Hydrology and Earth System Sciences

Competence formation and post-graduate education in the public water sector in Indonesia

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Abstract. The water sector is dependent on effective institutions and organisations, and, therefore, on strong competences at the individual level. In this paper we describe competence formation and competence needs in a case study of the Directorate General of Water Resources (DGWR) in the Ministry of Public Works in Indonesia. A framework is introduced for the water sector comprising three aggregate competences for technical issues, management, and governance, and a meta-competence for continuous learning and innovation. The four competences are further organised in a T-shaped competence profile. Though DGWR professionals have a firmly "technical" orientation, both surveys and interviews reveal a strong perceived requirement for other competences: in particular the learning meta-competence, as well as the aggregate competence for management. The aggregate competence for governance systematically scores lower. Further, a discrepancy appears to exist between the competences that staff perceive as needed in daily work, and those that can be acquired during post-graduate water education.

In both locally-based and international post-graduate water education, the aggregate competences for management as well as governance are reportedly addressed modestly, if at all. With low competence in these fields, it is difficult for professionals to communicate and collaborate effectively in a multidisciplinary way. As a result, the horizontal bar of the T-shaped profile remains weakly developed. In international post-graduate education, this is partially compensated by the attention to continuous learning and innovation. The exposure to a different culture and learning format is experienced as fundamentally formative.

1 Introduction

Many of today's water challenges are so complex in nature that they require the involvement of multiple disciplines and the collaboration of several organisations (Alaerts and Dickinson, 2007; Bourget, 2008; Loucks, 2008; Nash et al., 1990; Wagener et al., 2007, 2010). It can safely be predicted that water problems are likely to become more serious, certainly in developing country contexts, and that water resources use, management, and governance will continue to be a politically contested terrain (Mollinga, 2009).

In facing the challenges, water professionals are needed with specialisations in particular disciplines, and conversance with other relevant disciplines. An engineer should not only have an operational knowledge of theories and principles of mathematics, physics, chemistry, engineering economics and statistics, but also have an understanding of behavioural processes, systems analysis and computer modelling, laws and regulations, history, sociology and ethics (Loucks, 2008). Water professionals need to be able to cross boundaries: disciplinary boundaries, and also boundaries in society.

In this study we present a framework comprising three aggregate competences, namely for technical or substantive issues, management, and governance, together with a meta-competence for continuous learning and innovation. The latter is a prerequisite for obtaining and improving the other aggregate competences. The aggregate competences consist of a cognitive-explicit, a cognitive-tacit, functional, personal, and values or ethical components (Sultana, 2009). The aggregate competences are subsequently organised into various T-shaped competence profiles with the vertical bar representing a substantive specialisation, often disciplinary, and the horizontal bar representing competence in adjacent disciplines, a meta-competence for continuous learning and innovation, enabling the professional to act and collaborate across boundaries.

The framework and analysis methods are field tested in a case study in which the aggregate competences acquired in locally based post-graduate water education (LPE) and in international post-graduate water education (IPE) by professional staff of the Directorate General of Water Resources (DGWR) in the Ministry of Public Works (MPW) in Indonesia are compared.

The framework based on the concepts of knowledge and competence is presented in Sect. 2, followed by the research strategy and analysis methods in Sect. 3. Section 4 briefly describes the case study and the context for the research. Section 5 elaborates on the results and discusses the competences acquired in post-graduate education in relation to the needs as perceived by the Indonesian water professionals. We conclude in Sect. 6 with suggestions for research and practical recommendations for human resources management and for education.

2 Conceptual framework

2.1 Knowledge and competence

There is substantial debate in the literature concerning the concept of "competence", and it is impossible to identify a conclusive theory, or to arrive at a definition capable of accommodating and reconciling the multitude of ways in which the term is used (Delamare Le Deist and Winterton, 2005). However, approaches that were developed relatively independently in the US (McClelland, 1976, 1998; Prahalad and Hamel, 1993; White, 1959), the UK (Cheetham and Chivers, 2005), and Germany and France (Bohlinger, 2007/2008) have given way to frameworks that see competence as a multi-dimensional holistic concept (Delamare Le Deist and Winterton, 2005), including (i) a cognitive-explicit component that involves the use of objective and replicable theory and concepts; (ii) an informal cognitive-tacit component which is gained experientially; (iii) a functional component (skills or "know-how"), i.e. those things that a person should be able to apply when functioning in a given area of

work, learning or social activity; (iv.a) a personal component involving attitudes and knowing how to conduct oneself in a specific situation; and (iv.b) a values or ethical component involving the possession of certain personal and professional values (Sultana, 2009). We treat the personal and ethical component as one, as personal attitude is largely the consequence of one's norms and values. The concept of knowledge can be approached in a similar manner. Drawing on epistemological analysis, knowledge can be both explicit (that which can be articulated and transferred in written form, for example, and formally taught) and tacit, referring to knowledge embedded within a person (such as the ability to ride a bike) (Nonaka and Takeuchi, 1995; Polanyi, 1966; Sveiby, 2001; Tsoukas, 2002; Weggeman, 1997). Tacit knowledge is typically created by socialisation and mimicry if the source of knowledge is tacit, or by internalization when the source is explicit (Nonaka and Takeuchi, 1995).

The concepts of knowledge and competence have different intellectual roots, but they share the same ingredients: information equals the explicit part of cognitive competence, skills are similar to functional competence, experience is similar to the tacit part of cognitive competence, and attitude is comparable to personal and ethical/values competence. Furthermore, in the context of international development, these two concepts are also intimately related to that of "capacity", which refers to the ability of organisations or individuals to be effective in their endeavours (Alaerts and Kaspersma, 2009). In this article we choose to use the word competence, as this is the term most commonly used in the field of education.

2.2 Aggregate competences

Firstly, professionals require an aggregate technical competence to analyse and solve problems that are of a technical or substantive nature. Second, organisations need to have an adequate aggregate management competence, usually embodied in their senior staff. In many developing countries sector agencies may score well on technical and civil engineering aspects because they have a number of trained engineering staff, but often the competence to manage personnel and organisations, as well as the water resource itself, is modest. Individuals with high aggregate management competence can make a difference in this regard. Finally, an effective and performing water sector requires professionals that are competent in fostering and applying principles of good governance, such as working towards effective institutions, dialogue with stakeholders, resource allocation within policy frameworks that aim for equity and poverty alleviation, transparency and accountability.

In the water sector the difference between management competence and governance competence can be understood as a further broadening in focus from a socio-technical and organisationally-based understanding that places water users and water resources centrally to an understanding of the
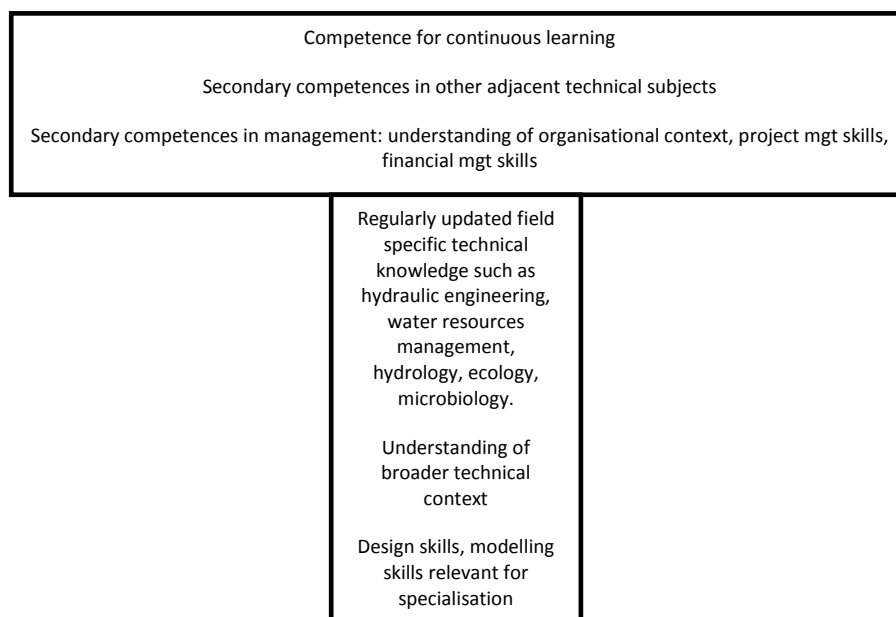
Fig. 1. Hypothetical T-shaped competence profile for a technical water specialist.

broader regulatory arrangements, the differences in interests and relations of power that drive water resources development and controversies, and thereby looks at all actors (stakeholders) rather than just water users. It problematises their roles, their organisational structures, and the institutional arrangements that connect them. In short, the concept of governance "*begins to recognise water resources development as an inherently political process, in which the negotiation of perspectives and interests needs to be actively mediated*" (Mollinga et al., 2006).

In addition to these aggregate competences, capable individuals are those who, by deliberate decision, keep learning and innovating. By innovating we mean that professionals try to come up with creative solutions to enhance and improve upon their work performance and that of their organisation. Learning and innovation do not come naturally but require financial resources, personal dedication and appropriate managerial procedures to foster knowledge generation and sharing. This learning can be incentivized by an acquired attitude or natural inquisitiveness, by financial and career opportunities, or by being held accountable for poor performance (Alaerts and Kaspersma, 2009). An overview of the three aggregate competences and the meta-competence for continuous learning and innovation are provided in Table 1 together with the four components and practical examples. The competence for continuous learning and innovation is termed a meta-competence because it exists beyond the other competences and enables individuals to monitor and develop the other competences (Cheetham and Chivers, 2005). We have displayed the meta-competence for continuous learning and innovation as an umbrella over the other three competences

because it is a prerequisite for every professional, whether he or she specialises in a technical, management or governance subject. The professionals working in these organisations will all need aspects of the technical, management and governance competences to a certain degree, together with the competence for continuous learning and innovation. The mere possession of knowledge and expertise in the professional's own field is in most cases no longer sufficient. It is now necessary to have a basic knowledge – though not necessarily an operational grasp – of adjacent and connecting fields in order to work in multidisciplinary ways and to be a good discussion and collaboration partner, both within and outside the organisation (Oskam, 2009). The combination of essential aggregate competences can be represented visually by a T-shape. A professional with a T-shaped competence profile has specialist knowledge in their own field (the vertical leg of the T), plus a broad knowledge base with elementary knowledge or insight in adjacent water fields or more general disciplines such as business administration (the horizontal leg of the T), as well as soft-skills enabling him or her to communicate with other disciplines (Oskam, 2009; Mollinga, 2009; Uhlenbrook and De Jong, 2012). In Fig. 1 we provide a possible profile for a technical water specialist. For example, a hydrologist will need cognitive-explicit competence in mathematics, physics, hydrology, water resources systems, and similar "basic" disciplines. Furthermore, he/she will need a broad understanding of the technical context in which he/she is working (cognitive-tacit competence), for instance in the fields of river or flood management. He/she also needs functional competence or skills such as hydrological modelling. These all belong to the technical aggregate

Table 1. Three aggregate competences and one meta-competence for continuous learning and innovation for professionals in the water sector, based on Alaerts and Kaspersma (2009) and Sultana (2009).

	Meta-competence for continuous learning and innovation			
	Cognitive-explicit component	Cognitive-tacit component	Functional component	Personal/ethical/values component
	Knowledge about learning and learning styles	Experience with and awareness of your learning style	Critical thinking, self-discipline, ability to concentrate	Availability for training and education in new knowledge, readiness to critically reflect on one's own performance, desire to "keep learning", creativity, self-confidence, non-individualistic attitude
Aggr. Competences:				
Technical	Regularly updated technical knowledge	Understanding of the broader technical context, application insight, intuitive understanding	Design skills, modelling skills	Conscious choices on where and how to build infrastructure
Management	Regularly updated knowledge about management	Understanding of broader organisational context, application insight, intuitive understanding	Project mgt skills, financial mgt skills, people mgmt, negotiation, mentoring, ability to "deliver", leadership	Willingness to involve staff in decision-making, knowledge sharing attitude
Governance	Regularly updated knowledge on governance, such as participation stakeholder involvement	Ability to apply inclusiveness, understanding of procedures and institutional structures, understanding of political consensus building, application insight, intuitive understanding, ability to cross disciplinary boundaries	Policy formulation skills, working in a participative manner	Achieving ethical objectives: non-corruption, transparency, etc., willingness to cross disciplinary boundaries (Mollinga, 2009)

competence. In terms of the aggregate management competence, a hydrologist will at least need understanding of the organisational context in which he/she works, such as an the operational rules, regulatory constraints or research establishment procedures (cognitive-tacit component), some project management skills, mentoring skills for junior staff (functional competence), and a knowledge sharing attitude and commitment to the job (personal/ethical/values component). Similarly he/she will require a willingness and ability to effectively work in teams across disciplinary boundaries for higher goals (aggregate governance competence). Ideally, the hydrologist should also develop his/her learning style, ability to think critically, and openness for continuous learning (meta-competence for continuous learning and innovation). Depending on the specialisation and the water sector context, other components of the technical, management and governance competences may be important. Still, the competence mix ("capacity") of the organisation is what matters most, with some staff being highly specialised and mono-disciplinary (long and narrow T's), but with a growing majority equipped with shallower yet broader T's. Those with broader T's serve to enhance team cohesion and overall effectiveness. This paper does not discuss the specific competences needed for given situations nor the optimum ratio of specialisation to breadth for an individual. Similarly, we do not address the mix of T's required for an organisation to enhance its effectiveness. Instead, we note that different

mechanisms exist to develop these competences and focus on the role of a particular mechanism in studying competence formation. Typical instruments for competence formation are formal education and training, which are suitable for acquiring the cognitive-explicit component, whereas the cognitive-tacit component can best be transferred through one-on-one interaction between junior and senior, apprentice and mentor. Also, networks – both formal and informal associations and "communities of practice" – are important mechanisms for professional improvement for many water professionals (Alaerts and Kaspersma, 2009). Depending on socio-economic conditions in a country, some mechanisms are more prominent than others. In less developed countries, post-graduate education often fulfils a key role in generating competence and accessing specialised knowledge, as other mechanisms to access this type of knowledge (professional associations, high-quality seminars, etc.) are less abundantly available. Finally, the perception of what competences are most needed, and how they should be acquired and enhanced, depends on policies and procedures in the sectoral institutions and on those of the "enabling environment" (Alaerts and Kaspersma, 2009). Competence valuation and acquisition, therefore, depend strongly on external factors of policy, administrative and cultural nature.

3 Research strategy and analysis methods

A case study approach was chosen to field test the conceptual framework presented above and the analysis methods to assess the need for, and formation of, competence. The DGWR of the MPW of Indonesia was chosen as a case because of (a) its track record as one of the largest professional water organisations in Asia for the past half century, (b) the availability of large groups of professionals who have completed post-graduate water education either in industrialized countries or at Indonesian universities, (c) the availability of a large body of studies and information regarding the development that the country's water sector has gone through in recent history, and (d) its standing as the largest employer of water professionals in Indonesia, and therefore, the most representative sample of public sector water professionals.

To accommodate the contextual factors of water resources management in Indonesia, we distinguish three paradigmatically different phases that influence the need and preference for particular competences and the way they are acquired. A description of these phases is provided in Sect. 4.

We adopted a two-pronged method in the case study, first conducting a sequence of 38 semi-structured interviews (hereafter referred to as interviews), followed by a quantitative survey to cross-check the interview results (Supplement).

The primary target group for the interviews and the survey was the professional staff of the DGWR, i.e. those holding at least an MSc or equivalent degree in a civil engineering or water resource related discipline. The interview respondents from the DGWR (the primary target group) were selected to form a representative sample on the basis of two main criteria: (i) the type of education they had enjoyed in the water field, that is, a locally-based (LPE) or international post-graduate education (IPE), and (ii) their involvement in the MPW during one of its three paradigmatic phases in the recent history of the Indonesian water sector (defined by year of recruitment). The DGWR respondents were eligible to register for a wide range of post-graduate programmes, ranging from engineering to business and social science degrees. The LPE respondents acquired their master's degrees at Gajah Madah University, the University of Indonesia, the University of Sri Wijaya, the Institute of Technology Bandung or the Institute of Technology Surabaya, amongst others. The IPE respondents acquired their master's degrees at various international institutions, such as the Colorado State University in the USA, the University of Manitoba in Canada, (UNESCO-)IHE or the Delft University of Technology in the Netherlands, the University of Grenoble or the University of Lyon in France, the Asian Institute of Technology in Thailand or the Indian Institute of Technology in India. For the semi-structured interviews, the secondary target group included people external to the DGWR, yet involved in water management in Indonesia from 1980 to the present day, with a good overview of the water sector. Respondents from the

Table 2. Interview respondents in seven sub-groups based on their participation in local post-graduate education or international post-graduate education and their recruitment in one of the phases (phase I = 1970–1987, phase II = 1987–1998, and phase III = 1998–present).

Degree type:	Recruited in phase I	Recruited in phase II	Recruited in phase III
LPE	3	1	5
IPE	12	1	2
Resource persons	14	–	–

latter group are henceforth termed resource persons. In total, the respondents can be categorized into seven strata (Table 2). All interviews and surveys were anonymised.

The semi-structured interviews were undertaken in Indonesian and in English in the period from November 2008 to January 2010. Each interview lasted between one and two hours. The first six interview questions concerned the key biographical information of each respondent. Subsequent questions concerned the main tasks and activities of respondents, the characteristics of their education, their opinions on the utility of the aggregate competences acquired during their education and their reflections on the aggregate competences needed in water management in Indonesia. The interviews were recorded, transcribed within a day and then checked for accuracy with the respondents. Following the completion of the interviews, Atlas TI version 6, a qualitative data analysis software package, was used for interview analysis. Each interview was coded thematically according to the method proposed by Saldaña (2009) using codes based on theory. In addition, open coding was used to identify topics that emerged during the interviews and that could not adequately be classified using the thematic codes. By cross-referencing the thematic and open coding with the seven strata, a rich and composite understanding of the evolution of the three aggregate competences and the meta-competence within the DGWR in relation to post-graduate education was obtained.

The survey was designed to complement the qualitative analysis of the interview data, to gain quantitative insight, and to test the reliability of survey results in a case-study where contextual factors were considered. The survey used random stratification as a sampling method. Seventy-one questionnaires were administered, guided by the primary author and categorized in the same sub-groups (Table 3). The choice for guided questionnaire sessions was made to ensure the quality of the responses by accommodating the need of respondents for clarification of the questions, and by ensuring that respondents allotted sufficient time to filling out the questionnaire.

The survey questions were designed based on the results emerging from the interviews. Respondents were asked to rate the aggregate competences acquired during

Table 3. Survey respondents per sub-group, based on their participation in local post-graduate education or international post-graduate education and their recruitment in one of the phases (phase I = 1970–1987, phase II = 1987–1998, and phase III = 1998–present).

Degree type	Recruited in phase I	Recruited in phase II	Recruited in phase III
LPE	14	11	9
IPE	20	7	10

post-graduate education and the aggregate competences necessary to execute daily tasks on a scale ranging from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively. To better specify the possible meanings of the aggregate competences, all questions were split up into a number of sub-questions referring to sub-competences (e.g. aggregate management competence comprising project management, organisational management, etc.). The results were analysed per stratum using SPSS software (version PASW Statistics 18). To analyse the extent to which variation between groups of respondents can be attributed to real differences instead of random fluctuations in the sample, tests of difference and analyses of variance (ANOVA) were performed. Differences between cohorts or between LPE and IPE that are statistically significant at a confidence level of 10 % are indicated with an asterisk. Where no asterisk appears it cannot be excluded statistically that observed differences are attributable to chance; however, they can indicate patterns. Large differences in the outcome of the surveys were not anticipated, as everybody is likely to value each of the aggregate competences and meta-competence to a relatively high degree and the response options were not mutually exclusive. Mutually exclusive questioning (e.g. by forcing respondents to prioritize options) was expected to lead to predictable outcomes – as we may assume that, both for the individuals and for their organisation, the technical competence would have the first priority and management the second. Also, Indonesian respondents tend to equalize ratings because "*maintaining work place and relationship harmony is very important in Indonesia, and no one wishes to be the transmitter of bad or negative news or feedback*" (Indonesia, 2012); hence, small differences around the median do matter.

4 Analysis of the recent history of water management in Indonesia

In the recent evolution (1970–2011) of the Indonesian water sector, three separate phases can be distinguished. The first phase, 1970–1987, is characterised by a strong focus on the construction of infrastructure. Building roads, canals, reservoirs and flood protection works was essential to start the economic development of the nation and for food security.

The principles of water resources and irrigation sector management in this phase were based on Law 11 of 1974 on water resources development. Good governance in the form of public transparency, accountability and public participation were not yet reflected in the law (Herman, 2007), and in this period, staff were appreciated for their technical competence and loyalty to the organisation.

The second phase can be considered to start with the introduction of the Irrigation Operation and Maintenance Policy (IOMP) in 1987 (Herman, 2007). Although the IOMP responded to the need for more decentralisation and collection of user fees, this policy did not change the top-down, construction-focused irrigation development because the government continued in its role as an operator, directly implementing activities and staying in charge of the operation and maintenance. In 1992 the first initiatives were taken to introduce Integrated Water Resources Management (IWRM) policies. But since Indonesian society was still controlled by an authoritarian state, initiatives such as first the IOMP and later the IWRM were counteracted in favour of the strong construction paradigm and centralised decision-making. Over time, construction contracts had also become a means for well-connected persons to enrich themselves, and it had become increasingly more important to be loyal to the regime rather than to be competent. Only in 1998, when the Suharto regime ended after 30 yr, was the time ripe to initiate institutional reforms in ways that could go beyond lip service (Mollinga and Bolding, 2003). This is the onset of the third phase. The new government embarked on an ambitious programme of decentralizing tasks and responsibilities (Alaerts and Herman, 2005). However, problems arose owing to limited management capacity and financial abilities at provincial and district levels. In 2004 the government revised the water law, which now emphasises IWRM but reflects an administration system that has been partly re-centralised (Schwartz, 2008).

This brief overview suggests that water management in Indonesia was predominantly technically oriented until the end of the nineties, with consequent demands for technical education. Since 1998, a transition has slowly taken place, and the appreciation for integrated water resources management and governance is growing.

5 Results

5.1 Three aggregate competences and the learning meta-competence

The aggregate management and governance competences receive a much higher appreciation than might be expected considering the strong technical orientation and history of the DGWR and the respondents (Figs. 2 and 3). It should be noted that the aggregate competences and the learning meta-competence are mutually non-exclusive response options,
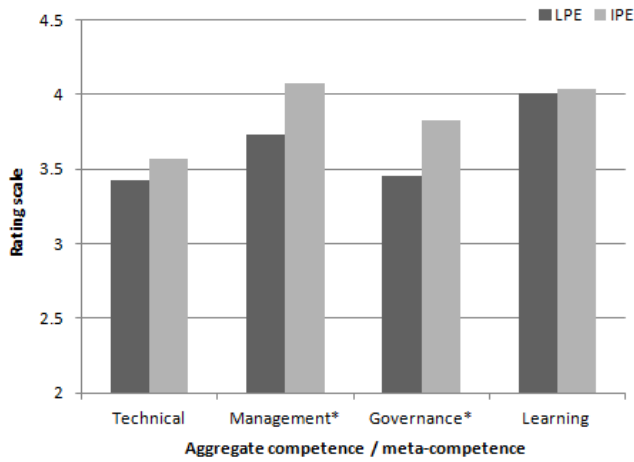
Fig. 2. Aggregate competences and meta-competence perceived to be required for daily tasks in the DGWR as rated by alumni from local post-graduate education and alumni from international post-graduate education; rating scale from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively.

Fig. 3. Aggregate competences and meta-competence perceived to be required for daily tasks in the DGWR, in phase I (1970–1987), II (1987–1998) and III (1998–present); rating scale from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively.

Fig. 4. Aggregate competences and learning meta-competence perceived to be acquired during local post-graduate education and international post-graduate education; rating scale from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively.

allowing higher scores on more than one option. Both LPE and IPE respondents attach lower weight to the aggregate technical competence (Fig. 2). These results are at odds with the outcomes of the interviews, and also with the historical and current incentive system and the expectations at the DGWR, which both tend to stress the aggregate technical competence. Across the board, the interviews stress that professional staff at the DGWR know that the other aggregate competences should become part of the overall set of aggregate competences of the DGWR. However, in practice, the orientation has remained overwhelmingly technical thus far.

Respondents with IPE experience tend to rate the need for competence higher than the respondents with LPE experience (Fig. 2). It seems they have stronger opinions about the need for, and value of, competence than LPE respondents. The interviews confirm the general value attributed to learning, but indicate, in addition, that the need for learning is especially highly appreciated by IPE respondents, and is viewed as key to personal and organisational advancement in an environment where the number of individuals with a post-graduate education is still limited.

Respondents from phases II and III all tend to undervalue the need for aggregate technical competence (Fig. 3). This contrasts starkly with the reality of low levels of technical competence at the DGWR during phases II and III. Furthermore, the meta-competence for continuous learning and innovation is perceived as highly necessary, especially by respondents from phases I and III. Although the differences are statistically not significant, the interview outcomes underscore this result. In phase I, DGWR was characterised by a strong *esprit de corps* and a focus on technical competence and development, also of skills, whilst phase III respondents
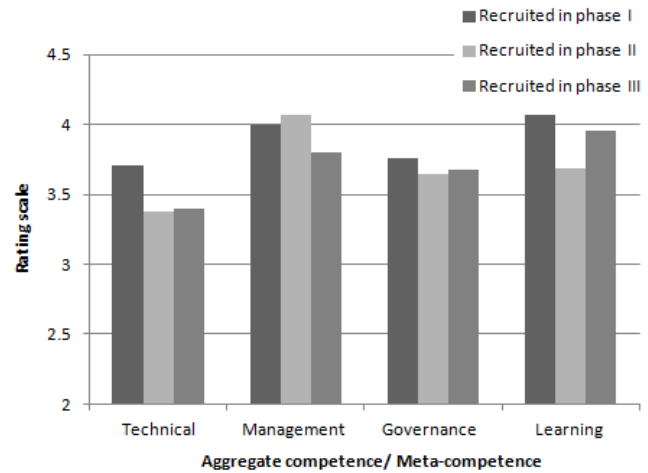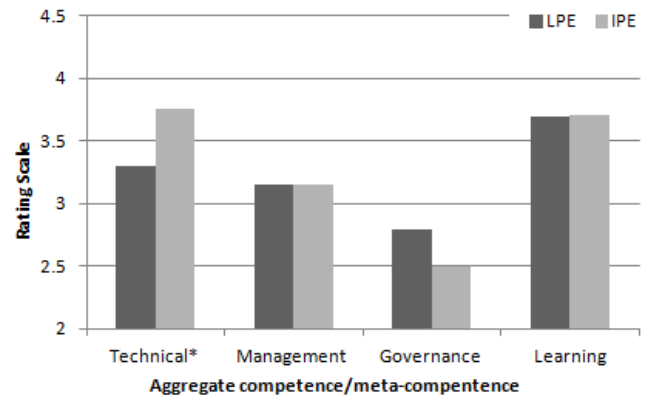
are much younger and are likely to recognize the necessity to improve on their specialisation.

Most of the LPE programmes are perceived to not yet strongly reflect the paradigm shift from "construction" to water resources management and to a new set of resulting competences (Fig. 4) (Ministry of Public Works – Directorate General of Water Resources, 2010). This observation is confirmed by both the survey and the interviews. During the interviews, all respondents confirmed the technical orientation of locally-based post-graduate education, but they added that this is the most directly appreciated educational background in the DGWR.

For IPE respondents, the interviews and the survey show the same trend (Figs. 4 and 5) with high scores for the aggregate technical competence and the meta-competence for

Fig. 5. Aggregate competences and meta-competence perceived to be acquired during LPE or IPE in phase I (1970–1987), II (1987–1998) and III (1998–present); rating scale from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively.
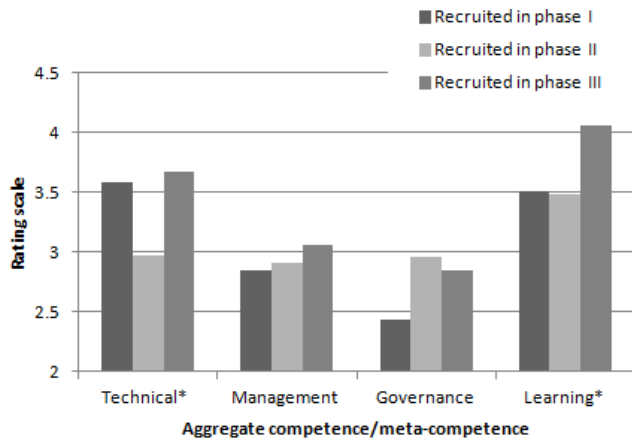
continuous learning and innovation, compared to the other aggregate competences. Both interview and survey respondents report that the IPE experience was particularly effective in acquiring specialised new skills such as computational techniques, as well as for the cognitive-tacit component of competence. Still, the idea that IPE might emphasise the non-technical competences more seems not to be borne out. Furthermore, it is surprising that the aggregate management and governance competences were scored higher by LPE than IPE respondents in the survey. This does not necessarily mean that LPE is more effective than IPE in absolute terms, as respondents cannot compare the effectiveness of IPE and LPE because each respondent has had only one such experience. In fact, the analysis of documentation and the interviews, in which the interviewer as outsider is able to assess both types of education, do not the support the perception of the respondents in this case.

Phase I respondents plausibly emphasise their acquisition of the aggregate technical competence. Indeed, water management concepts such as IWRM and water governance were not widespread, let alone incorporated in curricula, in that period (Fig. 5). We would expect this to be similar for phase II, but the survey results reflect a lower level of perceived need and formation of technical competence. A much higher appreciation for aggregate technical competence is again reflected among the young respondents from phase III, whereas in phase III there are more educational programmes available with an IWRM orientation. Moreover, in phase III, apart from the increasing attention for aggregate competences other than the technical, there is a new need for increasing the technical competence after a long period of erosion of this expertise, first in the aftermath of phase II and then during the financial crisis at the onset of phase III. Therefore, strictly technical subjects will remain a popular choice for students enrolling in an IPE or LPE. The lower

score in phase II could be a reflection of the perceived higher need for loyalty to the regime to the detriment of technical competence, as described in the case study description in Sect. 4 and in the interviews. The need to obtain technical competence through education may have been a relatively low priority.

Both the aggregate governance and management competences are rated low in Fig. 5. For phase I, this is plausible considering the dominant construction paradigm in the period. A low rating might also be expected for phase II, but the survey results do not bear this out. The interview results and literature confirm that in phase II, despite attempts to introduce the concept of IWRM and the IOMP, the organisational focus was still heavily on construction and infrastructure development. The IPE interviewees employed in phase III furthermore indicated that they consciously chose a water governance or water management orientation, stating that they had acquired the aggregate technical competence during their BSc degree or within the organisation itself. However, having an aggregate technical competence is a core priority of the MPW, and for post-graduate education a technical subject may still be the preference of many staff members.

The difference between the aggregate management and governance competences as acquired from post-graduate education and the aggregate competences as required for daily tasks is relatively large when we compare Figs. 2 and 3 with Figs. 4 and 5. For the aggregate management competence, the need in daily work is explained by the fact that work at the DGWR consists, for a large part, of administrative tasks, which forms part of the aggregate management competence. This is mentioned in all interviews. This finding suggests that a discrepancy exists between what is needed in daily work and the orientation people choose in their post-graduate education.

For the aggregate governance competence, the IPE respondents score the extent to which an aggregate competence is needed in daily work higher, whereas the LPE respondents, surprisingly, score the extent to which they obtained this aggregate competence in school higher. The latter is not confirmed by the interviews. Interviews with resource persons and LPE as well as IPE respondents raise the issue of the gap between the aggregate governance competence in the organisation and the extent to which it is obtained during a LPE or IPE. We can conclude from these results that for the aggregate management and governance competences an apparent imbalance exists between the aggregate competences required in daily work vs. what is obtained during post-graduate water education, be it local or international. This insight is confirmed by both the survey and the interviews.

5.2 Technical competences

The aggregate technical competence consists of four components. The cognitive-explicit component, e.g. specialised theoretical knowledge; the cognitive-tacit component, e.g. a
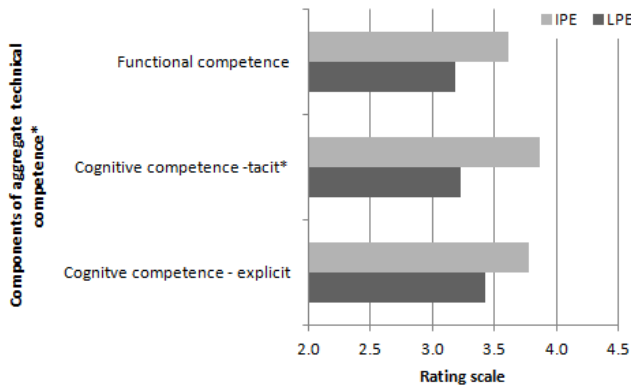
Fig. 6. Components of aggregate technical competence perceived to be acquired during local post-graduate education and international post-graduate education; rating scale from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively.

broader understanding of the technical context; a functional component, e.g. design or modelling skills; and a personal/ethical/values component, e.g. participatory design (Fig. 6).

The results for LPE and IPE respondents show higher scores for IPE for each component. The LPE programmes for water management show a slight preference for the cognitive-explicit component of the aggregate technical competence. This is also confirmed in the interviews with LPE respondents. For IPE respondents, the cognitive-tacit component is perceived to be higher than the others. The interviews confirm that IPE pays more attention to the cognitive-tacit component by, for example, creating broader understanding of the technical context and by technical problem solving. Further comparative analysis of the specific sub-competences did not reveal information additional to that already discussed in Sect. 5.1.

5.3 Management competences

A need is perceived to exist for each component of the aggregate management competence (Fig. 7). The need for the cognitive-tacit component is valued slightly more than the others. The cognitive-tacit component includes competences such as a broader understanding of how organisations and their staff are managed. Phase III respondents rated the need in daily work of the cognitive-explicit component (e.g. theoretical knowledge about organisational management and people management) lower than respondents of the other two phases; the reason for this low rating is unclear. This component of the competence, though essential, would automatically also become tacit, i.e. it is internalized when people start applying it in work situations they encounter. This may explain why the cognitive-tacit component is rated higher than the cognitive-explicit component.

Fig. 7. Components of the aggregate management competence perceived to be required in daily work in phase I (1970–1987), II (1987–1998) and III (1998–present); rating scale from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively.

Fig. 8. Components of the aggregate management competence perceived to be acquired during local post-graduate education and international post-graduate education in phase I (1970–1987), II (1987–1998) and III (1998–present); rating scale from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively.

When the management competence acquired during post-graduate water education is broken down into components (Fig. 8), the rating of the cognitive-explicit component is much lower than the rating of the other components. Phase III respondents emphasised that the education seemed to favour the functional component, constituted by competences such as written communication skills and project management, and the personal/ethical/values component, such as the willingness to share knowledge. The components, and especially the cognitive-explicit component, appear insufficiently addressed in the curricula of both IPE and LPE.
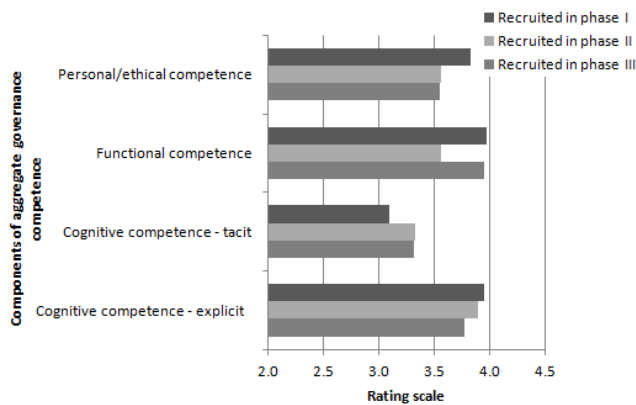
Fig. 9. Components of aggregate governance competence perceived to be required in daily work, in phase I (1970–1987), II (1987–1998) and III (1998–present); rating scale from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively.

Fig. 10. Components of the aggregate governance competence perceived to be acquired from local post-graduate education and international post-graduate education, in phase I (1970–1987), II (1987–1998) and III (1998–present); rating scale from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively.

5.4 Governance competences

As mentioned in Sect. 5.1, there is an imbalance apparent between the high rating of the aggregate governance competence required in daily work versus the markedly low rating for its acquisition during post-graduate water education, be it local or international (Figs. 9 and 10). The cognitive-tacit component, however, such as the understanding of political consensus building, is rated low in both figures, especially by phase I respondents. This can be explained by the fact that in phase I a strong *esprit de corps* existed because of the shared goal of the development of the nation, albeit under a highly centralised administrative and political system. There was only limited space for political consensus building as decisions were made by the top management, and these were the years where the power and successes of the MPW were at their peak. Therefore, there was no perceived need for governance competence in daily work and no reason to acquire this component in education.

The acquisition of the personal/ethical component, e.g. the ability to achieve ethical objectives, is scored higher by respondents from phase III (Fig. 10). Considering the more open atmosphere in phase III, with more attention for accountability and transparency in the DGWR, it is to be expected that the personal/ethical component scores higher, but this would naturally also be expected in Fig. 9. The results from the interviews indicate that the younger generation of phase III tends to appreciate the personal/ethical/values component, and the organisation also provides more space for this.

Multidisciplinarity

The survey results reveal that multidisciplinary thinking acquired during education is rated significantly lower for LPE than for IPE, although the score for LPE is not extremely

low. In the interviews, though, no evidence is found pointing to multidisciplinary working skills as obtained in LPE. In IPE the situation is slightly different. Even though aggregate competences such as management and governance are not taught sufficiently intensively according to the survey and interviews, and consequently connections between these topics and technical disciplines are weak, interview respondents stated that they were encouraged to look over the boundaries of their discipline and learn how to communicate with colleagues from other disciplines. However, for both IPE and LPE opportunities for improvement exist.

5.5 Meta-competence for continuous learning and innovation

Graduates of both IPE and LPE rate the need for the meta-competence for continuous learning and innovation in daily work very highly in comparison with the other competences (Figs. 2 and 3), and score the formation of this competence during education slightly higher than the other competences (Figs. 4 and 5). Phase I respondents pointed to the DGWR policies during phase I, which stressed the continuous learning concept and had in place mechanisms to rotate staff, provide mentorship and junior–senior learning arrangements, and also to the careful selection of IPE candidates (during this period, no LPE was on offer yet). On the other hand, phase II respondents rated this need decidedly lower, probably because in phase II competence and learning were sometimes subordinated to loyalty when it came to incentives and careers. Yet, also in this phase DGWR had suitable policies in place, albeit possibly less well enforced. The cognitive-explicit component (for example, intercultural sensitivity) of the meta-competence is rated lowest of the four components in terms of its need in daily work (Fig. 11) as well as the extent to which it is acquired in post-graduate education

Fig. 11. Components of the meta-competence for continuous learning and innovation perceived to be required in daily tasks, in phase I (1970–1987), II (1987–1998) and III (1998–present); rating scale from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively.

(Fig. 12). The perceived low need in daily work is remarkable as intercultural sensitivity is important in the Indonesian context, considering the diverse ethnical backgrounds of the staff of the DGWR.

Explicit attention for this meta-competence is only marginally present in the water curricula of LPE and IPE, and this is confirmed by both the survey and the interviews. This means that the cognitive-explicit component of the meta-competence is not taught. The other components of the meta-competence – i.e. the cognitive-tacit (for example, the ability to reflect on oneself), the functional (such as critical thinking), and the personal/ethical/values (for example, creativity) – are implicit in the curricula; they can, to some extent, be acquired while working on the other aggregate competences.

The interview outcomes, contradicting the survey results, confirm the acquisition of the meta-competence for continuous learning and innovation from IPE education only. For example, all phase III interview respondents with an LPE stated that the meta-competence for learning is a personality trait and exists independent of what one learns in school; they furthermore thought that they did not acquire this competence in school. IPE alumni, on the other hand, unanimously stated that acquiring the meta-competence for continuous learning and innovation while abroad was synonymous with the fundamental attitude changes associated with the IPE experience.

All IPE interviewees, together with 13 out of 14 resource persons, confirmed the hypothesis that the most important aspect of IPE is acquiring the meta-competence for continuous learning and innovation and the attitude change that happens simultaneously. This has been termed socialisation of tacit knowledge (Nonaka and Takeuchi, 1995). The aspects of education that catalyze the socialisation are summarised in

Table 4. Most important aspects of international post-graduate education, as perceived by interview respondents.

Aspect	How many times mentioned in interviews
Learning how to learn, encouragement of curiosity	10
Intercultural sensitivity	7
Being exposed to new concepts	10
Discussions with peers	7
Discussion with professors	5
International networking	7
Encouragement of critical thinking	10
Working in an inter-disciplinary fashion	6
Team building	6
Being away from home/living in a different country	5
Working independently	4
Exercises for self-reflection	1
Learning to plan ahead	6
Different working culture	8
Connecting theory to practice	6

Fig. 12. Perception of components of the meta-competence for continuous learning and innovation perceived to be acquired from international post-graduate education and local post-graduate education, in phase I (1970–1987), II (1987–1998) and III (1998–present); rating scale from 1 to 5, where 1 = not at all, 3 = to some extent, and 5 = extensively.

Table 4. Learning is encouraged by group work, role playing, debates, and through a working culture with smaller power distances in human relations, facilitating easier interaction between professors and students. Typical statements from the interviews confirm this picture: "*The very fact that you*

are in a different country changes the experience. You are told things you wouldn't accept from someone in your home country." Also, "*Receiving critical comments from teachers was difficult. They would tell you that you need to do certain things differently, but not how you should do it. You have to find out yourself but they help you getting started.*"

The one resource person who doubted the attitude change among alumni from international post-graduate water education suggested that MPW staff should learn together with NGO staff, civil society representatives and university staff. Indeed, the large majority of participants in international programmes have a government background. Creating a more heterogeneous mix of backgrounds and opinions in educational programmes would help increase the learning opportunities.

6 Discussion

A conceptual framework was introduced, comprising three aggregate competences for technical issues, management and governance, and a meta-competence for continuous learning and innovation in the water sector. The framework was tested in a case study on post-graduate water education for staff in the DGWR of the MPW in Indonesia. Though DGWR and the sector professionals have a firmly "technical" default orientation, both the surveys and interviews reveal a strong perceived need for the other competences: primarily the meta-competence to learn and innovate, as well as the aggregate competence of management. The need for the aggregate competence of governance is systematically rated lower; however, it is still regarded as reasonably important. A discrepancy appears to exist between the competences that staff perceive as needed in daily work compared to those that can be acquired during post-graduate water education. Respondents also indicated that the DGWR needs a wider palette of competences beyond the strictly technical ones, but these competences seem not to be acquired intensively from the post-graduate education even though some international courses do offer them. Respondents also mentioned that eventually a technical education is the most directly appreciated educational background in the DGWR. This apparent contradiction can be explained by a possible path-dependency that influences people to choose a familiar subject which is already appreciated in their organisation. As mentioned earlier, the interviews indicate that many people are aware that the DGWR needs expertise in fields other than water engineering, but, in practice, engineering is still the basic and, perhaps too often, singularly appreciated educational background.

Thus, it can be assumed that the DGWR is still located in a primarily mono-disciplinary technical paradigm. This situation is unavoidable given the current need to rebuild and expand the existing infrastructure and the added burden of staff shortage. It is likely that in the coming decade this discrepancy will increasingly call for a new human resource policy at DGWR. It might be expected that international post-graduate education would have helped in addressing the need for the aggregate management and governance competences, but this has not been the case, possibly because respondents hail from three different phases in the development of the water sector and international courses did not then offer such competence building prior to, say, 1990.

The LPE in Indonesia has a strongly cognitive-explicit and technical orientation. With this set of knowledge, a part of the vertical bar of the T-shape is filled. The aggregate technical competence is not addressed completely; the cognitive-tacit component (understanding, practical experience) and concomitant adapting attitude, tend to receive relatively less attention. IPE programmes, on the other hand, have a relatively strong technical focus as well, but, in particular in phase III, paid more attention to the cognitive-tacit component, in addition to the cognitive-explicit component. Amongst educationalists, the cognitive-explicit component is perceived as fundamental to post-graduate education, and is then internalized to become tacit when it is combined with personal experience gained on-the-job.

In both LPE and IPE, the aggregate competences for management as well as governance are reportedly addressed modestly, if at all. For the aggregate management competence, the explanation may be that people expect to obtain the management competence through on-the-job training. Management training is indeed available for staff of DGWR, although this type of training has a strong focus on the functional component of the competence, i.e. skills, only.

The ability to think and work in a multidisciplinary fashion is an aspect of the aggregate competence for governance that merits special attention. The documentation on existing local water curricula shows that in most water-related MSc curricula the connections between the different disciplines are made insufficiently, and multidisciplinary thinking is limited to the technical disciplines.

With little competence in these fields, it is difficult for professionals to communicate and collaborate effectively in multidisciplinary settings and in the water policy and political discussions that have characterised the Indonesian water sector since the onset of phase III. As a result, the horizontal bar of the T-shaped profile remains weakly developed. In IPE, this is partially compensated for by the (implicit) attention to continuous learning and innovation. The participants are in a totally different habitat for a substantial period, and in the assignments they have the chance to mingle with different cultures and experience different thinking patterns and work attitudes. They are encouraged to discuss with lecturers and professors and ask questions, which is a new experience for many participants. The exposure to a different culture and learning format is reported as fundamentally formative.

7 Conclusions

In regard to both IPE and LPE, the responses in this study cover a substantial period, and the study is not able to make conclusive statements about the performance of current post-graduate water education. Since 2000, the Indonesian water curricula in particular are becoming more responsive to the new demands of the sector. However, project-based learning could be used more extensively to train the multidisciplinary aspects necessary for enhancing management competence. To enhance the continuous learning and innovation competence, educational programmes could include teaching on learning styles (the cognitive-explicit component and also the functional and personal components) so that people are aware of their own learning style and can use this personal knowledge to help them in further competence formation. However, we have also indicated that eventually engineering is still the most directly appreciated educational background in the DGWR, and these findings could well pertain to the water sector in other developing and emerging economies.

The competence framework cannot resolve decisions on the details of the required T-shaped competence profiles and skills mixes for specific water specialisations of individuals and organisations (e.g. on the relative importance of "broad" competence versus "in-depth" expertise), but it can help in outlining requirements that subsequently help guide MSc-level water curricula improvements. It could be useful to design a number of modules in an educational programme that focus solely on the horizontal bar of the T-shaped competence profile. Students should choose from a number of subjects outside their specialisation that should help them connect to other disciplines. Furthermore, it would be beneficial for the educational institute, the student and the home organisation of the participant if there was more exchange about the needs of the home organisation and its ability to work with the new knowledge. The student can then prepare his or her return more thoroughly.

Further, the methodological differentiation of respondents as a function of their LPE or IPE experience, and of the administrative and political context in the country and sector, has proven useful in generating detailed insights into development of competence formation in the Indonesian water sector over a long span of time against the evolving economic, administrative and political contexts. However, the combined utilization of guided surveys, semi-structured interviews, and in-depth analysis of reports and policy papers proved essential for accurate and meaningful interpretation; survey results alone were often insufficient and difficult to interpret. Importantly, both the interviews and surveys reflect the perceptions of individuals. However, many respondents have had only one very personal experience with LPE or IPE, and their perceptions are not necessary mutually compatible. The presence of the interviewer/analyst, particularly in the guided surveys, offered the possibility to set robust assessment benchmarks and enhanced the quality of the data and its interpretation.

In view of the dominant position of the DGWR in the water sector within Indonesia and the care taken to span the different phases of water development as well as to interview water professionals external to the ministry, the findings of this research are considered representative for the water sector in Indonesia. Indeed, the findings could well be valid in the water sector in other developing and emerging economies. Further research aimed at determining the T-shaped competence profiles required for specific water specialisations (e.g. the relative importance of "broad" competence versus "in-depth" expertise) and the skill mixes required by water organisations is necessary, and could guide improvements in masters level water curricula and the selection of IPE training by organisations.

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