Aquaculture – A learning community

Report from workpackage 5 – Innovation in Teaching & Learning

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Contents

Introduction

This report summarises some of the research and reflections of the aqua-tnet working group on innovation in teaching and learning (workpackage 5). The group are primarily scientists, involved in academic research, and then increasingly in teaching. Only one of the group has a more direct background in pedagogy and support for learning. We are therefore a group of practitioners (aquaculture teachers) who are also learners in the sphere of teaching and lifelong learning. We have explored and used a range of tools and approaches in both our teaching and learning which have provided insights which we hope are shared in this report.

The report briefly summarises some of the drivers for lifelong learning within the aquaculture, fisheries and aquatic resources sector as justification for this focus. We then look at the general field of lifelong learning and current trends. Finally we examine some of the specific experiences both within and allied to the aqua-tnet project, which hopefully indicate potential for future development.

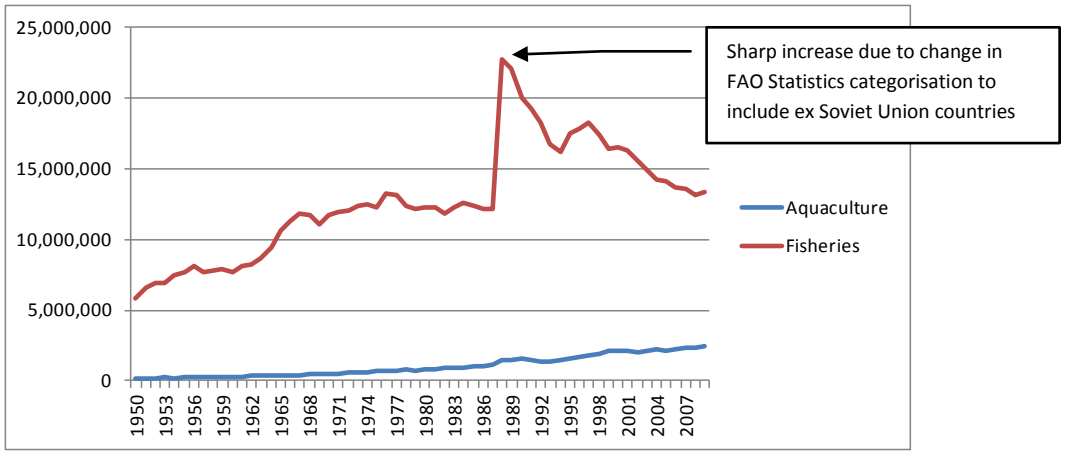
Challenges for the sector

Aquaculture and fisheries in Europe

Aquaculture and fisheries play an important role in European food security and wider economic activity. They are particularly significant for many rural coastal communities. The fishing sector in the EU and associated states (e.g. including Norway and Iceland) consisted of 83,796 boats in 2010 (Eurostat) employing around 187,000 people (IEEP, 2011). Turnover data for the fish capture sector is difficult to find, but on the basis of recorded landings is probably in the region €10-14 billion. The aquaculture sector in the EU has a turnover of approximately €2.9 billion and employs around 65,000 people (EC, 2010). Added to this is the processing sector, which is estimated to employ around 126,000 people (4,000 companies) across Europe, with an output value of €23 billion (EC 2010). Ancillary jobs e.g. in the supply sector add a further 18,000 jobs (IEEP, 2011).

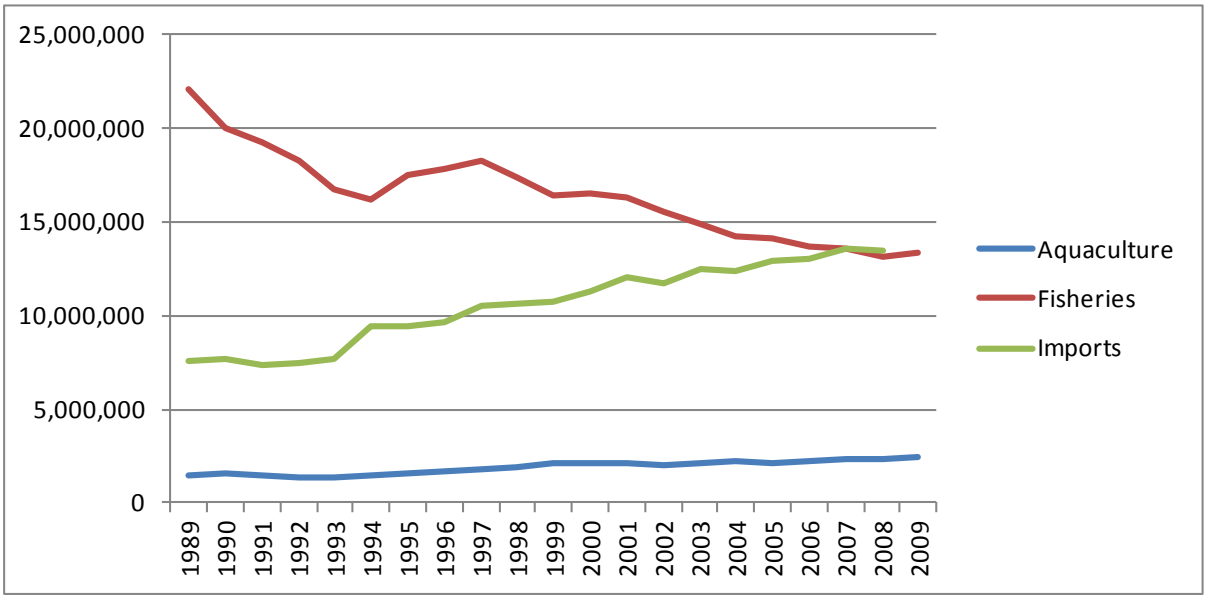
The problems in the capture fisheries sector have been widely publicised. Poor sectoral control combined with advancing technology has led to many stocks being overfished. In any case, maximum sustainable yields have been reached or exceeded for all species of commercial value. Demand has continued to grow however due to rising populations and increased per capita fish consumption (which is encouraged by government policies given the health benefits associated with fish consumption). After a long rise in production, European fisheries landings have been falling since the early 1990s. Aquaculture production rose strongly during the 1980s and 1990s, but stagnated for much of the first decade of the 2000s (Figure 1). The shortfall in supply was largely filled with imports from other regions of the world (Figure 2). This led to a renewed impetus at EU policy level for aquaculture development, launched in 2009 (EC 2009a), which is now being taken up in the renewed Common Fisheries Policy and the forthcoming European Maritime Fisheries and Fund.

Figure 1: Fisheries and aquaculture production 1950-2009



Source: FAO FishStat

Figure 2: Fisheries and aquaculture production and fisheries imports 1989-2009



Source: FAO FishStat

The reasons for the stagnation in aquaculture production despite apparent market opportunity appear to be due to external constraints on the industry leading to poor competitiveness compared with other sources (Bostock et al, 2009). However, this situation may well be turned around and prospects for future growth remain strong, provided that wider social concerns about sustainability and welfare can be properly addressed. The need for further knowledge and skills development within the sector to help drive innovation is widely recognised. For instance the EC policy document of 2009 (EC, 2009a) contains the following phrases:

> "The Commission.... Will pursue efforts in aquaculture R&D, and allocate a sufficient EU budget to aquaculture projects to further develop the **knowledge-base** for sustainable and competitive aquaculture"

> "Members States and the industry are invited to increase their investment in aquaculture **research** in the context of the European Research Area"
>
> "The Commission.... Will promote optimisation and development of key **research** infrastructures and reinforce **networks** and integration into broader scientific networks to address global challenges such as adaptation to climate change in the context of the new Maritime Policy and its strategic research agenda"
>
> "The Commission will... Develop guidance documents and organise specific workshops with stakeholders and national authorities to facilitate the **knowledge** and implementation of its main environmental policy instruments"
>
> "The sustainable development of aquaculture should be supported by excellence in **research** and **innovation**"

The more recent policy document on the reform of the Common Fisheries Policy (EC, 2011) includes the statements:

> "Science-industry partnerships can improve the quality and availability of data and **knowledge**. They can also foster mutual, common understanding between operators and scientists, without compromising the independence of the latter. Such **partnerships** should therefore be encouraged".
>
> "The social and economic importance of small-scale coastal fleets and aquaculture in certain regions calls for specific measures for these fleets. The measures should support green, **smart** and inclusive growth and should contribute to sustainable, low-impact fishing and aquaculture, **innovation**, income diversification, reconversion, improvement of science and a culture of compliance.
>
> "The reform will require Member States to prepare national strategic plans based on a set of strategic EU guidelines to create favourable conditions to encourage the economic activity and improve its competitiveness, to support its sustainable development and **innovation**, and to stimulate diversification"

There is a general theme recognising the importance of knowledge generation and its application in industry innovation. Education and training are not explicitly addressed, but clearly have a role, as discussed later. The wider importance of innovation, knowledge generation, transfer and application is emphasised in the European Commission's flagship 2020 policies[1] which aim to promote "smart, sustainable and inclusive growth" in particular "Innovation Union[2]" and "an agenda for new skills and jobs[3]".

[1] http://ec.europa.eu/europe2020/index_en.htm
[2] http://ec.europa.eu/research/innovation-union/index_en.cfm
[3] http://ec.europa.eu/social/main.jsp?langId=en&catId=958

The role of knowledge in competitiveness and aquaculture development

Although the nature of aquaculture varies tremendously both in Europe and across the world, from subsistence activity to multinational enterprises, most production is run on a business basis and sold into a competitive marketplace. Competition, whether between producers of the same product or potentially substitutable products, favours those that can achieve greater efficiency or quality, through for instance, more effective technology, management or marketing. These are all knowledge-intensive activities and areas where innovation can have a profound impact. It is common for smaller organisations in particular to value highly the knowledge that has been generated internally through experiential learning and own research (which can vary substantially with respect to scope and rigour). They frequently regard and protect this knowledge as "trade secrets" in the hope of not giving advantage to competitors. Whilst some of this knowledge may be unique, much is probably common knowledge among organisations involved in the same activity, but is largely unpublished and therefore less available to new entrants or indeed academic researchers and teachers. As companies become larger and industries mature, the proportion of know-how considered to be trade secrets generally diminishes as companies compete more on scale and logistical advantages.

Organisations can gain new knowledge through their own direct experience, deliberate research and learning, the employment of new staff, the engagement of consultants, or the advice of suppliers. Opportunities for most of these are more limited for smaller organisations. Anecdotally, the combination of unwillingness to share internal knowledge and relatively poorer access to external knowledge can lead to some industry stagnation and potentially longer-term vulnerability e.g. to foreign competitors.

A key provider of new knowledge for the sector should be the research community (public and private research organisations and research-active universities etc). Some of this is very well focused and is readily translated by sector suppliers (e.g. nutrition and pharmaceutical companies) into innovative products and services that can bring major advances. Other research can have lower impact for reasons such as:

- it is not well communicated to potential beneficiaries
- it largely repeats previous work
- it confirms existing working assumptions or practices
- it address issues that are not of economic significance
- it is insufficiently complete to provide any practical solutions

Initiatives such as the European Aquaculture Technology and Innovation Platform[4] (EATiP) are providing important platforms at various levels for research and industry organisations to work more closely together in defining research priorities and ensuring that research findings are properly disseminated and exploited. However, despite efforts by those involved, it is likely to be much easier for major companies and research organisations to engage in these processes than small companies or research organisations with more limited resources and capacity, which could ultimately influence the organisation's strategies.

[4] http://www.eatip.eu/

Whilst the larger companies and major research organisations in the sector tend to lead on incremental innovation, some of the most transformative technical innovation can come from small companies or research groups that may have had little previous involvement in the sector. Developments from other sectors are also transferred into aquaculture and fisheries through the actions of small or large companies without any involvement of aquaculture research institutes (e.g. ITC and communications-based developments). All these developments require the application of knowhow to introduce innovations that provide some competitive advantage to those who implement them.

Aquaculture production companies can be innovators themselves, especially with respect to process but possibly with respect to technology or product. However, they are also purchasers of innovations from their suppliers. This is a key factor, as there is little incentive for suppliers to innovate if producers are unwilling or unable to invest in adopting new solutions. On the other hand, producers need to be sufficiently critical of innovations that might be marketed to them to ensure they will achieve the promised benefits. They may also need to adapt their own processes or structures to take full advantage of the bought-in innovation. Both of these require higher-level skills. Throughout the sector therefore, and especially where there is a large number of smaller companies, a capacity for innovation and linked to that – the recognition and appreciation of knowledge and a willingness to learn – is essential for long-term development and competitiveness.

The role of learning

Lifelong learning

The premise that lifelong learning needs to be encouraged and fostered has been at the heart of European and National Government policies for over 20 years. This is largely linked to a perceived need for greater mobility and flexibility in the workforce given the changes in national economic structures over the period, driven by greater globalisation and technological change. However, there is also a strong social justice element of ensuring equitable access to education and career progression. In Europe generally, there has been a decline in manufacturing jobs and an increase in service sector employment. Much of the new employment involves "knowledge workers" where knowledge and the ability to acquire and use it are fundamental to the job. This has led to an analysis which places greater emphasis on building the skills of knowledge acquisition, analysis, appraisal and application than on the actual knowledge that is gained during the educational or training process. It is argued that during a person's career, they are likely to change roles and probably industries several times, so that very little of the subject matter learned during formal education will be directly relevant to their later work. There is also the pace of change to consider, with subject areas such as bioscience or information technology advancing exponentially during an average career.

Clearly learning does not stop at the end of full-time formal education. Adults often engage with further formal education on a part-time basis, and participate in shorter-term non-formal training. Much of the learning that takes place however, is informal, learned through experience on-the-job, or through self-directed learning as a person seeks to improve their understanding, performance and perhaps employment prospects. Whilst such learning is directly relevant to a person's competence to do a particular job, there is rarely any independent assessment and accreditation of the type common in formal education. This has been addressed to some extent in various initiatives to validate and accredit the type of professional competences that may be acquired, and fit them into a broader framework of qualifications. Within the European aquaculture sector, the VALLA project has made substantial progress in this respect. Proper recognition of knowledge and skills gained through informal learning would enable people to move more easily into appropriate formal education at later points in their life. However there is also a political dimension to this as some would see this as an undesirable dilution of the value and esteem that is given to degree holders, whilst others see it as a way of breaking down elitist social structures and creating a fairer and more meritocratic society.

In the context of this discussion paper, the question is whether lifelong learning should be given any priority and attention in hard-pressed commercial or even non-commercial environments, and in particular the aquaculture industry. As was argued in the previous section, commercial success is directly linked to the ability of a company to continue to innovate, or at least be open to, and capable of, implementing innovations. Such innovations imply new knowledge that has to be acquired in some way by the company. Traditional company structures have been hierarchical with well-defined points where innovation is expected to be initiated and then generally cascaded

downwards to the employees directly involved in implementation. This process often involved non-formal training courses, and in larger companies, the existence of training departments dedicated to this role.

The traditional company structure with defined hierarchies, functions and associated pay grades has come under increasing critique as more is understood about the psychology of employees and the dynamics of their interactions. Notably, there are more and more companies, especially in the IT sector, which have proved to be successful due to a more flexible and "agile" structure which views every employee as a potential innovator and encourages lateral rather than top-down learning processes. This approach tends to be based around teams working together to solve problems or achieve targets where all contributions are valued and members support each other in pushing the boundaries of their capacities. Such companies have an ethos of the "autonomous employee" where staff are mainly self-directed carrying out actions that are in alignment with company aims and objectives, rather than being primarily directed by others.

The perceived problem with this approach, especially in an industry such as aquaculture with already limited levels of hierarchy, is that autonomous employees who are encouraged and often directly funded to learn and improve their capacity and potential will soon be looking for promotion, higher salaries, or for other jobs outside the company. Smaller companies in particular simply do not have the resources to allow for much internal movement of staff. One potential answer to this is that small companies can more easily expand to become large companies by adopting this strategy. It can also be argued that employees that are motivated to progress will do so anyway, whether encouraged by their employer or not. Indeed changes of job can often seen to be driven as much by individual's desire to learn new things and take on new challenges as by a desire for better pay or seniority. Providing an environment where employees are supported in efforts at self-development can potentially engender greater loyalty to a company, whilst enabling employees to use the skills and knowledge that they acquire more fully, can also bring additional benefits to the company. Nevertheless, this remains an area requiring further investigation, especially in the aquaculture industry where the small size of local communities imposes additional constraints.

A different issue, perhaps, concerns the nature of the skills and knowledge that people gain working with a company. Various types may be identified, such as:

Generic skills -such as communication, interpersonal skills, negotiation, persuasion, critique and analysis etc. These tend to improve with experience and practice and may also be the subject of further training. Creativity on the other hand is arguably a generic skill that tends to be repressed in more traditional management structures or training courses.

Practical skills – these can range from vaccinating fish to doing the accounts, but often have a strong element of specific training or learning from someone else who knows the job.

Technical knowledge - the accumulation of technical knowledge (or expertise) is a key area for personal development as it enables individuals within companies to differentiate themselves. However, it is also of value to companies as it is a key means of identifying innovations that can be adopted to provide competitive advantage.

Company and sector-specific knowledge – knowing how the company works and having a strong internal network of relationships can be a very important element of acquired knowledge. Similarly, for many positions, an understanding of the wider business sector and the establishment of a personal network across it can be equally important. This type of "expertise" comes mainly from experience.

The balance between generic skills and knowledge and company/sector-specific skills and knowledge required for particular jobs or roles can be an important dynamic for management.

In the above analysis we have focused essentially on work or career-related learning but informal (and some non-formal) learning also encompasses other life skills, especially leisure interests. This may initially seem of little relevance to employers, but learning for leisure can often help develop generic skills that enhance performance at work. There is also evidence that all learning enhances the overall quality of life (Field, 2009). More subtly, job satisfaction can be affected by wider issues of quality of life. Many people in the aquaculture industry have leisure interests that directly relate to the rural and coastal environment in which they work. The degree to which their employment enables them to fulfil these can be an important factor for overall attitude to work. Local community factors can of course be similarly important.

Formal and non-formal learning

Formal learning

Formal education is mostly aimed at developing knowledge, skills and attitudes that help students to lead better lives. Although that includes building knowledge and skills that will be useful in a wide variety of workplaces, most educators are focused on helping students to meet their potential rather than tailoring them for specific productive functions. Within subject areas, educators often focus on teaching underlying principles and knowledge frameworks as a basis for deeper understanding and further knowledge building. The specific knowledge that can be taught is always limited and selected to help illustrate deeper principles or because it is considered to provide a stepping stone towards further exploration of the subject area, or act as a keystone necessary for understanding further topics. The emphasis is usually more on intellectual than manual skills, so that at university level for instance, critical analysis, reasoning and debating skills are particularly highly valued.

Most specifically however, formal learning takes place within educational establishments in a structured way with various types of student assessment and accreditation (i.e. leading to formally recognised qualifications). The (probably necessary) bureaucratic nature of educational assessment and accreditation systems means that formal education responds relatively slowly in comparison with the sometimes rapid pace of change in areas of technology and business.

A great deal has been written about the value of educational assessment and accreditation and indeed many different approaches are used throughout formal education. Most education is now based on identifying the learning objectives for a course or lesson in terms of the expected learning outcomes – what students are expected to know, or what they are expected to be able to do after the educational intervention. These outcomes should be measurable, so that the effectiveness of

the teaching or the degree to which individual students have achieved the learning outcomes can be determined. The specification of the learning outcomes and the way in which they are to be assessed is therefore critical to the overall value of assessment and accreditation systems. The widespread adoption and formalisation of this approach suggests that it has been found to be useful at many levels. However many critics remain concerned that focusing on the measurable can leave otherwise important aspects neglected. At its most basic a potential employer might look at 20 CVs that list a wide variety of qualifications, but most likely none will give any indication of which candidate possesses the most "common sense" or "responsible attitude" or other attribute that academic qualifications do not measure. It can be readily argued that these are more subjective questions that can be assessed by potential employers in other ways (e.g. via references and at interview). However, it illustrates some of the difficulties that are faced in devising formal educational programmes that meet the needs of each individual and of the wider society.

Non-formal learning

Non-formal learning is usually defined as education or training that takes place in a structured way (ie. as a course with teachers/trainers/tutors) but does not lead to a qualification that is part of a recognised national framework, and indeed often does not involve formal assessment and accreditation. Examples include continuing professional development courses, in-house training by companies, specific skills training provided by training agencies or companies, or leisure interest classes. A secondary feature of non-formal learning is that the contents of the course are usually tailored to meet the needs of a specific target group of learners for whom the subject content is of primary importance rather more than wider principles and intellectual frameworks.

In practice learning can be considered to be not only a continuum but also a mix from formal to informal so defining strict categories is not always possible or helpful. However, these can be useful categorisations when analysing the sector. Similarly there is a good deal of overlap between the terms "training" and "education" in common usage. Both terms can be applied to formal and non-formal learning, but training usually implies that it is oriented toward ensuring that the skills, knowledge and attitudes of an individual meet those that have been specified for a particular job or role. Education also aims to enhance the knowledge, skills or attitudes of an individual but for their own benefit and that of the wider society, rather than for a specific employer or activity. Strict definitions are difficult, but whereas a training course might be satisfactory enough to ensure that students have learned how to carry out a particular task and can demonstrate their competence in doing so, educators would also want to encourage students to understand the context for the task, to critically appraise different options for how it could be carried out and develop creative skills that would help them to innovate better solutions.

A common feature of formal and non-formal education/training is that it involves clearly defined roles of teacher and student and the organisation of students into groups who go through a planned learning process at the same time.

Informal and social learning

Informal learning encompasses learning on-the-job from more experienced (and often senior) colleagues, self-initiated learning, e.g. carrying out research on the Internet or reading books and technical journals, accidental learning – e.g. from mistakes made on-the-job, or unplanned viewing

of an interesting documentary programme on television. Informal learning is also the primary means of pursuing leisure interests. For most adults once they have completed formal education, informal learning is the primary way in which they experience lifelong learning. A key feature of this type of learning is that it is generally unstructured and unplanned. The roles of "teacher" and "student" are much less clearly defined, especially where colleagues learn from each other. This kind of learning (or education) has also been described as "Lifewide" (Barnett, 2010) as it spans social, practical and intellectual skills, vocational, leisure and socio-political knowledge. There is no specific start or end to any learning process and usually no formal assessment of what has been learned or the skills that have been gained. It starts at birth and continues throughout life.

Informal learning is also closely linked with "Learning on demand" or "Just in time learning". Adults who have undergone formal education should have the necessary knowledge frameworks and learning skills to build on those further in self-directed learning. However the motivation to do so is usually either necessity, or interest and enthusiasm. Neither of these necessarily leads to much structure in the sequence of learning. Questions or problems arise that need to be solved and doing so results in a learning experience that expands a person's knowledge and understanding of the world. Where specific learning activities are embarked upon within a work context, they tend to be strongly influenced by what needs to be known in order to carry out a specific task, or to respond to a specific situation. The starting point for the learning is the existing knowledge of the individual and their own learning objectives. In this sense, informal learning is highly "learner centred" in contrast to formal courses where the starting points and learning outcomes are largely determined by the course organisers (albeit on the basis of broader needs analysis).

Counterbalancing the individual nature of the "learner centred" approach is the observation that learning is often most effective when carried out with peers. i.e. learning is frequently a social activity (Johnson, 1981) involving various types of interaction within the context of some type of team, group or community. Such groups may range from the strictly defined and long lasting to the loosely defined and transient. Psychology studies can help to shed some light on group dynamics, which can be very complex. However, in simple terms, individuals within groups tend to share their interest and enthusiasm and sometimes compete in ways that provide motivation to all participants. Individuals within groups are often more ready to ask peers than teachers for help overcoming problems. Not only does this multiply the teaching effect within the group, but also strengthens the learning of those who play the teaching role (which may switch as topics change). Debate within groups allows participants to better test their knowledge and opinions, and develop both a more critical but also a more tolerant approach. Groups (or classes) are the norm for formal learning and most teachers will have experienced variations in performance between different classes which cannot be attributed to differences in teaching, materials or the individual capabilities of students; but seem much more linked to the degree to which the class comes together to collaborate in their learning experience.

Many learners find it difficult to follow formal courses when it is delivered as a one-to-one experience via distance learning (correspondence or online) (Swan, 2002). Many e-learning courses have been modelled on classroom courses, but without facilitating the level and quality of student interaction that occurs in campus-based courses, often with disappointing results for both tutors and students. This has led some people to conclude that e-learning is a very deficient approach that risks diverting resources away from well-proven academic practice. Counterbalancing this perhaps is the

observation that there has been phenomenal growth in Internet-based informal learning, including on very technical and professional topics. The group or social element has emerged as "Special Interest Groups" (SIGs) or "Communities of Practice" that communicate through e-mail discussion lists, website forums or more recently, social networking sites such as Facebook and LinkedIn. The learning that is enabled by these communities is unstructured, but driven by real questions that are then debated by people with both academic and practical knowledge to share. It is predominantly transient, although many groups engage in various forms of archiving, the creation of structured knowledge-bases, or at least the accumulation of learning resources to which new entrants to the community can be referred. This is leading some educators to see social networking as a key platform for future learning that may either complement or in some cases replace other traditional approaches.

Informal learning that leads to specific competences can potentially be assessed and accredited. This is done non-formally by many employers and professional associations, for instance. The formal accreditation of informal learning is less common, but has been rising up the political agenda not least as a means of ensuring that adult learners who may have missed an opportunity for further or higher education earlier in life, have a route into such education that takes account of their post-school learning through informal means. Many EU countries now have formal policies and developing practice for the formal recognition of prior learning[5]. As part of this, educational qualifications are increasingly based on credit frameworks that potentially allow students to gain credits in various ways and different times in order to achieve specific qualification outcomes (e.g. ECTS[6] and ECVET[7]) .

A further perspective on informal learning relates to creativity. It is has been shown that on some measures, creativity declines as children progress through formal education (Sahlberg, 2009). How much this is due to the educational process is less certain, but much formal education does little to stimulate personal creativity, especially in its later stages. Much informal learning on the other hand is related to individuals rediscovering or strengthening their creativity. This is perhaps too simplistic an analysis to stand much scrutiny, but the need for greater personal creativity as a means of achieving a more entrepreneurial or at least more innovative workforce is embedded in EC policy[8]. The implication is again that engagement in informal learning by employees can potentially benefit the performance of their company/organisation.

Combining this analysis with wider perspectives on social structure, economic development, environment, ethics and psychology, especially in the wake of the global financial crisis and its impact on European economic growth, many people are looking to a fundamental change in social and economic organisation. One vision that has already become a reality in some cases is the democratisation of business (and other) organisations. Hierarchical structures that rely on top-down innovation and management may have delivered labour and hence cost efficiency, but potentially at the cost of staff welfare, loss of social cohesion and impact on the environment and biodiversity.

[5] http://www.cedefop.europa.eu/EN/about-cedefop/projects/validation-of-non-formal-and-informal-learning/european-inventory-scope.aspx
[6] European Credit Transfer and Accumulation System
[7] European Credit System for Vocational Education and Training
[8] E.g. COM(2010) 2020 final, *Europe 2020*, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF

New leaner and flatter organisations are emerging where the model for innovation is based on "learning together" – ideas and knowledge exchange freely exchanged within the organisation as it works towards specific targets. Individuals are encouraged to fulfil their potential and take responsibility as a member of the team rather than relying on the ideas and instructions from their "superiors". By contrast, the traditional hierarchical structure encourages individuals to protect rather than share their knowledge as it is perceived as giving them competitive advantage amongst their workplace peers and hence improve their prospects of climbing the "corporate tree". It can be argued that an organisation that respects and equally values the differing skills and knowledge of its staff and encourages learning together as well as working together, can achieve greater innovation and commercial success whilst simultaneously building greater social/community capital through an engaged workforce. Such organisations also tend to place greater emphasis on other ethical values such as environmental sustainability and wider social justice.

Aqua-tnet as a learning community

The aqua-tnet project and network

Aqua-tnet is the "Aquaculture, Fisheries and Aquatic Resource Management Thematic Network" funded through the Erasmus action of the European Union Lifelong Learning Programme. The network started in 1996 as a workpackage in an agriculture and forestry network and became a network in its own right in 2005. Funding has been for periods of three years; this report is an output of the second period of funding (2008-2011) and will contribute to activities in the third phase of funding which is now active (2011-2014). The project comprises a network of member organisations (94 in Aqua-tnet 2) rather than individuals, although clearly it is the engagement and commitment of individuals within these organisations that enables the network to achieve the project objectives.

The work of the project is organised into a number of workpackages which have varied through the life of the network (See table below). As these are inter-related, the following discussion draws on various workpackage activities and outcomes. Nevertheless, as this report is an outcome of WP5 it draws mainly on its work and does not attempt to provide a comprehensive overview of the entire project.

Workpackage structures of the aqua-tnet projects

Aqua-tnet 1	Aqua-tnet 2	Aqua-tnet 3
Core implementation: WP1 – MSc curriculum development WP2 – PhD curriculum development and assessment WP3 – Transparency in teaching and education – TUNING approach WP4 – Mobility WP5 - Innovation in teaching WP6 - Languages and linguistic diversity	*Core implementation:* WP1 – MSc WP2 – PhD WP3 – Mobility WP4 – New generic skills and competences approaches WP5 - Innovation in teaching methods WP6 - Positioning lifelong learning	*Core implementation:* WP1 – MSc cooperation WP2 – PhD collaboration WP3 – On the move (Mobility) WP4 – Generic skills for future success WP5 – Innovative lifelong learning (with sub-groups on i) Lifelong learning pathways, ii) Curriculum framework, and iii) Innovative tools & methods)
Cross-cutting & stakeholder representatives: WP7- Needs of industry WP8 – Needs of research WP9 – Role of science in society and consumers' concerns	*Cross-cutting:* WP7 – Multilingual issues in international cooperation WP8 – ICT advisory group WP9 – Dissemination and outreach *Stakeholder Representatives:* WP10- Research institutes WP11 – Industry partners WP12 – Consumer and societal issues WP13 – Student association	*Cross-cutting & stakeholder engagement:* WP6 – Stakeholder cooperation (with sub-groups for i) Industry, ii) Research community, and iii) Students) WP7 – Dissemination & outreach WP8 – Exploitation of results
Management etc: WP10 – Project management WP11 – Dissemination	*Management etc:* WP14 – Project management WP15 – Exploitation of results	*Management etc:* WP9 – Quality assurance WP10 – Project management

Much of the activity of Aqua-tnet occurs and is channelled through the working groups associated with each workpackage, cross-linked via the Steering Committee and at the Annual Event, where all members meet to share and discuss activities. In Aqua-tnet 2, WP5 and WP8 are essentially the same team and although primarily interested in MSc level teaching, have looked at teaching and learning issues in other areas of lifelong learning. Members are mostly active university teachers who are also engaged in research, consultancy and other aspects of aquaculture and fisheries. Whilst one member is more specialised in pedagogy, for most members of the group, pedagogy and the use of ICT are topics that have come to importance mid-career, driven by a desire to improve on their own current practice and improve the quality of the courses in which they are teaching. In effect the group are a small "community of practice" engaging in "situated learning". The interest in developing this report therefore comes not only from the subject matter, but also from the process by which the knowledge it contains has been accumulated and developed.

In addition to experience within the Aqua-tnet project and their own teaching, group members are also involved in other European, National or International networks and projects which have provided further learning opportunities.

Using ICT and the Internet

The rapid development of the Internet over the past 20 years has surely been the single most important development for education and learning since the invention of the printing press, although the development of cameras, film, radio and TV have also had profound impacts over the same period.. Given the magnitude of change in the availability and accessibility of learning resources it is perhaps surprising that in many respects, the structures and patterns of education have not changed radically. A survey of current practice with respect to the use of Information and Communications Technology (ICT) at university level (Aqua-tnet, 2010) showed only modest uptake. The main uses were for making material available to students, improving the quality of lectures, and course administration. There is growing evidence that the use of video and podcasts for instance to support traditional teaching methods can enhance learning (e.g. Bridge et al. 2009)

The same survey found that students, although making use of social networking and media sharing services did not appreciate the potential for these to enhance their education. They valued all types of face-to-face teaching and especially practicals and hands-on experience. Whilst this may be interpreted as support for lectures and evidence that ICT is more of a distraction, this would be a complacent simplification of the dynamics concerned. It may be argued that the key aspect of the lecture is the relationship that is formed between the students and the lecturer (Bainbridge Frymier & Houser, 2009). For students who feel somewhat lost in a deluge of information, the lecturer becomes a trusted guide, someone who has a map and can guide students through difficult landscapes of knowledge. As teaching itself becomes more closely linked to assessable learning outcomes, it could also be argued that many students have become accustomed to picking up the cues from lectures on exactly what they need to know to pass exams, potentially leading them to avoid learning that would be of greater general benefit. The relationship between teacher and student is also important for inspiring and motivating students and for providing individual guidance that can make a critical difference to attitude and performance. The structure of formal education with set timetables and the requirement to be in a certain place at a certain time and to turn off

mobile phones and other distractions can also be an important discipline that helps many students, even if not popular at the time. Lastly, as already discussed, although lectures and practicals are focused on teacher-student interactions, face-to-face student-student interactions are also very important and in many ways an essential component of student learning.

Perhaps because relationship building is so integral and natural within traditional education, it was arguably overlooked in the design of early e-learning courses where the focus was on content and means of assessment. The main method of communication for participants in e-learning courses has tended to be asynchronous text-based forums. This suits some (though probably a minority) who prefer written to verbal communications. The materials were also predominantly text, diagram or photo-based with minimal motion and audio. Video for instance can be much more effective for engaging the senses so many people find easier to learn from than documents (e.g. Donkor, 2010). More recently the focus has been "blended learning" which seeks to combine the best of online with face-to-face learning so as to enhance courses that predominantly take either approach.

Much of the activity of the Workpackage 5/8 group has been on the potential for ICT and particularly Internet technologies to enhance the quality of teaching and student learning, with the emphasis on introducing tools and approaches that enhance traditional teaching skills, or that help teachers to adapt to changing circumstances. This was initially documented in Aqua-tnet 1 as a web report[9] and has been further documented through various Workpackage 5/8 outputs including the "Online Guide to New Media[10]" and "Examples of Innovative Teaching[11]". Most notably, the group ran a one-day workshop in new tools and methods at the final Annual Event of Aqua-tnet 2. The materials and outputs from this are also available via the Aqua-tnet website[12]. Two key themes can be seen to run through most of these outputs:

1) *Creating and sharing multi-media resources* – The value of good quality and relevant video, audio, photographic and other materials for learning is readily appreciated. However both teachers and students often lack the skills for creating these resources ("digital literacy") and once they do exist, effectively sharing and using them in teaching becomes a major issue. The workgroup activities focused on helping overcome barriers and learn about available resources and tools to overcome these constraints.
2) *Communicating and collaborating* – The social and collaborative aspect of learning is very important, so the workgroup examined how new Internet tools can assist these processes and especially enable people to collaborate over geographic, temporal or cultural boundaries.

Looking to the future, it is clear that we are still in the early years of the networked age and that the ease and quality of communication and access to information will continue to improve rapidly. Mobile devices are replacing desktop computers for a great deal of Internet access and younger people rely increasingly on ubiquitous electronic communications in managing their social interactions. Traditional educational constraints such as the time required to search for relevant information and the very limited amount archived at any one location are rapidly disappearing. One-

[9] https://docs.google.com/Doc?id=dc8mztpb_2gjbsrx
[10] http://www.aquatnet.com/index.php/145/online-guide-to-new-media/
[11] http://www.aquatnet.com/index.php/140/examples/
[12] http://www.aquatnet.com/index.php/71/teachers/

off lectures that can be attended by a limited number of people and which cannot be re-accessed for revision are also likely to decline. For those that are not replaced by other methods, audio or video recording and streaming make them much more available and effective for students. Most importantly however, the Internet has the potential to drive more fundamental social change, including patterns and structures for lifelong learning. The physical entities of schools, colleges and universities will most likely remain and in many ways be strengthened in the future. However, the nature of learning is becoming increasingly networked and individual learning pathways will be increasingly defined by their network connections rather than physical location. The barriers between learners of different ages, locations, social roles become much less relevant in a networked age.

Collaborative ventures

The Aqua-tnet project has facilitated a number of other projects and collaborations between member organisations and involved individuals. These bring a range of further perspectives which again can be considered thematically – with rather loose reference to aquaculture systems.

Enlarging the pool

No organisation has internal access to all the possible expertise it might require. By definition, smaller organisations will have a smaller pool of expertise on which to draw. Collaborations between organisations, or at least between individuals associated with different organisations, can increase the expertise available to both. This can be developed in different ways, but for Universities teaching a broad topic such as aquaculture, the potential to bring external expertise in for specific teaching inputs can be very attractive. Academic exchange greatly enriches the quality of many courses as students have direct access to a wider range of experts and are presented with a wider range of ideas and knowledge than would otherwise be the case. This usually involves a lecturer from one institution visiting another for a lecture or perhaps a week or more of teaching. However, improvements in video/web conferencing are making it easier to teach on another course remotely. Indeed elearning as conventionally practiced is based on distance learning. Since the cost of travel and accommodation is one of the major disincentives to the increased mobility of lecturers, the opportunity for far greater sharing of expertise across institutions is now considerable. The constraint becomes the willingness and ability of organisations to embrace more open models rather than cost and practicality. A simple example of this development is short presentations from an expert at one location to a class at another, e.g. between the Norwegian University of Life Sciences and the University of Stirling in Scotland which can be relatively easily and informally arranged. More advanced integration is taking place within the NOVA University Network[13] in Scandinavia, where courses are split across two or more universities.

[13] The Nordic Forestry Veterinary and Agricultural University Network – http://www.nova-university.org/

Deepening the pool

At a time when fees for University tuition are rising whilst economies in Europe are either in difficulties or crisis it is not surprising that the efficiency of education should be more closely scrutinised. One aspect of this (which is often not measured in any meaningful way) is the time spent preparing lecture and similar materials for students. This is an issue that deserves greater attention, but clearly time can easily be wasted trying to find or generate suitable images, video, data and other content to illustrate issues when such material might be readily available elsewhere. If the lecturer fails to find or generate suitable material, the quality of the teaching is potentially compromised. Furthermore many teachers find it difficult to spend enough time on material preparation, so there is substantial re-use from year to year which can result in illustrations and examples that are well out of date. A simple solution to this is the greater sharing of teaching resources (or "learning objects") to increase the depth of resource available to all. This has been picked up in many projects and a number of formal repositories have been developed at national and international levels. The key constraints appear to have been the lack of willingness of many individuals or organisations to share their own materials (although they are usually keen to take from elsewhere) and for the repositories to gain sufficient volume of material that gives users the confidence that they will find what they need within them. Raising awareness of the repositories is a related challenge. The commercialisation of education in some countries and encouragement of competition between institutions add further to the barriers for open sharing. Nevertheless, there is a strong global movement for Open Educational Resources (OER) which provides ground for optimism. The development of Creative Commons licensing is providing a legal basis for such collaboration.

The Aqua-tnet workpackage 5/8 group examined this area for aquaculture and considered that the public (Web 2.0) social media sharing sites had greater critical mass and provided more ease of use than niche academic sites. It therefore promoted the sharing of materials through Flickr (Images and short video), YouTube (video), Slideshare (Presentations) and Diigo (weblinks). This is very much work in progress, but the most successful so far (albeit limited) is the sharing of images via a Flickr group[14]. It could be questioned as to whether a group on such services is necessary as only a fraction of potentially useful resources will be posted to appear within the group search. However, it does give some focus to the issue of resource sharing and enables people to use images posted to the group for teaching purposes in the knowledge that they have the owner's approval. A particular opportunity is that these groups will provide a channel for people in other sectors (industry and research) to ensure appropriate and up-to-date material is being presented to students.

Enriching the pool

Aquaculture, fisheries and aquatic resource management are applied, very diverse fields that involve a great deal of interdisciplinary cooperation in their execution. A modern aquaculture business involves biology, engineering, finance, business management, law, human resources, transport logistics, and many other disciplines. An aquaculture course cannot expect to cover all of these in any depth, but it is increasingly important that students have an appreciation of these elements and are familiar with working in an interdisciplinary environment. The extent to which this happens

[14] http://www.flickr.com/groups/aqua-tnet/

varies considerably between universities and courses. The issue is being addressed to some extent through the initiatives of workpackage 4 on generic competences. Workpackage 5 has been looking at the potential for case studies to be used as a tool for greater interdisciplinary collaboration. These often involve role-plays where students take on the role of a business manager, regulator, buyer or environmental campaign group etc. This is useful, but a further step is to involve students from other courses in a way that provides a richer experience with a wider range of perspectives and expertise for all. A small trial involved a group of aquaculture student in Scotland with business students in the USA who were interested in aquaculture as a business opportunity. Both groups found it a useful experience and are likely to enter the workplace with a more balanced appreciation of roles and functions.

Making it flow

The headings in this section have made a rather loose analogy between education and aquaculture with the use of the term "pool" – representing some type of grouping that exists over time, with diffuse but somewhat definable boundaries, that can change in size and depth, that could be nutrient-poor and relatively lifeless, but in general is enriched and very lively. Most important for aquaculture however, is the flow of water through a pool as that will be a critical factor in determining its production potential. Taking that idea and returning to the theme of lifelong learning, what benefits all lifelong learners (from children to senior adults) is a good flow of knowledge. No academic institutions would survive for long if they did not take in the knowledge that is being generated elsewhere and share the knowledge that they are creating. They would become stagnant and rather lifeless. A good exchange of knowledge can be likened to water flow in aquaculture, or blood flow in living creatures. The flow of knowledge between academic institutions is well established, involving for instance conferences and academic journals. Rather less attention is sometimes paid to ensuring the outward flow of information to other sections of society (industry, policy-makers, consumers, school children etc), or the inward flow from these groups. It is for this reason that universities are sometimes seen as somewhat disconnected and remote by people in industry. If lifelong learning is to be taken seriously, there has to be some acknowledgement of the fact that the expertise of many people outside the academic system is very substantial and should be respected as a valuable source of knowledge for academia. This is particularly the case for applied topics such as aquaculture and fisheries. Whilst it is certainly true that academic courses may have rather different objectives than vocational courses, it is difficult to argue that the subject can be fully examined if it excludes the direct experiences of those who are actually engaged in the industry. In short, academic courses can benefit greatly from wider inputs from society.

The Aqua-tnet workpackage 5/8 group explored ways in which greater links can be made between formal education and industry. Face-to-face visits are very useful and even more so are longer-term exchanges (e.g. internships which have been examined and promoted by workpackage 3). However, these take up time, not only for the students but especially for industry partners. Here also, the use of live video links has proved a cheap and efficient means of creating connections. Work by Innovamar in Spain showed how a class could be linked in real time to events on a farm, whilst

Stirling University also made use of live video linked interviews with people in industry[15]. A mechanism to promote these types of links was launched on the Aqua-tnet website by the group[16].

More substantive links with industry were made in the related Vocational Aqualabs – Aquaculture Talent Hatchery project[17]. This involved senior industry mentors supporting groups of students competing in an entrepreneurial challenge. The value was two-way as the students benefited from the mentor's real experience of starting and running businesses whilst the mentors appreciated the link the students gave them to recent research and current academic thinking.

Real engagement with lifelong learning therefore offers tremendous potential for enriching existing formal courses as well as ensuring that the results of research and the insights of academics are better picked up by industry and policy makers and used for innovation and development. The barriers are increasingly institutional and social as the Internet and allied computing and communications technology are enabling new models of learning and knowledge-building to emerge. One possible model being examined by the Aqua-tnet working group on innovation in teaching, is giving special status to alumni by providing mechanisms for them to continue to access updated learning materials related to their original course, in return for their participation in student mentoring.

The challenge is also for aquaculture enterprises to embrace learning, creativity and innovation into their culture and organisation. This may be difficult for established companies without wider social and political change. The benefits will need to be demonstrated either through the example of new start-ups using different business models, or evidence-based research on learning and innovation patterns within the sector.

[15] See http://www.aquatnet.com/index.php/140/examples/
[16] http://www.aquatnet.com/index.php/137/experience-share/
[17] http://www.aquaculturetalent.com

Lifelong learning and the Aqua-tnet domain

This report has examined the nature of lifelong learning and some of the ways in which the Aqua-tnet project is itself learning and developing models for wider dissemination and adoption across the aquaculture, fisheries and aquatic resources sectors. Substantial change within the Aqua-tnet domain will of course depend on wider changes within society, the organisation of formal education and the engagement of people with non-formal and informal educational activities. However, the sector has the potential to be a leader rather than a follower of trends given the coherence and cooperation that already exists at many levels.

At the European level, perhaps the most important development is the establishment of the European Aquaculture Technology and Innovation Platform (EATiP)[18] and more recently the European Fisheries Technology Platform (EFTP)[19]. These platforms bring the various stakeholders together and enable long-term strategies for innovation to be developed, including how knowledge can be most effectively generated and shared. Lifelong learning is at the heart of this as the industry appreciates the need to engage the interests of school children; to pass on the wisdom of experience to new recruits to the sector; and to participate in new knowledge generation to find solutions to contemporary challenges.

New mechanisms for enhancing lifelong learning are rapidly emerging as the potential offered by the Internet is explored. Concepts such as personal learning networks, communities of interest, workbased-learning, collaborative and social learning can all be seen to be gaining traction within the Aqua-tnet domain. Formal education providers need to engage constructively with these developments as they offer great potential for enriching their teaching whilst also increasing the impact of academic knowledge generation for the rest of society. Industry also needs to be alert to the changing landscape and opportunities that new models of lifelong learning might bring to their business.

It is therefore recommended that through the Aqua-tnet network and the work of the Technology Platforms, concrete means be found to enhance collaborations that promote and enable knowledge creation and sharing. The tools as well as the personal networks which can achieve this are rapidly developing, but require institutional recognition and engagement for the full benefits to be realised.

[18] http://www.eatip.eu/
[19] http://www.eftp.eu/

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