Developing T-shaped water professionals: reflections on a framework for building capacity for innovation through collaboration, learning and leadership

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Abstract

In developed and development contexts, change is an increasingly central theme for water professionals. Growing populations, rapid urbanization and increasing demands for water, food and energy, are set against a backdrop of changing rainfall patterns and emerging trade-offs between the water required for water supply, energy provision, food production, livelihoods and ecological support. Building the capacity of water professionals to lead the changes in policy, planning, management and communities required to tackle these issues systematically is an essential component of our collective response to global water challenges. This paper provides a contribution to the fields of water leadership and capacity development by outlining, then critically discussing how a concept, the T-shaped professional, is being used as a framework to guide the design and delivery of postgraduate education programs to build leadership capacity in the water sector. The T-shaped concept integrates insights from leadership, learning theory, collaboration, critical thinking and praxis. In doing so, the concept and the way in which it has been applied in the context of postgraduate education provide an intellectually coherent and practical approach to developing the skills and knowledge required by water professionals to stimulate and lead change.

Keywords: Collaboration; Double-loop learning; Innovation; Integrated water resources management; IWRM; Leadership; T-shaped professional

Introduction: the need for change in water management

The need to integrate different aspects of water management to effectively provide social, economic and environmental benefits whilst avoiding problematic trade-offs and impacts has been a significant focus of concern since the 1980s. A response to these concerns can be seen in the emergence of integrated water resources management (IWRM) (Lenton & Muller, 2009), a movement which can be interpreted as focusing on changing the way in which water policy and management decisions are made.


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coordinated, undertaken and implemented across institutions, sectors, and locations. In the development literature, such changes also fall under the banner of capacity development (e.g. Baser & Morgan, 2008). More recently, the need to radically change the way in which essential services – water, waste-water, food, energy – are produced and managed with respect to each other has been argued for strongly (World Economic Forum, 2011) and is forming an agenda in which the institutional and organizational dimensions of change are probably more important to focus on than the technologies. In literature focused on change in water management in developed country contexts (Thomas & Ford, 2005; Brown & Farrelly, 2009; Spiller et al., 2012a, b) the primary problems faced are framed as being concerned with changing entrenched attitudes and behaviors – so-called ‘socio-technical regimes’ – which dominate and determine the ways in which large systems such as water management are structured and function (Smith et al., 2005).

For the ambitions of integration in water management to be realized, whether they lie rooted in IWRM or more recent dialogues around the water-energy-food nexus or socio-technical regimes, there is a need for water professionals to become skilled in stimulating and driving processes of change in a variety of contexts (see also Lincklaen Arriens & Wehn de Montalvo (2013) in this special issue). Building knowledge, skills, power, networks and confidence in driving change represents a significant capacity building challenge. Formal education can play an important role here, providing a process for building the capacity of water sector professionals, and of professionals in related sectors to:

(i) recognize the need for innovation and change;
(ii) develop innovative policies, plans and ways of delivering and managing water resources and services which avoid creating problems elsewhere (geographically, sectorally or to other groups of people); and
(iii) stimulate and drive processes of innovation and change.

But what should formal education programs for building such capacities look like? What skills and knowledge should they focus on and how should they be delivered?

The primary aims of this paper are to:

(i) outline a coherent concept to describe and relate the skills and knowledge required for water professionals to drive innovation and change – the ‘T-shaped’ skills and knowledge profile;
(ii) critically examine how, and how well, the T-shaped skills and knowledge profile has been used to underpin the design and delivery of a suite of postgraduate education programs for water professionals; and
(iii) critically reflect on what we know about how professionals with T-shaped skills and knowledge are able to act as effective change and capacity building agents.

The concept outlined in the paper is labeled the ‘T-shaped water professional’, lies rooted in the management literature of the 1990s and is described later in this paper and elsewhere (see for example Hansen & von Oetinger, 2001; Uhlenbrook & de Jong, 2012). Individual professionals with T-shaped skills have deep disciplinary or functional understanding and an ability to apply that understanding in different situations; an ability to ‘talk the language’ of other disciplines and functional areas and to translate between their interests, objectives and concerns and those of others; and an ability to network effectively across traditional boundaries.
In this paper, we primarily focus on explaining how the T-shaped water professional concept has been applied to underpin the Masters of Integrated Water Management (MIWM) and Water Leadership Program (WLP) run by the International WaterCentre (IWC). The IWC T-shaped water professional concept integrates content and process insights from ‘foundation’ literatures on leadership, learning theory, collaboration, critical thinking and praxis, and provides a strong emphasis on skills and knowledge for innovation and change. In doing so this paper provides a case study contribution regarding the application of the T-shaped professional concept to postgraduate education in the water sector. The reader should note that the concept is also being translated into use with other professionally oriented postgraduate education programs not covered here (see for example the programs by UNESCO-IHE – Uhlenbrook & de Jong (2012)).

To ensure that the conceptual basis of the T-shaped water professional is clear to the reader, the first part of this paper provides a description of the key skills and knowledge components before integrating these within the T-shaped framework, shortened from McIntosh & Taylor (2013). The second part of the paper provides a novel reflection on how the T-shaped concept has been applied – the topics selected, the nature of the delivery, what has worked well, what has proven to be challenging, what we know and don’t know, and how the concept of T-shaped skills and knowledge relates to capacity building. The paper ends with a set of conclusions for how the T-shaped professional concept can be used to build professional competence for change agency, capacity development and more broadly the implementation of integration in water management.

Foundation 1: innovation

Innovations can be distinguished along a continuum from incremental to radical, where incremental innovations are relatively easy to develop and manage changes which improve the performance of existing ways of doing things (usually building on existing knowledge), whereas radical innovations are more complex and difficult to develop and manage, involve generating new knowledge as well as applying it, but afford the possibility of qualitative, breakthrough change (Tidd & Bessant, 2004). The management of incremental innovations is relatively well understood (but not necessarily well done), whereas radical innovations are more complex, uncertain, less well understood and less amenable to being generally understood (by definition).

We do not know what changes will be required to successfully adapt the structure and function of our water supply, food, energy and wastewater systems to the pressures of the present century but the nature and extent of those pressures are becoming clear (World Economic Forum, 2011). The kinds of policy, planning, management and infrastructural innovations required may have to be radical and multi-faceted, involving changes across multiple levels of governance and action, through the application of multiple bodies of disciplinary and functional knowledge across multiple sectors. They may require re-thinking the way in which we seek to structure the physical, economic and social characteristics of cities and regions (Boyer et al., 2009; De La Salle & Holland, 2010; World Economic Forum, 2011) – sets of radical innovations that affect entire systems of production and/or consumption (Smith et al., 2005).

Here we put forward the argument that professionals are needed who have the skills and knowledge to be able to stimulate, drive and manage innovation in the water sector and across related sectors (e.g. food, urban design and management, energy). Investing in developing such skills is an investment in adaptivity – the capacity to adapt to as yet unknown future circumstances.
Foundation 2: learning

Changing the way in which we formulate and deliver policy, planning and management of water resources and services requires capacity to challenge existing ways of thinking and doing. The work of Argyris & Schön (1974) into single loop and double loop learning offers a framework for thinking about how innovation, as a process of challenge, relates to learning at individual and organizational scales. Tosey et al. (2012) summarize:

- Single loop learning is concerned with improving the efficiency of current ways of doing through the recognition and correction of errors. Single loop learning is based in asking the question ‘are we doing things right?’ (Romme & Van Witteloostuijn, 1999).
- Double loop learning is concerned with learning how to question the values, norms and relations of ways of doing, and of generating knowledge and changing how thing are done. Double loop learning is based on asking the question ‘are we doing the right things?’ (Romme & Van Witteloostuijn, 1999).

A third level of learning can also be found discussed within the literature, often termed triple-loop learning (Tosey et al., 2012) and defined as involving change in ways of knowing, or in underlying principles and purpose. One might relate triple-loop or Level III learning to asking the question ‘how do we decide what is right?’ Ethical and value-based considerations play an increasing role as one proceeds from single to triple loop learning.

The three levels of learning can be viewed as being related to change arranged from status quo-preserving, incremental (single-loop) to radical (triple-loop or Level III). Here we propose that the challenges of the 21st century will require water professionals who are able to engage in, lead and manage the process of double-loop learning, and potentially also of triple-loop learning. Radical innovation processes, we argue, are linked to asking and addressing questions of ‘are we doing the right things?’ and ‘how do we decide what is right?’.

Foundation 3: collaboration

We know that innovation processes are becoming more ‘open’, with innovations occurring as a consequence of knowledge generated from collaborations across organizational boundaries (Chesbrough, 2012). We also know that promoting and enabling collaboration between personnel across units within organizations, and between organizations, is a key part of developing new opportunities, as well as effectively and efficiently solving problems (Hansen & Oetinger, 2001). And we also know that effective collaboration – collaboration characterized by the creation of shared understandings of purpose, values and activity which yields benefits to the group as well as to individuals separately – is essential to group effectiveness (Head, 2003). Finally, we also know that effective, as opposed to functional, collaboration tends to have effects like double-loop learning, whereby collectively generated reflection and knowledge lead to more radical, status quo-challenging action (Head, 2003). This is similar to saying that the ability of a group to think creatively and to innovate is related to the ability of the members of that group to collaborate effectively.

So, here we put forward the argument that, in order to be able to stimulate and manage radical innovation and incremental change, water professionals must develop the ability to critically and collaboratively synthesize the insights of multiple potential solution sets embodying multiple
disciplinary, sectoral and stakeholder perspectives. Innovation and change will not come about from working within silos.

**Foundation 4: leadership**

Change is also the focus of the leadership literature, where the term ‘leadership’ can be defined as a process of influence that involves three elements (Taylor et al. (2012), drawing on the work of Drath et al. (2008) and Ernst & Chrobot-Mason (2010)): the first is setting a direction or shared vision, whether for a project, team or organization; the second is aligning resources to that direction – resources may include people, projects, tasks or funds; the third element is building commitment amongst a group of people towards achieving the vision and collective success, which usually involves motivating and inspiring others.

We argue that the capacity for effective leadership is one of the key components of a T-shaped water professional. We make this argument for three key reasons. First, leadership is needed to initiate and drive change, enable innovation (both incremental and radical), build shared visions for a more sustainable water future, and deliver these visions through aligning resources and building commitment to collective success. Second, specific forms of leadership are needed to address the complex, cross-boundary and multi-stakeholder nature of challenges that commonly face the water industry; it is simply not enough to be a technical expert, or a good project manager. Third, social research in the water sector has clearly highlighted the critical role of different types of leaders, and networks of leaders in enabling transitions from traditional to more sustainable forms of water management (Brown & Clarke, 2007; Meijerink & Huitema, 2010; Taylor, 2010).

Once we accept that water professionals need greater leadership capacity, the question becomes which leadership competencies are critical? Many of the forms of leadership that we know are relevant to water practitioners who wish to innovate, drive change and advance more sustainable forms of water management (such as project champions – see Howell & Higgins (1990); Howell (2005); Brown & Clarke (2007); Taylor (2009, 2010)) have significant consequences for educational programs that aim to support such professionals. As just one example, consider the concept of ‘innovation/creative leadership’ (see Mumford et al., 2002; Horth & Buchner, 2009) which requires skills of the team leader in (i) facilitating conditions that are conducive to the generation of new ideas – questioning the status quo, using creative problem-solving techniques, building bridges between people and organizations, providing people with freedom to pursue new ideas, fostering group diversity, encouraging open communication and building a culture that celebrates new ideas, (ii) providing detailed guidance to members on the technical and organizational merits of new ideas (i.e. specific feedback), clearly communicating expectations (e.g. goals), available resources and time frames, and encouraging integration between relevant projects, and (iii) gathering support from their organization for innovative ideas or projects, acting as a ‘champion of innovation’ on behalf of the team. This brief example illustrates the broad range of knowledge and skills which need to be developed in water team leaders to be effective in just one leadership context – fostering innovation in teams.

**Foundation 5: ethics, values and context**

The ability to collaborate with professionals and community members who operate from different epistemological bases and perspectives is essential but also not sufficient. Water professionals must be cognizant of and act upon the ethical dimension of their work. Why?
First, clarifying personal values, communicating these to others, and acting in accordance with these values are the core steps to building credibility as a leader (Kouzes & Posner, 2007). Personal values play a critical role in leadership emergence, motivation, the choice of behaviors in ambiguous contexts, the formation of organizational cultures and the process of building shared visions for initiatives. They are so fundamental to leadership that they are often referred to as ‘the leader’s compass’. In addition, there is now a strong demand for more authentic leadership across society (see Northouse, 2010) – leaders who are self-aware, transparent, honest, value doing the right thing and place meeting group needs above personal needs. Increasingly, leadership without a strong ethical foundation is seen as being socially unacceptable. Consequently, we argue that educational programs that aim to foster effective water practitioners who can engage in leadership should incorporate ethical and value-related components to their curricula.

Second, we must move beyond the heavily critiqued, values-free approach to management embodied by hard systems or operational research and modern management science (see critiques by Ackoff (1979) and by Saul (1992)). Flyvberg (2001), using the distinctions of knowledge provided by Aristotle is his Nicomachean ethics, argues that knowledge of how to wisely and ethically use scientific knowledge (episteme) and engineering knowledge (techne) is the most important form of knowledge. This knowledge is key to avoiding disproportionate or unexpected negative impacts on different groups of people or other species here now, further into the future, or elsewhere (see the sustainability framework described by Thiele (1999)).

The T-shaped water professional concept

How might one conceptualize the innovation, collaboration and leadership-focused skills and knowledge profile we have argued will be necessary for water professionals to effectively respond to the climate and population challenges of the 21st century? How might one use the resulting conceptualization as the basis for the development and operation of education programs? Figure 1 presents a model of the kind of professional with the kinds of skills and knowledge we have described over the course of this paper: the T-shaped water professional.

We have framed the T-shaped water professional to share some of the same characteristics found in other applications of the concept – deep functional or disciplinary knowledge (the vertical bar, or the ‘I’ part of the T) capped with a breadth of knowledge (the horizontal or cross-bar of the T) which represents the T-shaped water professional being able to operate across disciplinary, functional and organizational boundaries.

What makes the T-shaped model shown in Figure 1 different is the clearer focus on specific sets of skills and knowledge embedded within a surrounding context of professional attributes – a proposal about what the cross-bar of skills and knowledge should be for water professionals. Looking at skills and knowledge, there are three core groups of relevance as identified from work on emergent leadership in the water sector (Taylor et al., 2011, 2012):

- Understanding – the mix of additional skills and knowledge required to turn deep disciplinary or functional specialists into professionals able to collaborate across boundaries. In water, this knowledge would include natural sciences (e.g. hydrology, ecology), social sciences (e.g. sociology, psychology, governance, economics) and engineering (e.g. process treatment, hydraulics).
- Organizing – the mix of management skills and knowledge which are essential for effective implementation of innovation, and for more general problem solving and team work within organizations. Examples include project management, systems thinking and stakeholder engagement.
- Influencing – the set of behaviors, strategies, tools and skills which are associated strongly with leadership as a process of influence. Examples include social networking, planning effective influence attempts and team leadership.

Within the T-shaped water professional model, these sets of skills and knowledge are positioned within a broader framework which includes ethics, personal values and context. Context here is intended to show recognition that different organizational, governance and cultural contexts will demand different skills and knowledge, and that effective T-shaped professionals will have developed skills to help them appreciate the context within which they work and to nuance their approaches correspondingly (Taylor et al., 2012).

**Applying the T-shaped model to professional, postgraduate education**

The concept of the T-shaped water professional shown in Figure 1 underlies the design and delivery of the suite of postgraduate water management programs offered by the IWC – particularly the MIWM (which contains related Graduate Diploma and Graduate Certificate programs) and the WLP. Both the MIWM and WLP can also be viewed as being centrally concerned with developing effective water
leaders. The T-shaped model was developed as a way of encapsulating how the skills and knowledge of water leaders (understanding, organizing and influencing) relate to a broader skills profile framework. This is important, as the overall ambition of IWC postgraduate programs is to develop specialists able to operate across boundaries and in different situations rather than generalists with limited depth of knowledge. Figure 2 indicates graphically the difference between:

- T-shaped skills profiles – deep disciplinary or functional understanding and an ability to apply that understanding in different situations; an ability to ‘talk the language’ of other disciplines and functional areas;
- generalist skills profiles – knowledge of many areas to a limited extent; able to recognize the need for change and to connect people but not likely to be deep enough in any one area to identify how to innovate or to drive processes of innovation; and
- I-shaped or specialist skills profiles – deep disciplinary or functional understanding; an ability to resolve complicated tasks and problems and to deliver technically deep, high quality outcomes.

The first element of understanding how the T-shaped concept is applied is to understand the rationale behind the target market for the programs delivered by the IWC. The IWC focuses on recruiting professionals – participants who already have a developed set of deep disciplinary and functional skills and knowledge (i.e. they have a well-developed ‘T’ shaped skills profile by education and practice), and who want to broaden their thinking, to take on emergent leadership roles and to play a strong role in creating positive change. Such persons probably have some form of T-shape to their skills and knowledge emerging already as a consequence of experience.

Whilst the idea of introducing deliberately T-shaped education programs at undergraduate level exists (Harris, 2009), we argue here that such early breadth risks sufficiently deep formation of disciplinary or functional knowledge, which in the long run would be bad for both individuals – as well as more systematically. Alternative arguments claim that the growing complexity and scale of water management challenges requires a deliberately earlier introduction of T-shaped profile development approaches to education (Uhlenbrook & de Jong, 2012). Our view is that careful attention to developing depth of knowledge remains essential at the undergraduate level and beyond – breadth too early could end up producing generalists rather than flexible, T-shaped skills and knowledge profiles.

Fig. 2. Professional skills profiles differentiated by breadth and depth of knowledge (adapted from Uhlenbrook & de Jong (2012)).
The second element of understanding how the T-shaped concept is applied is to understand how the programs of the IWC have been developed to deliver different components of the T-shaped water professional skills and knowledge profile. Table 1 provides this information.

The ambition of developing T-shaped water professionals is significant, perhaps more significant than in other professions, because of the sheer diversity of skills and knowledge required. Developing a broad, systemic appreciation of water management and how one’s own area of professional expertise is situated and relates to others involves a range of subjects from governance, law and policy through social impact assessment, stakeholder engagement and conflict management, to hydrology, water quality, ecology and engineering. In addition to these areas of substantive understanding there are skills in project management, team work and management, time management, networking and collaboration as well as reflective personal values clarification and application.

To respond to the sheer diversity and volume of skills and knowledge involved, the IWC has positioned the MIWM to cover some of the T-shaped components and the WLP to cover others. There is some overlap but, essentially, the MIWM focuses primarily on developing breadth of understanding, skills and knowledge in organizing, skills for collaboration and for reflective values clarification and application (ethics). The WLP focuses primarily on developing influencing skills, strategies, behaviors and knowledge, and a little bit on organizing along with skills for collaboration and reflective values clarification and application (ethics).

The main point of difference is that the WLP is concerned more with developing capacity to lead change and innovation (a process focus) rather than with the skills and knowledge which are needed to underpin the setting of direction for change (an outcome focus); influencing skills and knowledge are central. The MIWM has the opposite focus, with understanding and organizing skills and knowledge being central. Having said that, both MIWM and WLP have been designed to be complementary – the aim being that alumni from one program could then undertake the other to fully develop their leadership abilities and T-shaped skills profile. Table 2 provides additional detail on the subjects which are covered within each program to deliver the components of the T-shaped skills profile.

**Reflections on learning approaches for the development of T-shaped water professionals**

The set of topics covered by both the MIWM and WLP are significant in scope, deliberately cutting across and integrating skills and knowledge across multiple disciplinary boundaries as required to understand and to be able to manage water systemically. Rather than providing reflections on the specifics of how both programs have sought to cover all of these topics, the aim of this section is to provide critical reflections on some key approaches to learning which the programs have employed.

<table>
<thead>
<tr>
<th>T-shaped skills profile component</th>
<th>MIWM</th>
<th>WLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding</td>
<td>Covered</td>
<td>Minor coverage</td>
</tr>
<tr>
<td>Organizing</td>
<td>Covered</td>
<td>Minor coverage</td>
</tr>
<tr>
<td>Influencing</td>
<td>Minor coverage</td>
<td>Covered</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Covered</td>
<td>Covered</td>
</tr>
<tr>
<td>Ethics, context and values</td>
<td>Covered</td>
<td>Covered</td>
</tr>
</tbody>
</table>
Table 2. Detail of the topics covered by the IWC MIWM and WLP against each T-shaped skills profile component (note, the list of topics is coarsely grained and consequently not detailed or exhaustive).

<table>
<thead>
<tr>
<th>T-shaped skills profile component</th>
<th>MIWM</th>
<th>WLP</th>
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<tbody>
<tr>
<td><strong>Understanding</strong></td>
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<tr>
<td></td>
<td>- Natural science (e.g. hydrology, water quality, aquatic ecosystem function and health, sustainability, climate science, urban climatology, dryland agriculture);</td>
<td>- Systems thinking;</td>
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<tr>
<td></td>
<td>- Social science (e.g. water governance, water policy, water law, environmental economics, development theory, sustainability, behavior change, gender, participation and collaboration);</td>
<td>- Methods to build leadership capacity over one’s career (e.g. mentoring, individual leadership development plans, feedback, challenging job assignments, etc.).</td>
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<td></td>
<td>- Applied science (e.g. social impact assessment, environmental impact assessment, IWRM, sustainable livelihoods, participatory rural appraisal, decision-making techniques, urban metabolism, life cycle assessment, urban agriculture, conceptual modeling);</td>
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<td></td>
<td>- Engineering (e.g. water treatment, sustainability, low cost water and sanitation systems, water supply system design, mass balance modeling, rainwater and stormwater harvesting, water sensitive urban design, water / energy / nutrient recycling and recovery).</td>
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<tr>
<td><strong>Organizing</strong></td>
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<tr>
<td></td>
<td>- Project proposal development;</td>
<td>- Self-leadership;</td>
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<tr>
<td></td>
<td>- Project management;</td>
<td>- Team development and leadership;</td>
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<tr>
<td></td>
<td>- Team working;</td>
<td>- Time management;</td>
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<td></td>
<td>- Survey and interview design, execution and data management.</td>
<td>- Leadership development planning;</td>
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<td></td>
<td></td>
<td>- Individual leadership development project planning and management.</td>
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<tr>
<td><strong>Influencing</strong></td>
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<td></td>
<td>- Team leadership;</td>
<td>- Water leadership models (relevant to the target audience) – e.g. project champion, enabling leader, team leader models;</td>
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<td></td>
<td>- Presentation skills;</td>
<td>- Models and theories from the organizational leadership literature (e.g. transformational, authentic, team leadership).</td>
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<td></td>
<td>- Conceptual modeling.</td>
<td>- Social networking;</td>
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<td></td>
<td></td>
<td>- Communication skills (e.g. active listening, giving and receiving feedback, etc.);</td>
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<td></td>
<td>- Planning successful influence attempts, including the selection of appropriate influence tactics;</td>
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<td></td>
<td></td>
<td>- Fostering innovation and creativity within teams;</td>
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<td>- Individual leadership development project.</td>
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The underlying philosophy is that standard classroom didactic teaching is at best only ever partially successful as an approach to catalyzing learning in program participants. Alternative approaches to learning emphasize peer-to-peer interactions, dialogue, problem rather than discipline orientation, real-life or immersive education, and critical pedagogy (where the scope of learning is at least partly under the control of the learner). In leadership development there exists the ‘70:20:10 rule’ articulated by Lombardo & Eichinger (2000). This ‘rule of thumb’ states that approximately 70% of learning and development occurs as a consequence of doing, 20% as a consequence of receiving feedback and 10% from formal instruction. Of course, this depends on how formal instruction occurs – if it involves peer-to-peer feedback, then the percentages might vary. However, the essence of the rule is that learning by doing and learning by listening are crucially important. The critical, participant-centred approach to learning developed by Freire (1972) is also central to the pedagogy of the MIWM, and manifested partly through immersive, real-world and problem-based approaches to learning (Dennison & Oliver, 2013).

Table 3 lists some of the key learning approaches employed in the MIWM and WLP to develop T-shaped skills components in professionals.

**The Masters of Integrated Water Management**

Learning about the skills and knowledge of other disciplines (‘understanding’ in the T-shaped model) is core to the MIWM. There are two key challenges in a broadening education such as the MIWM, in delivering such breadth of knowledge:

- the first is ensuring that each discipline or functional area of knowledge can be learned to a Masters level (with its emphasis on higher order skills – such as critical assessment – and synthesis) from essentially no – or only high school level – knowledge beforehand; and
- the second is to ensure that opportunities are provided to participants to take part control of the learning agenda, so that they are able to focus on content which is of most relevance to their own professional goals and context, and are also more motivated to learn.
These challenges are met through a range of approaches. First, significant effort goes into developing and maintaining high quality printed and online learning resources for each module. This enables participants to do a significant component of basic learning outside the classroom setting, and then time within the classroom can be spent actively discussing subjects rather than listening passively to lectures (and more effectively learning as a consequence). Recently this kind of approach has taken off under the label ‘Flipped Classroom’ (see the Flipped Learning Network: http://flippedlearning.org/FLN). There are

<table>
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<th>T-shaped skills profile component</th>
<th>MIWM</th>
<th>WLP</th>
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<tbody>
<tr>
<td>Understanding</td>
<td>* high quality learning resources and classroom flipping</td>
<td>* course notes, case studies and readings (modules)</td>
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<td></td>
<td>* PBL</td>
<td>* classroom instruction by leading academics and practitioners</td>
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<td>* immersive education field trips</td>
<td>* exercises and plans to encourage the practical application of</td>
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<td></td>
<td>* head, heart and hands</td>
<td>new knowledge to real problems</td>
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<td></td>
<td>* peer-to-peer learning</td>
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<td>* placement-based, integrative projects</td>
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<td>* one-to-one support</td>
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<tr>
<td>Organizing</td>
<td>* inter-disciplinary, culturally diverse team projects</td>
<td>* individual leadership development plans</td>
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<tr>
<td></td>
<td>* peer assessment and feedback</td>
<td>* one-to-one coaching sessions</td>
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<td></td>
<td>* PBL</td>
<td>* leadership projects</td>
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<td></td>
<td>* placement-based, integrative projects</td>
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<td>* classroom instruction</td>
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<td>* exercises and plans to encourage the practical application of</td>
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<td></td>
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<td>new knowledge</td>
</tr>
<tr>
<td>Influencing</td>
<td>* inter-disciplinary, culturally diverse team projects</td>
<td>* self-assessment exercises and critical reflection</td>
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<td></td>
<td>* placement-based, integrative projects</td>
<td>* feedback mechanisms, including 360-degree feedback processes</td>
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<td>* conceptual modeling</td>
<td>* one-to-one coaching sessions</td>
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<td>* group and individual mentoring</td>
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<td>* individual leadership development plans</td>
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<td>* leadership projects</td>
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<td>* specialist training including course notes, lectures, exercises,</td>
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<td></td>
<td></td>
<td>discussions, practice, reflection, readings, case studies and</td>
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<td>feedback</td>
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<tr>
<td>Collaboration</td>
<td>* inter-disciplinary, culturally diverse team projects</td>
<td>* training on topics such as team leadership and social networking</td>
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<td>* peer assessment and feedback</td>
<td>mentoring and coaching</td>
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<td></td>
<td>* PBL</td>
<td>* individual leadership development plans</td>
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<td>* immersive education field trips</td>
<td>* leadership projects</td>
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<td>Ethics and values</td>
<td>* head, heart and hands</td>
<td>* self-assessment exercises and critical reflection</td>
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<td>* PBL</td>
<td>* training and exercises on ethics, ethical thinking, authentic</td>
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<td>leadership and self-leadership</td>
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<td>* feedback, including 360-degree feedback</td>
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<td>* coaching and mentoring</td>
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PBL: problem-based learning.
risks in this model if used in an un-coordinated manner across too many subjects or modules, as it can almost increase learning time, with demands placed on learners to work outside the class using resources, and to then also participate in classrooms.

Second, an emphasis is given to conceptualization, skills and problem-solving rather than the acquisition of bodies of factual knowledge in modules and generally across with MIWM. This, alongside other measures, enables participants with little knowledge of a subject to more quickly progress to possessing higher level abilities (e.g. critical assessment, synthesis). Focusing on conceptualization and skills acquisition develops the ability of participants on the MIWM to understand other disciplines, so that they will be able to more effectively engage with people from those disciplines when working. Conceptualization can also be viewed as a method through which the ‘language’ of other disciplines is learned – the elements of thought and discourse, and how they are related. Of course, this means that participants will not end up with deep factual knowledge at their fingertips for every discipline they encounter on the MIWM, but they should retain a deeper, less brittle, conceptual understanding.

The use of real-world problem-based learning is pervasive throughout the MIWM, and used as a device to promote active and integrative learning across disciplinary boundaries. Significantly, 50% of the assessment for the taught modules comes from four large problem-based learning assignments (termed ‘PBLs’) which are used as devices to promote the synthesis of skills and knowledge across modules. Participants are able to select case studies and topics of personal and professional interest. As a consequence of this motivating interest, the PBLs promote more rapid learning and more cross-boundary, systemic learning than within-module assessments do. Immersive, problem-focused field trips also feature strongly within the MIWM and have multiple functions, focusing learning on real-world situations which are inevitably messy and complex, and may be conflicted. MIWM participants also have to tie together multiple bodies of knowledge and multiple skills, in sophisticated ways.

Deliberate reflection is encouraged throughout the MIWM for the purposes of developing conscious decision-making on behalf of participants about how they develop professionally (what skills and knowledge do I need and why?), as well as developing praxis – conscious action to transform (part of) the world (Freire, 1972) – an element of reflective practice closely linked with the development and implementation of a value-based/ethical framework. At the start of the MIWM program, a group ‘head, heart and hands’ exercise is carried out to inventory the knowledge, the values and the experience that each participant brings to the program. This helps form the cohort as participants get to know each other, helps identify who knows what in the cohort as a mechanism for enabling peer-to-peer learning to begin, and provides a baseline (an entry point in terms of knowledge, ambition and direction) for participants to reflect upon as they progress through the program. Providing mechanisms such as this, which encourage individuals to actively take responsibility for their learning and help form bonds between participants (so that each cohort provides a substantial amount of peer-to-peer learning), is invaluable.

Finally, every participant can expect to command one-to-one time with the academics responsible for each module/subject. The academics involved are engaged for their knowledge, skills as educators and passion for learning, and through dialogue with participants, are able to offer very tailored support in the vein of a coach or tutor.

The Water Leadership Program

Rather than pin-pointing a particular T-shaped skills component, the WLP is a set of learning approaches which cut across several different T-shaped skills components. It is a feedback-intensive leadership
development program (Guthrie & King, 2004) and, although lasting for 9 months, contains only two face-to-face classroom contact periods, the remainder of the course being undertaken by means of individual leadership development plans, leadership projects, one-to-one coaching, mentoring and monthly online discussions. The extensive use of individually tailored feedback is crucial to the effectiveness of the WLP.

At the start of the WLP, participants complete a customized, on-line 360-degree questionnaire that gathers information on the extent to which they use key leadership behaviors associated with effective water leaders, in particular non-executive leadership roles. Each of the WLP participants complete this questionnaire, along with their supervisors, at least five of their peers and at least five of their staff (if relevant). This element of the program yields detailed knowledge of the nature of the target audience (in this case non-executive water leaders – the participants) and their work environment, which can be used to customize the program individually, and provide developing leaders with specific and relevant feedback on their leadership strengths, weaknesses and opportunities for improvement. The 360-degree tool also helps to highlight the extent to which participants are self-aware, as self-aware leaders typically have a high level of agreement between self-assessed ratings and ratings from others (see Atwater & Yammarino, 1997). During subsequent training, participants use the results from the 360-degree questionnaire to help identify specific actions to improve their leadership ability. These actions are documented in an individual leadership development plan.

During the initial face-to-face training and mentoring session in February, participants are given guidance on building an individual leadership development plan, a plan template and a model plan (as an example). During each training module, participants review relevant feedback from their 360-degree feedback report, consider the relevance of new information, reflect on the outcomes from various exercises, then identify actions to include in their plan. For example, following a session on social networking, a participant may identify the need to prepare a simple ‘networking plan’ to guide their activities and place a greater emphasis on ‘strategic networking’ (see Ibarra & Hunter, 2007). As leadership is sensitive to context and the bulk of the development process is thought to occur in the workplace (Lombardo & Eichinger, 2000), leadership projects are used as ‘challenging job assignments’. All participants have an opportunity to scope at least one project as they build their individual leadership development plans. These plans provide ‘practice fields’ where participants can concentrate on using specific leadership behaviors and strategies with guidance, support and feedback. Ideal projects have the following characteristics:

- they represent a significant project or policy associated with sustainable water management which has the support of the participant’s supervisor and organization;
- the project involves working with a group of people across boundaries; such boundaries may relate to functional units within and across organizations, geography, management levels or professional disciplines;
- developmental objectives relate to individual elements of leadership (e.g. specific behaviors the participant is seeking to use more effectively) as well as group-based elements of leadership (e.g. outcomes that the group needs to deliver, such as a clear, shared vision for the project); and
- they include building social networks and leadership capacity within groups of people who frequently work together on sustainable water management issues.

As participants finalize and implement their individual leadership development plans they receive one-to-one feedback and guidance from a leadership coach over three sessions which are approximately six weeks apart. These sessions include a mix of coaching and mentoring, involving reviewing the participants’ progress and focusing on one or two elements in their developmental plans. The coach also
provides follow-up support to participants where required, such as identifying and supplying suitable
guidance on topics that arise during these sessions.

Four experienced executives from the water industry (i.e. current or former CEOs) also spend time
with the participants at the face-to-face sessions. They share their views and experiences on ‘water-leadership’,
and directly address leadership challenges that the participants are experiencing. These ‘group mentors’ also assist participants to build and revise their individual leadership development plans.

In addition, participants are provided with information, guidance and practice in how to establish pro-
ductive relationships with mentors when they return to work. This element of the program reflects the
view that, for many participants, relationships with mentors who know their local work environment are
particularly valuable. Most of the participants in the program to date have established at least one new
mentoring relationship during the program. Some of these relationships are formally structured, whilst
others are more informal.

**Reflections on the empirical basis for T-shaped skills and knowledge development**

This paper has developed a set of propositions about the nature of the skills and knowledge required by
at least some water professionals to meet the combined challenges of climate change, population growth
and urbanization for water resources and the delivery of water, food and energy supplies. The propositions
have been developed on the basis of literature evidence and integrated in the form of a conceptual
framework – the T-shaped water professional. It is reasonable to ask what we know about (i) how we
can best develop T-shaped skills and knowledge profiles in water professionals and (ii) how different
T-shaped roles are related to effectiveness in water sector innovation, change and capacity development.

To answer the first question requires that we answer the second – to know what the most effective
methods are for T-shaped profile development, we must first know what the ideal ingredients are in
terms of skills and knowledge for T-shaped water professionals. The short and honest answer here is
that we currently only have limited, sector-specific evidence. The T-shaped profile, whilst being
known in water education (Uhlenbrook & de Jong, 2012) has not been well studied in practice. The
foundation literatures which underpin the IWC T-shaped model (innovation, learning, collaboration, lea-
dership, and ethics and values) each have strong empirical and theoretical bases for the claims made
about the importance of the skills and knowledge they emphasize. But how these skills and knowledge
are best combined, what the ideal form of the T-shaped profile might be, in the context of water sector
policy, planning and management, has not been directly studied.

Evidence does exist from the water leadership literature to demonstrate the importance of particular
forms of leadership (e.g. project champions, emergent leaders and policy entrepreneurs – see, for example,
Brown & Clarke (2007); Taylor (2009, 2010); Meijerink & Huitema (2010)), in stimulating and driving
water sector change across policy, planning and management settings. This evidence shows the kinds of
skills, strategies, behaviors and tools which effective water leaders use to achieve innovation and change,
and they bear striking resemblance to the influencing and organizing skills sets proposed in the T-shaped
model presented here. We also have evidence regarding how best to develop leadership skills in water pro-
fessionals, so some sector-specific understanding of development intervention effectiveness exists
(Taylor, 2010; Taylor et al., 2012). Further, the demonstrated utility of T-shaped professionals from a
range of other areas is clear. For example, BP has had formalized T-shaped roles and has been
developing T-shaped skills profiles for many years now (Hansen & Oetinger, 2001).
By examining contemporary models of capacity development, we can distinguish five key areas of capability which must be present for capacity to exist, where capacity is defined as the ability of an organization to create public value (Baser & Morgan, 2008). These five areas are outlined below in terms of the individual skills and organizational capacities which must be present, and how these relate to the skills and knowledge emphasized by the foundation literatures underpinning the T-shaped concept:

1. **Capability to commit and engage** – involves the ability to encourage mindfulness, to persevere, to aspire, to embed conviction, to take ownership and to be determined. These are attributes closely associated with effective leadership (Northouse, 2010).

2. **Capability to carry out technical service delivery and logistical tasks** – involves capacities for delivering services, strategic planning and management and financial management. These are related to the proposal that effective organizations are composed of I-shaped and T-shaped professionals, with few, if any, generalists. Without technical depth, and without the ability to use technical depth to think strategically, organizations cannot deliver successful outcomes.

3. **Capability to adapt and self-renew** – involves capabilities associated with improving individual and organizational learning, fostering internal dialogue, repositioning and reconfiguring the organization and incorporating new ideas. These are related to the skills and knowledge emphasized by the foundation literatures on innovation, learning, collaboration and leadership.

4. **Capability to balance diversity and coherence** – capabilities to communicate, build connections, manage diversity, and manage paradox and tension. Similarly these are related closely to the foundation literatures on innovation, learning, collaboration and leadership.

5. **Capability to relate and attract resources and support** – capabilities to earn credibility and legitimacy, to buffer the organization from intrusions, to earn the trust of others (such donors or clients), and to combine political neutrality and assertive advocacy. These capabilities are less easily linked with elements of the T-shaped water professional model.

There is a clear alignment between the capabilities stressed in the capacity development literature and those which are emphasized in the T-shaped concept and underpinning foundation literatures, providing a triangulation of sorts on the evidential basis for the skills and knowledge proposed within the T-shaped concept developed. However there is an obvious need for specific research, both into the ideal forms of T-shaped skills and knowledge profiles in the water sector, based on an understanding of how T-shaped professionals play roles in stimulating and driving innovation and change, and into how best to develop those profiles. There are also questions surrounding how organizations might be best structured in terms of distributions of more or less I-shaped versus more or less T-shaped professionals, in order to maximize both delivery effectiveness and the capacity to adapt, to innovate, to change and, finally, how one might best develop those capacities.

**Conclusions**

In summary, we have argued the following:

- The set of 21st century global water, food and energy challenges is significant and requires new ways of formulating and delivering policy, planning and management of water resources and water services,
which themselves require skills in radical and incremental innovation, and in change management, to tackle them effectively.

- Innovation and change are related closely to double-loop and triple-loop learning, all of which require effective collaboration, skills and (consequently) the ability to work across disciplinary and functional knowledge boundaries.
- Skills in collaboration will therefore be essential for water professionals, along with the ability to reflect upon the ethics of action, and to integrate values and evidence.
- Leadership as a broad set of competencies is highly relevant to water professionals who recognize the need to initiate and drive change, including fostering creativity and innovation (e.g. in teams). As there are many forms of leadership and leadership competencies, we argue that educational programs that aim to boost the leadership capacity of water professionals should focus on those competencies that are known to be associated with effective water leaders. Context-sensitive research is needed to identify such competencies.
- The set of skills and knowledge, including leadership competencies, required of water professionals in the 21st century can be characterized by the concept of a T-shaped water professional and used to guide the curriculum of professionally focused, postgraduate education programs.
- Delivering T-shaped professional development is a challenging and highly diverse area of activity. Use of participant-centred, immersive and PBL approaches, with intensive feedback through peer-to-peer and one-to-one coaching mechanisms, is central to the delivery process.
- Focusing on T-shaped development curricula is an important component of building capacity for positive change in the water sector, and the foundations of the T-shaped concept – innovation, learning, collaboration, leadership, ethics, values and context – are closely related to the individual capabilities emphasized by contemporary models of capacity development.
- We need to know more about the empirical success of different approaches to developing T-shaped skills and knowledge profiles, and more about the relative success and role of these profiles in driving innovation and change in the water sector. Having said that, knowledge is accumulating about the relative importance of different leadership roles in the water sector, and there is clear evidence from other sectors about the usefulness of broadened, T-shaped profiles, and from the capabilities suggested as essential by the capacity development literature.

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