rather than simply 'filling' them with a standard curriculum, Freire wanted to empower his students with both the skills

and strategies to pursue what they wanted and needed to know. What is fundamental in Freire's efforts to raise consciousness is that skills on their own are not enough. Freire's starting point was to establish the "thematic universe" (1972) of his students by establishing a view of the world, as they specifically understood it. The next step was to take the students through journey that passed through concentric circles, from the particular to the general, and from the local to the global.

Freire draws on Martin Heidegger's (1927) phenomenological concept of the 'threshold' – a second important theorist that can guide us on our engagement journey. When discussing 'threshold, Heidegger is describing those moments of change – when we move from a state of ignorance to one of reflection, moving from mere existence to seeing the world for the first time. It is as if we return to an adolescent state and are experiencing something that we have never seen; perhaps something foreign and as a consequent it makes us stop and reconsider our lives. This is not simply a sense of wonder, but compels us to ask 'why?'

This sense of wonder that emerges allows us to see and feel everything in a different way. At its best, we see a world full of possibilities – where change can happen – where we no longer feel alone or isolated, but part of a broader humanity. It creates a sense of hope: but this is not a hope that is passive – where you just sit and wait for things to get better – but an active hope (Hage, 2003). This is a hope that inspires us to act and respond.

For Heidegger, it is the artist who opens the doorway into this other world and guides us through the threshold: the poet, playwright, musician, sculptor or painter. At our best, it is we as researchers, teachers and scholars when connecting with the community as well as our students (who may or may not be the same people).

What we can learn from these authors is that they raise important issues around engagement and transformation. This is relevant for our 'engagement' because the aim of our interactions with the community should be about deep change, and by deep change I mean personal and political.That is, including the student body and community working to enhance skills within the university and when engaging the community is only one step. We should be looking at wider cultural change focussed on active citizenship, agency and the *civus* more broadly.

Drawing on Freire and Heidegger, our interactions with the community should be from the position that they are already engaged and reflective social beings, introducing the sociological and cultural tools to decipher both the world and power structures around them, encouraging a sense of agency and potential to create change. This has the effect of both teaching skills and affecting emotional desires to confront issues important to them. It is these desires that can be described as creating a 'threshold' for change. Key here is not to see those we engage with as being in deficit (or 'citizens in waiting'): but rather acknowledging that there exist complex networks and interactions that allow communities to exist.

Within the university, this can give rise to engaged learning where students have the opportunity to apply the theoretical curriculum to their personal, professional and academic journeys. Using specifically designed exercises, the students map their interactions and to reveal how they both influence, and are influenced by, power relationships. The outcome, then, is to produce not just knowledgeable and skilled students, but active citizens who will want to contribute to the *civus* – and it is this concept I turn to next.

The Heterogeneous Citizen

As discussed above, a broader aim and outcome of university engagement is the promotion of active citizenship, agency and the *civus*. I would argue that a full understanding of the complex and heterogeneous nature of contemporary citizenship is fundamental to the success of such an endeavor. Traditionally, citizenship has been presented as a set of social and political practices (Turner, 1993) directed by law that bind us to a nation (Mueller, 2002). Critically, citizenship tends to describe what people are included in as well as excluded from (Turner, 2009). Drawing on T.H. Marshall's (1950) discussion of 'social citizenship', we identify rights and responsibilities that "define the identity of members of a political community, thereby regulating access to the benefits and privileges of membership" (Turner, 2009). This presents us with a form of belonging and constructs a unifying sense of what we may consider 'the civic'. The traditional

model implies vertical and linear relationships between civic institutions and citizens (Brodie 2004) that sometimes may be reciprocal but always are asymmetrical. The way the strength of these relationships are assessed is through broad quantitative measures such as polls, voter attitudes and participation (Kymlicka & Norman, 1994).

As discussed elsewhere, the concepts of citizenship hold simultaneous and contradictory aims (see Arvanitakis & Hodge, 2012). From above, citizenship is often a strategy of governance and a way to ensure the populace aligns with ruling sections of the state; while from below, it is seen as a mechanism of empowerment, agency and activism. The way this plays out varies and should not be assumed to be stable, pre-fixed or simple. Rather, as the Arab Spring, the Occupy movement and the Tea Party have shown us, the *civis* is a site for struggle that is constantly redefined.

Despite major contestations and a dramatically changing demographic, economic and political environment, concepts of citizenship have remained stagnant for decades. My focus here is Australia, where we have seen a number of simplifying assumptions deployed in an attempt to force a better fit between potential citizens and a single, homogenous ideal of citizenship. The proposed 'civic education' course that is to be introduced in Australia secondary schools, for example, repeats many of the standard approaches to understanding citizenship: treating young people as citizens in waiting and taking a one size fits all approach (ACARA, 2012). What we are presented with is the idealised citizen framed within a limited range of values and identities: conservative, mono-cultural, Anglo-Australian (Dyrenfurth, 2005), rational (Isin, 2004), one who is economically successful and above acertain age. Even by embracing 'multiculturalism', Kenan Malik (2012) argues that we are seeing a homogenising of complex communities because governments demand representatives of complex communities rather than acknowledging this diversity. In this way, civic institutions search for the representative and acceptable 'Muslim voice' or 'youth representative'. Both are undoubtedly fictions. While Malik is discussing examples in the United Kingdom, similar observations can be made in the Australian environment.

In addition to this shifting environment, we are seeing the changing nature of governance. No longer is the vertical model of citizenship acceptable as we see the emergence of highly complex and changing governance relationships for all citizens to negotiate if they are to access their rights or fulfil their responsibilities. To have even minimal control over our lives, we must negotiate dealings with formal government structures plus interact with private service providers (schools and hospitals), national and international non-government organisations, supra-state bodies (the United Nations and International Monetary Fund), and trans-national corporations (rating agencies and corporations whose income, capital and influence dwarfs that of many states) (Hindess, 2002). In addition there are various non-formal organisations and networks (including environmental, human rights and religious) well beyond the "sociopolitical geography of nation-states" (Hayes et al., 2010). Even though this is a minimal sketch of the contemporary environment, it does highlight that treating people as homogenous citizens with parallel experience as being clearly counter-productive.

The new global environment emphasizes the changing relationship between individuals and the state: no longer is it a simple vertical one, but subject to a multitude of formal and informal relations. The nature of these relations enables our capacity for action with other (heterogeneous) citizens, in many 'horizontal' relationships that have emerged (Arvanitakis, 2011). Citizenship is now more than ever *relational*: subjected to a complex constellation of relations. This 'relational' approach to citizenship means that the bonds between civic actors is complicated by the various connections with other citizens and institutions (near and far). As a result, both local and global issues in the formal and informal political and civic sphere can influence the cultural practices of citizenship (Kuisma, 2008; Hayes et al., 2010; Malik, 2012).

It is within these complex networks of relationships that university engagement can have significant consequences and strategic interventions can be undertaken. If we look at our community engagement as a one off, research gathering process, however, then we may achieve publication outputs but any reciprocated relationship will quickly end. The gage discussed above, will be a pledge with

limited meaning and consequence: no matter how relevant the research, its influence will rapidly dissipate if it is a one-off article. Rather, the university and associated scholars must see themselves as embedded in this complex web of relationships.

This position is nothing new, as Bergmen (1993) argued when researching the victims of marital rape. Bergmen's position was that any interaction comes with a reciprocated responsibility that should be encased in a sense of justice. The pitfall, however, is to see the community as vessels needing assistance. This was not the point she was making. Rather, as Freire argues, these are active agents in challenging situations in which our goal should be to facilitate a threshold moment – to work with them to build a sense of hope that another world is possible.

If this is achieved, then our engagements are successful. This is what will ultimately justify the existence of the university community. If we see engagement as only a form of industry participation, then the scholars will be only one voice of many vying for attention. The engaged university has a unique position in the complex web of relations within the contemporary society – and its influence has never been more important, and its existence more relevant.

Conclusions

Some years ago, a friend of mine was researching and writing the way neoliberal discourse came to be embraced and reproduced by vulnerable communities. Her research, which is unpublished, reflected that even those that see themselves displaced through restrictive economic policies and practices embrace a neoliberal discourse of economic growth and the 'inevitability of progress' (see the work of Peck and Tickell (2002) and their discussion of 'neoliberalizing spaces'). This was an important project for her because it was her community that was being displaced by such developments. In a meeting with her supervisor, she informed me that he advised her to 'drop her project', criticising her emotional attachment to the issue and telling her she was 'in Foucault'.

This may be only one example, but it does capture the sense that scholarly pursuits should be detached (Stanfield, 1998). Furthermore,

it reflects the 'empty vessel' pedagogical approach that Paulo Freire rallied against. But within this example, we also find elements of the detached university – one that stands above or outside such challenges.

In this paper I have argued that in the changing and complex contemporary environment that sees the relevance of universities challenged, the way forward is to engage the various communities around us – the near and the far. To do this is not to produce research that 'we may think' is relevant', but work with the community and continue our researching and teaching practices within the complex networks that exist. This process should be driven by a long-term pledge. While the functioning of these networks can be understood in terms of different relationships of *engagement*, we must consider where does the citizenry sit and what influence, if any, do they have? If we undertake our engagement properly, then this influence can expand along with the active citizenry and the bonds that bind us to these communities.

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Notes

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Six Ideal Types of Public Engagement with Science and Technology: Reflections on Capital, Legitimacy and Models of Democracy

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Six Ideal Types of Public Engagement with Science and Technology: Reflections on Capital, Legitimacy and Models of Democracy

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Abstract

A number of researchers have been analysing apparent shifts from top-down approaches to public engagement with science and technology towards more participatory ones. Some have revealed the existence of often unacknowledged assumptions about how science and public should interact. These normative visions shape public engagement and may go against any shift towards inclusiveness. To further probe this, interviews with 41 stem cell scientists were carried out. They reveal diverse normative visions of publics, scientists, dialogue, relevant technical and political capital, and scientific citizenship. From this, six ideal types of public engagement with science and technology are constructed and connected to models of democracy. This typology, built on an analytical framework that draws on Science & Technology Studies, Sociology and Political Theory, can be used as a heuristic device to examine particular instances of (and discourses about) engagement. This enables reflections on their legitimacy and opens up for potential transformation the norms that underlie them.

Keywords: Science & Technology Studies, public engagement, stem cell research, scientific citizenship, lay political science, Bourdieu and capital

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Seis Tipos Ideales de Vinculación Pública con la Tecnociencia: Reflexiones sobre Capital, Legitimidad y Modelos de Democracia

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Resumen

En los últimos años, se ha podido comprobar un aparente cambio de rumbo hacia una vinculación mayor del público con la ciencia. Estudios sobre ese cambio han revelado también la existencia de supuestos básicos no examinados con anterioridad sobre cómo la ciencia interactúa con el público, que tienen influencia y pueden dificultar una mayor inclusión en la toma de decisiones. Este artículo examina los discursos de personas científicas, vinculadas con el estudio de células madre, explorando (mediante 41 entrevistas) sus visiones normativas sobre los públicos, la comunidad científica, el dialogo, el capital técnico y político, y la ciudadanía científica. A raíz de ahí, elaboro seis tipos ideales de vinculación pública con la ciencia y los conecto con modelos de democracia basados en disciplinas como los estudios sobre la ciencia y la tecnología, la sociología y la teoría política. Mi argumento es que esta tipología puede ser usada como aparato heurístico para examinar ejemplos concretos de (y discursos sobre) vinculación pública con la ciencia. Además, puede reflejar aspectos sobre su legitimidad y abrir un espacio para la potencial transformación normativa de estas actividades.

Palabras clave: Science & Technology Studies (STS), vinculación pública, investigación con células madre, ciudadanía cientifica, ciencias políticas no profesionales, Bourdieu y capital

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Researchers from Science & Technology Studies (STS) and other disciplines have examined apparent changes in public engagement with science and technology[1] (e.g. see reviews in Burgess & Chilvers, 2006; Lengwiler, 2008). Some argue that elements of practice and discourse in this area have shifted away from the "deficit model" of public understanding of science (Wynne, 1995) - where public ignorance needs to be fixed by education - towards encouraging public participation in science. However, these shifts may be limited and many attempts at improving public participation in practice have failed (e.g. Goven, 2006; Stirling, 2008; Kurath & Gisler, 2009; Kurian & Wright, 2012).

One reason for these limited changes is that those who organise, advocate or take part in public engagement bring with them unacknowledged assumptions about science and publics, and about how these should come together during public engagement. These normative visions may work against any participatory ideal that is meant to guide the particular instance of public engagement (see Wynne, 2006). These visions have been studied in key policy documents and reports made by scientific institutions[2]; in publications by social scientists and others who advocate public participation[3]; and in data from interviews and focus groups with publics and scientists[4]. Multiple normative visions of public engagement are revealed, ranging from educating members of the public in order to prevent anti-science sentiments, all the way to empowering them to change science governance. Depending on whose normative visions frame particular instances of science-public interactions, different kinds of engagement will be facilitated (Bickerstaff, et al., 2010).

Of specific interest here, Michael and Brown (2000) analyse these often unacknowledged norms by examining discourses which touch on political theory and processes, and on ideals of democracy, dialogue and representation. They call these discourses "performances of lay political science". Different discourses of this kind put forward different types of dialogue as preferable. For instance, some scientists portray themselves as separate from the public and recommend dialogue with some "publics-in-particular" (such as moderate animal activists); these scientists thus deploy what Brown and Michael call "external" model of dialogue. Others deploy an "internal" model of dialogue where

discussions around science should be conducted only within the scientific community; these scientists see themselves as part of "publics-in-general" and, therefore, as holding the same fears, concerns and "commonsensical stories" as publics. These performances of lay political science can therefore put forward different people as appropriate participants in discussions and/or decision-making about science. In other words, they articulate different normative visions of the "scientific citizen" (Irwin, 2001).

For instance, calls for public education, epitomised by the Bodmer Report in the UK, bestow scientific citizenship only upon those who can be educated to make appropriate and reasoned decisions about science. These citizens can participate in a "consumer democracy" where they can be educated to consume the products of science (Elam & Bertilsson, 2003, pp. 238-240), or in a "competitive elitist democracy" where educated elites speak on behalf of others (Michael & Brown, 2000, p. 7; Held, 2006, pp. 125-157). On this view, the public cannot legitimately shape the direction of scientific research. By contrast, calls for more participatory forms of engagement bestow scientific citizenship upon anyone able to enter into rational and reasoned debates. This aligns with the principles of deliberative democracy (Elam & Bertilsson, 2003, pp. 240-243; Papadopoulos, 2011; Lövbrand, et al., 2011) which can accommodate a wider range of opinions and may offer different kinds of citizens the opportunity to shape scientific research.

It is clear then that there are multiple normative visions of public engagement with science and technology which can be mutually exclusive. According to Bourdieu, a key role for social scientists is to reveal the arbitrariness of how social relations happen to be organised - what he calls the arbitrariness of the structure of the "field"[5] (1980, 1975). He argues that if the unacknowledged norms that shape the structure of a particular field (say that of public engagement with stem cell research) map onto the unacknowledged and embodied norms that guide our ways of thinking and doing (our "habitus"), the structure of this field seems given by nature (1980, pp. 229-230). For instance it may seem natural that only scientists have a say in scientific matters. If social scientists highlight the normative visions at play and suggest alternative ways of structuring the field (for instance by suggesting

other scientific citizens whose participation can be legitimate), they can offer opportunities for transformation, or at least encourage the status quo to be justified.

In this paper, I do two main things. I contribute to the STS body of knowledge about public engagement with science and technology by examining the normative visions embedded in the discourses of key players in engagement: I focus on scientists and their various normative visions of publics, scientists, dialogue, relevant technical and political "capital" (Bourdieu, 1986, see below) and scientific citizenship. In parallel, following calls to refine STS reflections on engagement by connecting them with the political theory literature (Michael & Brown, 2000; Wynne, 2007; Papadopoulos, 2011; Durant, 2011), I organise these normative visions into six "ideal types" (Weber, 1949, see below) of public engagement and sketch connections to different models of democracy with which they share similarities. The ideal types and models of democracy do not map exactly onto each other; rather the hope here is that by highlighting some resonances between theory and empirical data, we can reflect on both. This may facilitate critical reflections on different approaches to public engagement and open up for potential transformation the unacknowledged norms that shape these approaches.

In what follows, I explain the derivation of my typology from empirical findings and argue that it is a useful addition to existing typologies. I then describe my six ideal types of public engagement with science and technology: Type I - internal dialogue with scientists as publics; Type II - recruiting publics/patients to support science or lobby; Type III - educating scientific consumers/citizens; Type IV - public relations exercise; Type V - mixing elite expertises; and Type VI - upstream mixing of situated knowledges. In the discussion, I argue that social scientists can use this typology to examine organisers' or participants' unacknowledged normative visions of public engagement. They can then move beyond simple endorsement and/or critiques of engagement: these ideal types can be used to reflect on the legitimacy of different normative visions of public engagement with science and technology because they connect STS with political theory which has for decades discussed these issues. In the conclusion, I suggest that this typology is

a useful heuristic device which I hope will be further developed and refined.

Not another typology! Connecting empirically-derived normative visions of engagement with models of democracy

A number of typologies of public engagement (with science and with civic life more generally) have been developed. A classic is Arnstein's (1969) "ladder of citizen participation", ranking participation according to how much power is devolved to citizens. Rowe and Frewer (2005, p. 260) criticise it for only focussing on one dimension (power). Instead, they put forward a well-researched and oft-cited typology to evaluate engagement activities according to diverse measures of acceptability and effectiveness (2005; see also 2000). This typology is also limited: according to Burgess and Chilvers (2006), it is based on the researchers' normative views and does not take sufficient account of broader institutional contexts which can shape engagement. Burgess and Chilvers argue that most engagement evaluations and typologies are based on one of three criteria: "the opinion of research practitioners"; "theory-based criteria" derived from specific models of democracy; or "the views of process participants" (2006, pp. 722-723). In parallel, STS' championing of "democratic" forms of engagement has been criticised for not paying enough attention to what is meant by "democratic" (see especially Durant, 2011). I here discuss how the present typology addresses some of these concerns.

Drawing inspiration from Weber (1949), I establish six ideal types of public engagement with science and technology (henceforth PE) that I hope can serve as useful heuristics. To construct these ideal types, I start with empirical "reality" (in all its infiniteness and complexity, Weber, 1949, p. 72): I draw on data from in-depth semi-structured interviews with 41 researchers of different levels of seniority, working in the UK and Australia on different types of stem cells, and with varying experience of PE. Data collection took place in 2004-5 and most interviews lasted one hour. I analyse scientists' discourses about PE because these have the potential to shape engagement practices (see Marks, forthcoming). In this mess of everyday language (1949, pp. 108-109), I focus on discourses that express normative visions of members

of the public, scientists, dialogue, relevant technical and political capital (discussed below), and scientific citizenship. I distil these multiple normative visions into ideal types of PE[6]. These are not ideal in the sense that they reflect my personal preference, or some theoretical ideal drawn from the literature, rather they represent "logical" ideals: they are a synthesis of the complexities of the empirical world (1949, pp. 90, 92). They are not an "average" of what is in the empirical world, they might not exist there at all (1949, p. 91). Their construction is guided by my analytical interest in what different visions of PE are expressed, and on what bases they might claim their legitimacy. The usefulness of these ideal types is as a means not an end (1949, p. 92): they should be compared back to the empirical world (e.g. practices and discourse of public engagement), and used to analyse it.

To enable this typology to guide reflections on legitimacy, these empirically-derived ideal types firstly highlight the kinds of "capital" that are recognised as relevant and legitimate, and secondly are connected to the political science literature and its reflections on legitimacy. Regarding the second way of reflecting on legitimacy, I argue that the six ideal types of PE share features with different models[7] of democracy. I discuss how these models claim legitimacy in different ways. For instance, legitimacy according to deliberative democrats might rest on "free and unconstrained public deliberation of all about matters of common concern" (Benhabib, 1996, p. 68), whilst competitive elitist democrats see legitimacy in situations where those in power are the ones with the best technical skills (Held, 2006, pp. 149-150). Connecting ideal types of PE with models of democracy enables STS to connect with political theory's analyses and critiques of different sources of legitimacy.

Regarding the first way of reflecting on legitimacy, I draw on Bourdieu's notion of capital (especially 1986). It goes beyond economic capital to include "social capital" - connected with group membership - and "cultural capital" - connected with education and social status. Importantly, these different kinds of capital can be converted into each other. Of relevance here, scientific authority, which is a mixture of technical capability and social power (1975, pp. 91-92), is a type of social capital. It can be accumulated and converted into capital relevant

outside the scientific field (1975, p. 97). Accumulation of capital enables (and is enabled by) "symbolic power", which is acceptance of the legitimacy of someone and what they say or do (Bourdieu & Wacquant, 1992, p. 148). For example, large numbers of quality publications in physics can give someone high levels of scientific authority within the scientific field, since publications reflect technical capability. This can also give the author symbolic power in policy settings, potentially enabling them to legitimately advocate for the importance of physics (and other sciences) in society.

In this paper, I draw on the notions of convertibility of capital and the importance of socially- and culturally-dependent legitimacy. I also distinguish several types of capital. Technical capital includes technical knowledges; that is those painted as rational, objective and universal. It also includes forms of authority typically recognised by scientists, such as publications. This is contrasted to political and consumer capital which include the ability to shape the direction of science by voting, consuming, funding, criticising etc. PE ideal type VI (detailed below) fits into a slightly different framework: the technical and the political are no longer separated. Rather, in a manner more consistent with the common STS view that knowledge is contingent, capital encompasses a range of socially situated knowledges, as well as the ability to contribute to decision-making.

To summarise, this typology complements and further develops others: it considers multiple dimensions, not just power (it does not consider practicalities such as effectiveness); it is derived from the views expressed by potential process participants, but does not uncritically use these to assess quality; and it draws out a set of theory-based criteria to reflect on legitimacy, based on multiple models of democracy, not just the one(s) I favour. So rather than calling for more democratic PE as many STS scholars do, I here offer a typology that, if used as a heuristic to examine particular instances of engagement, can highlight the different meanings of "democratic" forms of engagement, and drawing on decades, if not centuries, of work in political theory, enable reflections on their legitimacy.

Six Ideal Types of Public Engagement with Science and Technology

Ideal Type I – PE as internal Dialogue with Scientists as Publics

In this ideal type of PE, scientists self-regulate because they have the necessary technical and political capital to do so. This ideal type was constructed from interviews with five PhD students and three group leaders (from the UK and Australia)[8].

During interviews, a number of scientists describe themselves and their colleagues as the only ones holding relevant knowledge for decision-making around science. They deploy an "internal" model of dialogue where they describe themselves as part of "publics-in-general" (Michael & Brown, 2000): they consider themselves to have all the necessary capital to make decisions around science. They have the technical capital to judge the promises and risks of research and its application and to know what concerns publics may raise. They also have all the necessary political capital to vote or make decisions in their field. These scientists locate themselves apart from outside influences and, if they have any concerns about their work, they turn to their peers. Here, technical capital is automatically converted into political capital.

Publics are depicted as emotional and are not seen to hold experience-based expertise, such as different understandings of disease. There is no role for publics as scientific citizens, beyond the provision of biological material when needed:

> As scientists, we know there's a chronic need for better therapy, and we're all extremely motivated, so I don't see what [people with diseases] could particularly tell us that would make us do anything differently.

However, some publics are described as sharing "commonsensical stories" (Michael & Brown, 2000) with scientists such as: if you accept abortion, you cannot reject embryonic stem cell research. Other publics are too irrational to share these stories (for example extreme anti-abortion groups, similar to Michael and Brown's extreme animal activists) and their views must not shape research.

PE involves the incorporation of commonsensical stories into rational discussions between scientists. It also includes a small measure of

talking to the public and "letting them know what we're doing". Informants that have experience of PE at the parliamentary level discuss an exceptional role for politicians in setting legal frameworks (such as banning reproductive cloning or legalising research on embryos) but do not accept a role for the public shaping of research any more routinely. Scientific citizenship is only held by scientists.

The features of this ideal type echo some versions of republicanism, which involves a community with shared values, whose members handle common concerns through discussions within that community (e.g. Cunningham, 2002, pp. 55-6). My ideal type most closely resembles Polanyi's concept of Republicanism, where the "republic of science" is a "society of explorers" who "strive towards a hidden reality" (1962, p. 67) and are independent of external pressures. Legitimacy in the Republic comes from being accountable to members of the community but not slave to rule by ignorant mobs (Held, 2006, pp. 32-3); it also rests on the assumptions that those in the community of decision-makers are trustworthy "club members" willing to engage in a restricted form of "direct democracy" (Held, 2006, p. 39).

Ideal type II – PE as recruiting Supporters

PE here involves educating publics about science in order to recruit them into supporting it and perhaps lobbying politicians and other decision-makers on behalf of scientists. The notion that education automatically leads to support was drawn upon by many informants in both countries (explicitly by twelve) and the strategic use of patients or public groups to convince politicians or other decision makers was explicitly made by four of these informants (all senior).

Scientists here see themselves as objective and with the necessary technical capital to predict the best future for science and society. However, they view themselves as lacking the necessary political capital to make decisions around science; these are made by funders and politicians. Scientists cannot easily convert their technical capital into political capital; in particular scientists seen as promoting their interests can lose their image of neutrality: "it's seen as self-serving". In turn, this may diminish their technical capital as well as their political capital.

As in the first two ideal types, publics are portrayed as ignorant and emotional but some, especially patients, have the political capital to convince politicians and others about the promises of science. The notion that patients have more political capital than scientists was specifically expressed by group leaders with engagement experience. Thus, experience of engagement can lead to scientists becoming more aware of strategies to improve their position – here, by using patients who support their cause.

Knowledge is depicted as objective, and it is assumed that knowing more increases support for science - echoing the traditional deficit model of public understanding. Patients initially are usually "not informed" and perhaps sceptical. However, once they know what is happening, they will be more supportive: "the more education that people receive, the more liberal they're prepared to be, because they understand the issues better".

When informants made statements in which deficit model assumptions were apparent, I raised research challenging these. Some respondents went on to delineate two types of publics: a majority public that can be educated to see the promise of science, and that holds a worldview compatible with science as a vehicle of progress; and a minority public, such as religious groups, that will not be convinced by education and whose worldviews contrast with those of scientists (similar to Michael and Brown's extreme animal activists mentioned above). The respondents who stayed within this ideal type did not go on to suggest that engagement should be abandoned or modified (unlike others, see type IV below); nor did they suggest that these minority views should be listened to in a democracy (unlike type III below). Instead, they suggested that these views were not legitimate as they were not founded on good reasoning, and could therefore be set aside and ignored. Thus, legitimate citizens will use their political capital to support science. In a circular manner, if they do not support science, they are not legitimate citizens.

Some elements of this ideal type echo liberal democracy, in particular what Held calls "developmental democracy" (2006, pp. 81-93). According to liberal democrats, the State does not automatically know what is best for its citizens, and therefore needs guidance from these

(see also Habermas, 1996, p. 21) - e.g. here through powerful appeals by ill patients. There is an assumption amongst theorists such as John Stuart Mill that education is key and that the most educated people will be able to make the best decisions (here, to support science). Mill even suggests a voting system whereby intellectuals hold more votes than working people - Held calls this "education elitism" (2006, p. 92). Whilst liberal democratic theory can be seen as laying the seeds for social equality, there remains a concern about some people - the working classes - "spoiling the political order" (Held, 2006, p. 85). This connects with the above exclusion of some people from scientific citizenship: those who cannot see reason and support science. Legitimacy comes from not imposing a political order through strength, but by gaining consent from citizens (Held, 2006, p. 89) - here education would be assumed to lead to increased knowledge and therefore consent.

Ideal type III – PE as educating scientific Consumers/Citizens

In this ideal type, PE is aimed at providing a variety of publics with neutral information. Individuals can then choose between the different options on offer, either by exercising their rights as consumers (by choosing or not to buy a product) or as citizens (by voting). Elements of this ideal type are drawn from interviews with five PhD students, one post-doc and six group leaders in the UK and Australia.

As in ideal type I, scientists hold all the relevant technical capital. They do not have the right to make all the decisions about science however; they lack political capital. Their role is to give impartial advice about technical issues: "I'm not really competent to get into religious/philosophical discussion with these individuals about their beliefs, not my job, not my role." Scientists are objective providers of neutral information (cf. Kerr, Cunningham-Burley, & Amos, 1997). The purpose of PE is to inform publics about options made possible by scientists, such as donating or not, participating in a trial or not. Publics are seen as temporarily ignorant but can be enabled, through education, to make informed decisions. Although education is essential, it is recognised that some publics will never be swayed towards the

scientists' point of view; unlike ideal types I and II, this does not mean that their views should be dismissed: "we have to make a democratic decision and either move forward or not". However, publics in this ideal type are not only potential voters, they are also potential consumers. Patients for example are labelled "the number one consumers" and their "opinions" are legitimate: they have citizen rights through their consumption. Michael and Brown similarly note a "blurring of the boundaries between 'citizen' and 'consumer'" (2000, p. 16). This can be connected to the rise of the "New Right" where it "seems to be becoming increasingly problematic to separate out – to keep distinct – the practices of citizenship from those of consumption" (Michael, 1998, p. 320).

Science is not an independent republic as above, with scientists as the only citizens. Rather, scientific citizens are all sorts of publics who vote and consume, and scientists who educate. I see them as belonging to what Elam and Bertilsson call an "advanced consumer society" (2003, pp. 239-40). This society is a "market structured network of interactions among private persons" who are trying to advance their "private interests" (Habermas, 1996, p. 21). This indicates a liberal version of democracy that highlights the importance of individual freedoms (Cunningham, 2002, p.30). More specifically, this engagement ideal type reflects a notion of "advanced consumer democracy" or "competitive elitist democracy" (Michael & Brown, 2000, p. 7; Held, 2006, pp. 125-157). In classic Schumpeterian or Weberian competitive elitist democracy, publics are seen as emotional and unable to guide policy; they can only choose between leaders (Held, 2006, pp. 135-36, 149-150). The parallel here is that publics cannot guide science policy or product development; only choose between the options made available to them by science. In this restricted democracy, legitimacy derives from having the educated elites in positions of power (e.g. creating knowledge and products), with the public able to vote them out (e.g. refuse to buy their products) if they are no good (Held, 2006, pp. 149-150).

Ideal type IV – PE as a Public Relations exercise

In this ideal type, scientists should ideally be left alone to self-regulate

as they have all the necessary technical capital to do so. However, irrational public fears can go against scientific progress and need to be managed through engagement, which involves projecting a good image of research. This ideal type was constructed from core elements of an interview with a senior Australian adult stem cell researcher and from more minor elements of interviews with seven other researchers (working in both countries, at various levels of seniority).

Scientists here portray themselves as objective and endowed with all the necessary technical capital to set agendas around science and know what is right for society. Similar to engagement type I, they consider themselves responsible enough to self-regulate, with the internal workings of science ensuring that fraudsters and pseudo-scientists are not given free rein. For instance, scientists have better things to do than clone human beings (Marks, 2012).

Publics are portrayed as unable to contribute to science but nevertheless able to counter progress if not effectively managed. Informants focus on a variety of specific publics, depending on who they have had interactions with. These include: funders, who hold the purse strings and therefore need to be shown promising results if they are to continue investing their money; members of ethics boards, who need to be won over to permit research; animal rights groups who already have had a detrimental effect on science by increasing scientists' paperwork; and the media, who have a strong influence on public opinion and, therefore, need to be given the "right" stories to prevent widespread unpopularity. Thus, all these publics have political capital that can go against science: they can mobilise existing modes of communication and power structures to slow science down.

PE is about promoting science. One respondent is unusually clear and consistent with her criticism of public interference in science and the need for engagement to highlight the promises of therapies and to "portray a certain message to the general public that isn't too complicated". She does not allow her students to participate in PE as they are "still developing their communications skills". Most other researchers who draw on this ideal type do so intermittently, and express discomfort at the idea of being explicitly strategic in theirommunications. They often blame the contexts of research (e.g.

funding pressures) which might dictate the need to select the sorts of information made available to particular publics.

This ideal type is similar to ideal type I, but draws on lessons learnt from experience of PE or from critiques of the deficit model; I call it the in new republic of science. Scientists here long for the independence of science from politics and publics, but have learnt that they need money and to be strategic about their engagement. Both promises and risks of research can be discussed within the republic; however PE only involves telling people about the promises of science. Like in ideal type I, scientific citizens are scientists, and legitimacy comes from being accountable to members of the republic. The concerns seen here about disruptive publics and science's dependence on others when it comes to resources is reminiscent of the problems encountered by Renaissance Italian city-republics: these were successful whilst small (with similar-minded people in power), but encountered challenges when those who were excluded claimed their right to citizenship or with the historical changes towards bigger, more densely populated cities and nation-states, with complex international inter-dependencies (see Held, 2006, pp. 29-55).

Ideal type V – PE as mixing elite Expertises

In this ideal type, scientists and other experts decide together on the course of action in a rational way. They can be aware of, and interested in, broader public views. It was developed from interviews with thirteen scientists - from both countries, of all areas of seniority and working in all areas of SCR.

Scientists who used this ideal type describe themselves as holding partial objective knowledge, and needing help from others to make decisions about science; they are expert and lay at the same time (cf. Kerr, Cunningham-Burley, & Tutton, 2007). Technical capital, which encompasses various types of knowledge and symbolic power, is shared amongst different groups, or diverse "publics-in-particular" (Michael & Brown, 2000). Suggestions of appropriate publics depend on informants' experiences. For instance, those with experience setting up companies acknowledge the expertise of business people and patent

lawyers; those involved in clinical trials acknowledge the expertise of clinicians and biotech companies. One respondent suggests the need for input from experts in community views into the design of clinical trials, to ensure these would be publically acceptable. Not all publics, however, hold this technical capital. In particular, emotional or subjective publics, such as "individual patients" must not be included in these interactions. They need to be represented by, for instance, experts of community views, ethicists, or patient groups. To qualify as a potential "public-in-particular", people must convert their capital into capital recognised by scientists (e.g. publications on PE).

The tacit model of dialogue drawn on here is "external" (Michael & Brown, 2000), where decisions are made externally to the scientific community, in discussion with other experts. For Michael and Brown, the purpose of these "external" discussions is to educate these publics-in-particular (see especially 2000 pp. 5-6). By contrast, in my version of "external" discussions, the purpose is to share expert knowledges; one respondent for instance talked about "constructive dialogue". Accounts such as these echo what Collins and Evans (2002) advocate when arguing that people with relevant technical expertise can shape research.

This ideal type of PE shares resemblances with deliberative democracy - which emphasises the importance of decisions based on informed public discussions amongst equals (e.g.Held, 2006, p. 232; Dryzek, 2000) -- but an elitist version thereof. The type of public discussions that the above informants describe most closely resembles the versions of deliberative democracy described in early Habermas and Rawls or some aspects of Benhabib's thesis. Their respective focus on "ideal speech situations", reasoned arguments and "practical rationality" all emphasise the importance of an impartial standpoint from which to judge public deliberations; citizens should come together and reach decisions through rational debate that articulate reasons that all can accept (Held, 2006, pp. 238-241; Benhabib, 1996, p. 83; Dryzek, 2000, pp. 11, 15-17, 22-14). Legitimacy is gained through proper procedures, for instance "each individual has the same symmetrical rights to various speech acts, to initiate new topics, to ask for reflection about the presuppositions of the conversations, and so on" (Benhabib, 1996). Here, scientific citizenship is bestowed upon anyone who can enter

reasoned discussion resting on sound argumentation, rather that personal, emotional opinion. There is also a focus on learning (from others' expertise) to improve decision-making (Held, p. 238), which is key to Habermas' view of deliberation, but not Rawls's which assumes fixed and competing individual interests (Dryzek, 2000, p. 15).

Ideal type VI – PE as Upstream mixing of Situated Knowledges

In this ideal type of PE, scientists and a variety of publics hold diverse socially contingent knowledges that can be used to shape the future direction of research. This ideal type was developed from core elements of an interview with one mid-career researcher working on embryonic stem cells in Australia and from more minor elements of interviews with six informants, including PhD students, post-docs and group leaders, from the UK and Australia.

One of the most striking differences between this ideal type of engagement and the five others discussed, is that scientists here do not portray themselves as completely objective and rational. For them, "science is inherently political" and they argue they cannot dissociate their science from their other views and ethics, e.g.: "it's the evidence that you're prepared to accept that influences your medicine". These scientists draw on, and recognize, a diversity of fragmented identities, such as: researcher, mother and relative of a sick person.

Publics are seen as multiple and include scientists. Examples are: highly informed patients, patients who want no say in their treatments, people who have no problem donating tissue or embryos, people who only want to donate certain tissues, scientists who have never entered a fertility clinic, and people with paraplegia who have heard too many unrealised promises. Knowledge is depicted as non-universal and based on life experience. For me, this implies that these informants accept it as "situated" or "contingent".

These scientists do not believe they can, or should, self-regulate. PE involves the upstream shaping of science (including future directions of research and the set-up of clinical trials) by diverse people sharing their situated knowledges during constructive conversations. For example, one neuro-scientist explained how he changed his research priorities after meeting particular patients.

The criteria for legitimate scientific citizenship are different from the ones discussed above: one does not have to present one's contribution as based on rational and objective facts, and on expertise certified through formal education. One scientist talks about the "expertise" of patients and of people with infertility then, after demonstrating knowledge of social science studies on the limits of the deficit model, she criticises the need for high levels of knowledge in order to have a valid opinion and act upon it. Another informant highlights that certain decision making bodies, such as ethics committees, can be too elitist.

Features of this ideal type resonate with more recent models of deliberative democracy, in particular those that come out of critical theory and identity politics. These models build on work by radical plural democrats and others who argue against the focus on reason as the one guiding principle for deliberation since it can reinforce power imbalances and fails to recognise the existence of multiple standpoints (e.g. Mouffe, 1992, p. 237). For instance, Dryzek's (2000) "discursive democracy" highlights the need to make room for a plurality of voices and identities, not just those that sit well with the constraints of ideal speech; he argues for the inclusion of story-telling and other means of communication into deliberation. He also emphasises the possibility of changing people's views through deliberation and learning. Legitimacy comes from the inclusion of diverse voices, expertises and ways of communicating. Thus here, there can be multiple forms of scientific citizenship for people from all parts of society; they can participate in the creation of agendas for science, or even shape legislation. However, many of the scientists who highlighted the importance of alternative voices also highlighted the current need to, at least rhetorically, appeal to reason and rationality (see also Marks, 2012). Thus, situated knowledges, if acknowledged as such, do not easily convert into symbolic power.

Reflections on Capital, Legitimacy and Democracy in Public Engagement

Six ideal types of public engagement with science and technology were developed in this paper and connected to models of democracy. These are: Type I - internal dialogue with scientists as publics; Type II -

recruiting publics/patients to support science or lobby; Type III - educating scientific consumers/citizens; Type IV - public relations exercise; Type V - mixing elite expertises; and Type VI - upstream mixing of situated knowledges. These were constructed from an analysis of empirical findings: from stem cell researchers' discourses, in particular their "performances of lay political science" (Michael & Brown, 2000) and their normative visions of publics, scientists, dialogue, relevant technical and political capital, and scientific citizenship. This typology develops previous studies of science-public interactions. Although the respondents here work in a specific area of science, their discourses echo those of scientists working in other areas such as xenotransplantation, and of social scientists and scientific institutions (e.g. Michael & Brown, 2000; Elam & Bertilsson, 2003).

My informants draw on various conceptions of relevant "capital" (Bourdieu, 1986). In ideal types I and IV, they argue that decisions about science should be made internally, by scientists who have all the necessary technical and political capital; this illustrates Michael and Brown's (2000) "internal" model of dialogue. All those who are experts are those who belong to the republic of science and should be making decisions. Here, technical capital should automatically convert into political capital; technical knowledge of science implies the ability to make decisions about science and society. Expertise is "certified" (Collins & Evans, 2002) through years of study and the acquisition of diplomas or the publication of papers.

The remaining four ideal types illustrate Michael and Brown's (2000) "external" model of dialogue. In ideal types II (recruiting publics) and III (educating consumer/citizens), technical capital is held by an elite minority who do not automatically have the power to make decisions alone but can educate decision-makers with the appropriate knowledge. Relevant knowledge in these two ideal types is scientific technical expertise. For ideal type V (mixing elite expertises), the pool of relevant knowledge is widened and technical capital derives from scientific technical expertise as well as technical expertise in patent law, bioethics or professional social sciences. Diverse elites hold partial technical and political capital.

In ideal type VI (upstream mixing of situated knowledges) capital is

not split between technical and political. Rather knowledge is culturally and socially situated. Technical knowledge is not the main source of symbolic power, and experience as well as opinions can be converted into capital relevant to discussions and decision-making about science. I would argue that expertise here is not given by a higher order - such as reason - but negotiated politically (see Turner, 2001).

This typology then may be used as a heuristic device to examine the unacknowledged norms which underlie practices of, and discourses about, PE, thus following Weber's exhortations to use ideal types to examine empirical reality. Social scientists can identify which kinds of expertise are put forward (e.g. by examining who is invited to be part of a panel or who is described as an important participant) and reflect on whether these expertises are certified, experience-based or negotiated politically. They can identify which kinds of capital (scientific/technical, other technical) are easily converted into political capital (e.g. used in decision-making). This will indicate who can more straightforwardly take on a role as a scientific citizen in particular types of science-public interactions. Social scientists can then compare their findings to the ideal types put forward here and identify which ones most closely resemble their data. They can also contrast the ideal types that different participants draw upon, or contrast those drawn upon by organisers and by participants. This may help identify future areas of tension and challenge how particular instances of PE are set up.

In particular, by highlighting that different forms of expertise are considered legitimate in different ideal types, social scientists can enable reflections on why this is the case and whether other forms of expertise should be legitimised. They can also identify the structural conditions that may inhibit or promote different kinds of PE. For example if the sponsoring institution of a particular instance of PE is a scientific body for which certified expertise is the only recognised capital that can provide symbolic power, ideal type VI may be harder to enact. Nevertheless, an opportunity for transformation comes from highlighting this and therefore making possible discussions about other sources of symbolic power.

In addition, because these ideal types of PE are connected to models of democracy, we can turn to the political theory literature for further

reflection and critique. For instance, liberal versions of democracy draw their legitimacy from people being seen as able to shape their lives through active participation in politics (e.g through voting, see Held, 2006, p. 82) and having educated elites in positions of power. However, Marxists, pluralists and deliberative democrats have highlighted unavoidable power inequalities that may exclude people from full participation (e.g. Cunningham, 2002, pp. 52-72; Held, 2006, pp. 103-08, 138-109; Mouffe, 1992; Habermas, 1996). For instance, just because voters seem to consent to something because they had the option to vote against it or not purchase it, this does not mean that they really had the choice not to consume or vote in a particular way (Held, 2006, p. 155). Moreover, criticisms have been levelled at the form of liberal democracy called competitive elitism: although it claims to be democratic, the conditions for legitimate participation can be very exclusive and technocratic, thus leading to this form of government being relabelled an "oligopoly" (Held, 2006, pp. 155-56). Therefore, if a particular instance of PE draws on liberal democratic principles such as those echoing ideal types II (recruiting supporters) and III (educating scientific consumers/citizens), social scientists might want to encourage organisers to pay particular attention to power inequalities. Depending on their desired outcomes, they may wish to implement processes that invite better inclusion, or be explicit as to why only particular kinds of experts can be given scientific citizenship. These decisions then become open to challenge.

Republicanism draws its legitimacy from decisions being accountable to members of a small group of people with similar interests and from "trusted club members" being in positions of power. Republicanism has been criticised for being undemocratic due to the limited constituency for citizenship (Held, 2006, p. 32) and for relying too heavily on the ethical virtues of individual citizens/club members (Habermas, 1996, pp. 23-4). As such we can ask whether the ideal types of PE that are underpinned by republicanism expect too much of their citizens; for instance whether they take for granted that scientists are more virtuous than others and whether this is appropriate (see also Fuller, 2000 for a critique of Polanyi's republic of science). Republicanism has also been criticised for being inapplicable to complex modern societies. This

suggests that instances of PE that draw upon ideal types I (internal dialogue with scientists as publics) and IV (public relations exercise) may need to open-up by including more people as legitimate citizens, by improving the quality of participation or as above, by not claiming to be democratic or to involve the public. This can help us address the disjuncture between calls for inclusive participation (that might correspond to ideal type V which rests on deliberative democracy, see below) and engagement practices that are exclusionary.

Deliberative democracy has been put forward as a solution to the issue of ethical over-burdening of republicanism (Habermas, 1996; Dryzek, 2000). This is done by institutionalising the conditions for democratic opinion- and will-formation (Habermas, 1996, p. 27 especially) through providing the conditions for "ideal speech" (Benhabib, 1996), thereby lending deliberative democracy its legitimacy. However, a number of people have criticised ideal speech, for instance for its "naivety about the politics and power relations of such encounters" (Leach & Scoones, 2005, p.25). Similarly, Elam and Bertilsson argue that its emphasis on "rationality, reserve, selflessness and powers of argumentation" (2003, p. 242) fails to provide conditions for members of the public to fully participate in discussions about science and, rather, reinforces scientists' power to dominate these discussions. Instead, they put forward "radical and plural" versions of democracy that recognise the complex and situated nature of knowledge, and recognise a diversity of scientific citizenships, including activism (Elam & Bertilsson, 2003, pp. 243-6; see also Papadopoulos, 2011).

Versions of democracy that draw on radical pluralism and inclusive versions of deliberative democracy (and which draw their legitimacy from this inclusiveness) have also been criticised. For instance, they are seen as impractical - marred by "utopian irrelevance" and inapplicable to complex modern societies (discussed in Benhabib, 1996, pp. 84-5). Benhabib responds to this by highlighting that many current ways of making decisions draw on some principles of deliberative democracy, thus indicating its feasibility. Inclusive versions of deliberative democracy are also seen as likely to lead to demagoguery and arbitrariness because of the emotionality of arguments that do not follow the conventions of ideal-speech (Benhabib, 1996, p. 83; Held, 2006, p.

236). Dryzek (2000) responds to this in his normative account of discursive democracy by putting forward a set of conditions for communication that focus on the absence of coercion rather than rationality and impartiality.

These discussions about the legitimacy of different forms of deliberative democracy can help us reflect on ideals types V (mixing elite expertises) and VI (upstream mixing of situated knowledges). Organisers of PE who aim to draw on deliberative democracy should reflect on their normative positions regarding reasoning: e.g. are the best decisions made by seeking an impartial standpoint from which to judge all positions put forward and reach informed and value-neutral consensus, or should there be a recognition of irreducible value-differences that might need to be expressed through non-rational expositions such as story-telling and that may never lead to consensus? This reflection can be aided by drawing on Schumpeter: he argues that people have irreconcilably different values that are beyond logic and that therefore there is no "common good" derived from rational thought; thus it is illegitimate to reject someone's view as sectarian since all views are in some sense (Held, 2006, pp. 146-8). Highlighting this literature forces organisers and participants of PE to consider the legitimacy of including/excluding particular voices and modes of reasoning.

Conclusion

The typology put forward here may be a useful heuristic device to highlight some of the contrasts between individual people's implicit and explicit normative visions of PE and between different people's normative visions thereof. This can highlight the arbitrariness of how PE is practiced in particular instances and open up opportunities for transformation through an acknowledgement of these norms (see Bourdieu, 1980, 1975). By connecting ideal types of PE to particular versions of democracy, this typology enables us to turn to political theory to seek further critiques of social arrangements, reflections on legitimacy and potential ways of improving science-public interactions. This is important in order to better understand our current forms of

public engagement with science and technology and to strive towards "democratic" and "legitimate" decision-making - in all its complexity and contradictions.

This typology is a work in progress and hopefully can be built upon by constructing additional ideal types of PE and refining the ones discussed here. One avenue for further development would be to examine what kinds of PE are appropriate for different topics of discussions; some might require more attention to inclusivity than others. A second avenue would be to examine how applicable this typology is to "performances of lay political science" by other groups such as publics or policy makers. A third avenue could focus on institutions and how they can facilitate (or not) different types of PE (e.g. see Brown, 2009). Finally, this typology might be complemented by investigating the role of public engagement in education and how that connects to scientific citizenship; this could be done by drawing on pedagogical models, in particular from critical pedagogy (e.g. see Freire 1972; Kincheloe, 2008).

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Notes

[1] I follow Rowe and Frewer (2005, p.255) in using the term public engagement broadly to designate all science-public interactions, whilst public education indicates a one-way flow of information from scientists to the public, and public participation indicates two-way interactions.

[2] E.g. Michael and Brown (2000), Elam and Bertilsson (2003), Irwin (2006), Michael (2009), Bickerstaff et al. (2010).

[3] E.g. Michael and Brown (2000), Elam and Bertilsson (2003), Chilvers (2008), Papadopoulos (2011), Lövbrand et al. (2011), Durant (2011).

[4] E.g. Michael and Brown (2005), Felt et al. (2008), Wilkinson et al. (2011), Parry et al. (2012), Marks (forthcoming).

[5] For Bourdieu, fields are objective complexes of socially and historically contingent relations, structured by the uneven distribution of capital (e.g. Bourdieu, 1986; Bourdieu & Wacquant, 1992).
[6] This is slightly different to Weber's approach: he starts with concepts that are already used in everyday language (e.g. agriculture, Christianity). He is aware that these have multiple meanings and uses, and his interest is in constructing one ideal type that highlights what he interprets to be the key elements (of Christianity etc.). By contrast, I derive my own labels for each ideal type: the term "engagement" is used in everyday language, but the point here is to show its multiple meanings, so I do not wish to construct one ideal type of engagement. Weber also considers historical "facts", whereas I focus solely on discourse.
[7] "Model" here means a mixture of normative and descriptive features (Held, 2006, pp. 6-7).
[8] Each interviewee often presented different visions of PE during one interview, but it is beyond the remit of this paper to discuss this in more detail.
[9] For reasons of space, I only offer a few quotes for illustrative purposes here.

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Building Bridges between Biotech and Society through STSE Education

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Building Bridges between Biotech and Society through STSE Education

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Abstract

Science and technology are developing at a very high rate of speed both in basic research and applied technology. New technologies continue to expand their important role in Western and other societies. We review here the most relevant advances in modern biotechnology, considering the new challenges that this technology poses to the 21st century society.

As science and new technologies continue to expand their important role in modern societies there is an obvious need for well-informed citizens. Scientific literate citizens are people who have the skills of critical discrimination, the abilities and the desire to take part in decisions about scientific issues that affects their daily lives. Thus nowadays, science education should become a bridge between science itself, technology, and the social and environmental contexts in which both science and technology operate. This paper deals with the need of developing a 'scientific literacy' during the formative stages of students and points out educational views, approaches and orientations to achieve this shift of the educational paradigms, to reach literate citizens that make informed decisions to link science, technology, environment and society.

Keywords: modern biotechnology, scientific literacy, Science-Technology-Society-Environment (STSE), education

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Construyendo Puentes entre la Biotecnología y Sociedad mediante la Educación STSE

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Resumen

Ciencia y tecnología se están desarrollando a gran velocidad tanto en la investigación básica como en la tecnología aplicada. El importante papel de las nuevas tecnologías se expande tanto en todas las sociedades. En el presente artículo revisamos los avances más relevantes en materia de biotecnología moderna, teniendo en cuenta los nuevos retos que plantea esta tecnología para la sociedad del siglo XXI.

Ante esta expansión, hay también una necesidad obvia de tener ciudadanos bien informados. Las y los ciudadanos alfabetizados científicamente son personas capaces de hacer juicios críticos, además de poseer habilidades y el deseo de participar en las decisiones sobre temas científicos que afectan a su vida cotidiana. Por lo tanto, hoy en día, la educación científica debe convertirse en un puente entre la misma ciencia, la tecnología y el contexto social y ambiental en el que la ciencia y la tecnología operan. Este artículo aborda la necesidad de desarrollar una "alfabetización científica" durante las etapas formativas de los estudiantes y se señala los puntos de vista educativos, enfoques y orientaciones para lograr este cambio de paradigmas educativos, con el fin de llegar a ciudadanos alfabetizados que toman decisiones vinculantes con la ciencia, la tecnología, el medio ambiente y la sociedad.

Palabras clave: biotecnología moderna, alfabetización científica, Ciencia-Tecnología-Sociedad-Medio Ambiente (STSE, en inglés), educación

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In western societies today, science and technology are cornerstones of development that affect and sometimes determine important aspects of the daily life of all citizens. In the last number of decades, there has been a revolution in the field of biological research. The idea of managing or manipulating biology to develop specific characteristics is not new. Beginning in the 1970s, scientists have used DNA to create genetically engineered cells and organisms. For instance, genetically modified foods are nowadays sold in grocery stores across the U.S., insulin produced through recombinant DNA technology has transformed treatment for diabetes, transgenic mice are indispensable to biomedical research, and medical testing for genetically linked illnesses is on the rise (Presidential Commission on the Study of Bioethical issues, 2010). Genomics and its related technologies (generally called modern biotechnology) have the potential to become one of the most important scientific and technological revolutions of the 21st century (Kirkpatrick et al., 2002). New techniques have been developed that allow both the sequencing of genomes and the global analysis of these genomes at different biological levels (gene, mRNA, proteins, etc). Modern biotechnology applications are vast and span the gamut of biomedical research (gene therapy, genetic illness and diagnosis, functional food etc.) and agriculture (bioenergy, transgenics, genetic modified organisms (GMO) and so on). One crucial achievement started in 1990 when the Human Genome Project (HGP) was officially initiated with the plan for completing human genome sequence in 15 years. Sequencing the human genome signified the beginning of an exciting new era of science. Finally, rapid technological advances accelerated the completion date to 2003, when highly polished sequence of the human genome was published, free and readily accessible to all. Actually, anyone with a computer and an Internet connection can now explore the draft sequence of the human genome (National Center for Biotechnology Information, NCBI). A challenge facing researchers today is that of piecing together and analyzing the plethora of data currently being generated through the Human Genome Project and scores of smaller projects.

Biotechnology has stepped forward by the emerging during last decade of a new and revolutionary field: synthetic biology. Using a

number of technologies and intellectual approaches, synthetic biology solves biological engineering problems by designing and reconstructing new biological parts, or systematically redesigning existing, natural biological systems. Synthetic biologists are expanding the boundaries of biotechnology by attempting to create the "software" of life from scratch. Can a complete genetic system be reproduced by chemical synthesis starting with only the digitized DNA sequence contained in a computer? This question was finally answered by Craig Venter's team, when in 2010 they published the creation of a bacterial cell controlled by a chemically synthesized genome (Gibson et al., 2010). Briefly, C. Venter's team synthesized in the laboratory a copy of the sequenced genome of a bacterium. This synthetic genome was introduced in another bacterium, with slightly different characteristics, and the new synthetic DNA got the control of the cellular machinery allowing cell division and thus, becoming the first living being that has all the genetic material artificially created. This has been the first synthetic cell, a clear landmark in synthetic biology.

With great Power comes great Responsibility

Some beneficial applications of modern biotechnology or synthetic biology could also be used in harmful or unintentionally dangerous ways. Other issues considering synthetic biology include the potential impact of organisms created by synthetic biology on the environment, the ownership of technologies, and distribution of the benefits of such research and its products (Garfinkel et al., 2008). In all aspects of modern biotechnology (genome sequencing, GMO products, synthetic biology, etc) raise both familiar and new ethical, social, environmental, and philosophical questions. All those questions and hazards must be faced by scientific literate citizens, people who have the skills of critical discrimination, the abilities and the desire to take part in decisions about scientific issues that affects their daily lives.

Sooner than later we all as a citizens will have to take decisions about issues derived of new biotech applications, e.g. the suitability of using large amounts of land to grow crops to turn into fuel rather than food, the legality of use GMO's in our lands or the ethics behind the "genetic

use restriction technology", colloquially known as suicide seeds. As well as answer ethical questions related to new biotech applications and genetic information management, e.g. who should have access to personal genetic information?, how will it be used?, how genetic information will be stored?, how we will control GMO?, etc. There are also concerns about who will benefit from synthetic biology, who will bear the risks, and who will decide. Modern biotechnology also renews old questions about whether scientists are "playing God". Questions have also been raised about ownership and control of products developed from modern biotechnology, including access, sharing, control of intellectual property, and regulation (Garfinkel et. al., 2008). Therefore society must understand that new advances in science and technology require taking informed decisions and those decisions must be taken by scientific literate citizens.

Scientific Literacy of Citizens

Undoubtedly, we are living a historical moment where multiple challenges must be handled by Humanity. In near future society should face important challenges that will require specific scientific advances to overcome problems derived from interactions of human activities with the global ecosystem. Globally we face a number of social, economic, and environmental issues resulting from interactions of human activities with the environment. With the human population at 7 billion people as of October 2011, and projected to be 9 billion by 2050, the pressures caused by these interactions are unlikely to abate. The need for food, clean water, fuel, and space will increase. Changes to the natural and built environments will continue to have significant economic and social impacts (Hollweg et al., 2011).

The perspective of a socially-viable science should be shared with citizens and, in this way, socially accepted technological innovations can be created (Gaskell et al., 2005). However, in order to involve society in the decision-making process about scientific policies, we need well-informed citizens who are able to make thoughtful decisions based on scientific conclusions combined with ethical and moral considerations. Thus, society should have a minimum scientific basis

upon which to come to a reasonable opinion about, for instance, the use of genetically modified organisms (GMO's) in agriculture or medicine, how these products should be labelled, etc. Science educators, in collaboration with experts from other disciplines, are starting to debate ethical, legal, and social implications of science and technology in today's world. If the public has voice, say some, and it is involved in the decision-making process about scientific and technological issues better decisions could be made. In other words, a more participative society will lead to more socially appropriate and viable scientific innovations. Such questions as 'What kind of society do we want? How can new technologies help us to reach this new society?' that involve social values and ethics may answer questions that science by itself may not able to answer. Therefore, citizens should play and active role in terms of scientific policy.

In this 21st century, science education should become a bridge between science itself, technology, and the social and environmental contexts in which both science and technology operate. Much research in science education worldwide promotes, as an important goal of science teaching, the scientific and technological literacy of whole populations (Zoller, 2012; Dimopoulos & Koulaidis, 2003; Jenkins, 1997; Miller, 1998). Science literacy means developing the capability of evaluative system thinking in the context of science, technology, environment, and society, which in turn requires the development of students' higher-order cognitive skills (HOCS), system critical thinking, question-asking, decision-making, and problem solving. This should become the top priority goal of contemporary and future effective scientific education (Zoller, 2012). The underlying notion is to develop the knowledge and the mental habits that allow people to become responsible citizens, able to create their own informed opinions, all the while living in a society that is becoming increasingly complex and more dependent on science and technology.

Shifting educational Paradigms

As previously mentioned, researchers in education argue that scientific literacy of whole society should be the ultimate goal of scientific

education. However, a meaningful education in science requires a revolutionized change in the guiding philosophy, rationale, and models of our thinking, behavior, and action (Zoller, 2012). The frame of the current paradigm of science education, mainly characterized to be teacher-centered, disciplinary, decontextualized and low-order cognitive skills (LOCS) oriented should move to more adaptive paradigms. Science education should be an interdisciplinary teaching approach, leading to the development of our students' higher-order cognitive skills (HOCS), promoting critical system thinking, problem-solving and decision-making (Table 1).

Table 1

Recommended Paradigms Shifts in Science, Technology, Environmental, and Society (STSE)-Oriented Education (Adapted from Zoller, 2012).

To Foster Critical Thinking Skills and Science Education and Environmental Approaches, Society and Educators Should Move	
From These Current, Maladaptive Paradigms	**To These More Adaptive Paradigms**
Technological, economical, and social growth at any cost	Sustainable development in the global context
Corrective responses	Preventive actions
Reductionism; i.e., dealing with in vitro, isolated, highly controlled, decontextualized components	Uncontrolled, in vivo, complex systems
Disciplinarity	Problem solving-orientation, with decision making based on systemic, inter-, cross-, and transdisciplinary approaches
Technological feasibility	Economic and social feasibility
Algorithmic, LOCS-oriented[b] teaching	HOCS learning[c] in the STSE[a] interfaces context
Reductionist thinking	System and lateral thinking
Dealing with topics in isolation or closed systems	Dealing with complex, open systems
Disciplinary teaching (physics, chemistry, biology, etc.)	Interdisciplinary teaching
Knowing and recognizing orientation in teaching (e.g., applying algorithms for solving excercices)	Conceptual learning for problem solving and transfer
Teacher-centered, authoritative, frontal instruction	Student-centered, real-world, HOCS oriented learning

[a] STSE: Science, Technology, Society and Environment. [b] LOCS: lower-order cognitive skills. [c] HOCS: higher-order cognitive skills.

One of the most discernible trends of the last two decades in science curriculum development across a number of countries has been to use contexts and applications of science as a means of developing scientific understanding. Teaching in this way is often described as adopting a *context-based or STSE (Science–Technology–Society-Environment)* approach. The trend toward the use of context-based/STSE approaches is apparent across the whole age spectrum from primary through to university level, but is most noticeable in materials developed for use in the secondary age range (Bennet et al., 2006). The essence of the role of STSE in education is in teaching towards personal agency through active, civic participation in technologic and scientific decisions. This type of science education, if successful, should, over time, allow citizens to understand at some level important scientific processes, to analyze and assess them, and to be able to use some of the tools related to them. At the same time, STSE education should also lead to the development of participative and open-minded attitudes. These attitudes should be the basis of the decision making processes that citizens follow regarding the potential problems associated with specific scientific and technologic development (Jenkins, 2002; Manassero et al., 2001; Lee & Roth, 2002; Martín & Osorio, 2003; Martín, 2005).

One of the main questions inherent in the STSE approach is if or how scientific literacy could be promoted and developed by means of science teaching. Many different studies in educational research point towards the approach of social constructivism, based on Vygotsky's (1978) theory of social development, as the most appropriate way to carry out teaching and learning processes geared towards greater scientific literacy (See, for example, Freedman, 1997; Bennett, 2001). Learning gained through constructivist teaching practice could become the mechanism to adjust personally-held mental models based on new experiences. In constructivist theory, we are active creators of our own knowledge. Learning is not just the process to receive and integrate new information from the teacher (Driver et al., 1994). A constructivist approach confers an essential role on the social and cultural contexts of students, as they try to make sense of what is happening in society and thus to build their knowledge on this comprehension.

Different associations in different countries have driven STSE-based

teaching programs. As examples, we found the association NASTS (National Association for Science, Technology and Society) at USA, ASE (Association for Science Education) at UK, the international IOSTE (International Organization of Science and Technology Education) and EOI (Organización de Estados Iberoamericanos), the european EASTS (European Association of STS) where The Netherlands is one of the main leaders (Acevedo & Acevedo, 2002). One of the most challenging problems that teachers must face towards any educational innovation is the lack of curricular material (activities, lesson plans, resources, etc). To solve this situation, the EOI, as a part of its program of sciences, has developed several initiatives focused on the design and assessment of new teaching materials and teacher training for the dissemination of scientific culture. As a result of these initiatives, the Spanish group ARGO (www.grupoargo.org) has developed new STSE resources for secondary education, using simulated case strategy to deal with citizenship participation in scientific and technological issues (Martín, 2005).

Other courses in different countries have being designed following the STSE approach. Among the most important projects we encountered: (i) “Science: the Salters Approach" (England and Wales) a 2-year context-based science course for students aged 14–16; (ii) “ChemChom” (USA) a 1-year STS course for high schools students (taught to groups aged between 12 and 17); (iii) “PLON *Projekt Leerpakket Ontwikkeling Natuurkunde*” (Netherlands) a 5-year context-based physics course for students aged 12–17; (iv) "STS British Columbia” (Canada) a 1-year STS program for students aged 16–17; (v) “Science and Technology For All” (Israel) a 1-year STS course for non-science students (Bennet et al., 2006).

Additionally, an interesting example of curricular modification, which has become a referent in Medicine teaching, is the Mc Master model. McMaster University (Canada) pioneered the first problem-based learning (PBL) curriculum in 1969, the rationale that introducers of this methodology proposed for the McMaster curriculum, which included learning in small groups for the study of clinical problems, was that itwould make medical education more interesting and relevant for their students (Neville, 2009). In PBL, fundamental knowledge is mastered

by the solving of problems, so basic information is learned in the same context in which it will be used. Also, the PBL curriculum employs student initiative as a driving force and supports a system of student-faculty interaction in which the student assumes primary responsibility for the process. Neville (2009) summarized the cognitive attributes of PBL that promote learning, which are: (i) knowledge acquired in relevant context is better remembered; (ii) concepts are acquired in a way that they can be mobilized to solve/view similar problems; (iii) acquisition over time of 'prior examples' facilitates pattern recognition; (iv) promotion by PBL of prior-knowledge activation facilitates processing of new information; (v) elaboration of knowledge occurs at the time of learning; and (vi) provision of similarity of context for knowledge acquisition and subsequent application also facilitates recall.

Looking closer in our country, at the Universitat Rovira i Virgili, URV (Spain), an interesting project focused in didactics of science based on STSE approach has been developed, the project APQUA (Aprenentatge de Productes Químics, els seus Usos i Aplicacions). APQUA started in 1988, as a result of the collaboration between the URV's Department of Chemical Engineering and the SEPUP, Science Education for Public Understanding Program of the Lawrence Hall of Science of the University of California in Berkeley. APQUA is a project for scientific literacy addressed to whole society, focused on the chemical products and their processes and the risks which its use represents towards the people and the environment. APQUA has broadened and consolidated its Educational Program, which provides children and adolescents with knowledge and understanding of science and technology. Actually, APQUA has been highly widespread in Spain, since more than 173.000 students of 1.110 schools of elementary and secondary education have followed APQUA modules.

Summarizing, it has been clearly exposed through this article the challenging historical moment that we, as a society, are living. In one hand, the fast development of science and technology allow the whole world to face future challenges by creating powerful tools. Nonetheless at the same time, difficult and complex decisions rise in the horizon to link science, technology and the social and environmental contexts in which both science and society operate. This perspective points out

the need of a citizenship more concerned in scientific issues. However, in order to involve society in the decision-making process about scientific policies, we need well-informed citizens who are able to make thoughtful decisions based on scientific conclusions combined with ethical and moral considerations. From this point of view, scientific literacy promoted through compulsory education appears as the clue strategy to achieve this responsible and concerned society on scientific issues.

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Successful Science Communication

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Review

Bennett, D. & Jennings, R. (Eds.). (2011). *Successful Science Communication, Telling It Like It Is.* Cambridge: Cambridge University Press. ISBN: 978-0-521-17678-1

If Galileo were a scientist today he would probably be a blogger and have a Twitter account. Wisdom communicated down from mountain tops and ivory towers no longer cuts it for 21st-century science. Today's successful scientists and science communicators reach out, network, go on TV, create podcasts, guest on talk radio, and have a website, a LinkedIn profile, a Facebook page, and a Twitter account. They are your neighbour, the guy next to you on the bus, the soccer mom you cheer with as your kids play. They are tuned in, plugged in, multi-taskers and more communications savvy then ever before. Such is the contention of editors David J. Bennett and Richard C. Jennings in this must-have collection of essays for scientists who, love it or hate it, have to broaden their outreach and connect with people outside their peer group and outside their comfort zone. Not a scientist? No problem. This book is equally useful to professional communicators, educators, researchers, policy makers, and students alike.

Subtitled *Telling It Like It Is* Bennett and Jennings have assembled a diverse collection of straight-talking essays from a broad spectrum of communicators of science such as academic authors but also from the industry and media. Written in a practical, readable style and all well-researched and well thought out, we are presented with history of scientific communication but also a handbook for those who could use a primer or those who are new to the communications game.

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The authors contend the public understanding of science is at stake which, increasingly, is also the primary driver behind the success or failure of political and commercial pressures that affect change that improves not only human life but all life. Scientists can talk among themselves all they like but if your science is not getting out to the masses, you or your institution or agency or business could lose prestige, or funding, or worse.

This book contains 27 short essays in four sections and all thread off, more or less, from the Royal Society's *Bodmer Report* of 1985. Most of the authors and discussions are located in the UK but that hardly matters. The concerns and advice are global. The authors are agreed that what worked decades ago, no longer works well today. The skillful communication of science is vital to the modern scientist and connecting with consumers of science be they peers, media, or laypersons, has never before been so easy. That is not without its caveats but science communicators must be bold, they say, to advance the cause and to defend it *everywhere*. The Internet is Dr. Jekyll and Mr. Hyde. It is chock-a-block with bad information but somebody has to set the records straight and that somebody is *you*. Misinformed journalists are a problem but there are also people – professional and not – with agendas to push and often a lot of money at stake to keep pushing nonsense that harms science but also potentially imperils our very existence (i.e. climate change).

"The fruits of science are often sweet, but sometimes they are bitter," writes Jennings in his chapter "Science: truth and ethics." Science has given us wonderful things but also terrible things that scare people. Trust in science – and scientists – is at risk. People do not quite know who to trust any more. Bad information is everywhere and the reputation of science has been suffering because of it. Now, it is time to turn the tide. The authors urge science communicators to reclaim their ground and up their game but also lay the foundations for a new generation of science communicators to change the discourse by standing firm on truth, cultivating trust, and maybe put a bit of sizzle on the steak but not too much. Science must be kept interesting and scientists must be approachable. This, the authors feel, is becoming the norm but insist it must continue and thrive if science is to remain

credible to the people that both foot the bill and those who also elect makers of policy.

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On behalf of the *International Journal of Deliberative Mechanisms in Science*, we sincerely appreciate the work of its reviewers, in 2012, for offering constructive feedback and ensuring the quality of the published contents. This journal would not have been possible without their valuable contributions. Respectfully yours,

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