Optimal

No. 2016-1-NO01-KA202-022106
Erasmus Plus Strategic Partnership

Optimized Training - Innovative Methods and tools for Acceptance of prior Learning in qualifications and workplace training

OUTPUT 6: Designing, testing and planning new tools for recognition of prior learning in VET schools and fish farming companies

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Version: Final

Date: 1.09.2019

Funded by the Erasmus+ Programme of the European Union

This project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use, which may be made of the information contained therein.

Executive summary

The Optimal project VET providers, Guri Kunna Upper Secondary School and Inverness College, based in mid-Norway and the north of Scotland, respectively, have developed and piloted methodology for the Recognition and Accreditation of Prior Learning (RPL/APL) supported by Pisces Learning Innovations Ltd. (PLI). Although both VET providers were working with experienced employed status learners, they work within different VET regulatory environments (more fully revealed in the Output 3 report) and deploy different delivery modes, one being classroom based and the other work-based learning.

The paper is introduced by an academic overview of the process of giving learners feedback within the 'recognition of prior learning'. Thereafter, the key differences in the regulatory environments and delivery modes that have some bearing on the development of methodology for the Recognition of Prior Learning (RPL) and the Accreditation of Prior Learning (APL) are revealed through a direct comparison. This sets the scene for the development of RPL/APL approaches, led by the Norwegian partners who are experienced in Response Technology (RT) applications.

The Aquaculture National Qualifications (NQs) in each country were examined and analysed through 'curriculum mapping' activities, to reveal opportunities for RPL to satisfy prescribed knowledge requirements in the case of the Scottish Modern Apprenticeship (MA) system, and to derive a more detailed description of learning outcomes for the Norwegian NQ. This made it possible to identify considerable 'common ground' between the two curricular and make this visible, eventually opening the door to collaborative development and sharing of resources.

The opportunities and barriers to RPL/APL and the deployment of learning technologies are highlighted, before considering the definitions of RPL commonly applied within Europe, and how RPL may be applied, in each country and VET institution, knowledgeable of the restrictions and opportunities.

The initial early phase development of RPL approaches during the first two years of the Optimal project is described, including technical details provided on the response technology used by Guri Kunna Upper Secondary School in mid Norway. This led to some initial conclusions and amendments to the approach piloted more comprehensively during the third and final year (See output 8 report).

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1. Effective ways to give learners feedback

There are several reasons for 'recognising prior learning' explored and piloted within the Optimal project. This includes the systematic analysis of the data gathered and its application to teaching and learning, within which, 'giving feedback is a central element.

In 1956, Benjamin Bloom with collaborators Max Englehart, Edward Furst, Walter Hill, and David Krathwohl published a framework for categorizing educational goals: *Taxonomy of Educational Objectives*. Familiarly known as Blooms Taxonomy. The levels are thought to build on one another. The six levels pertain to thinking, the so-called cognitive domain:

1. Remember
2. Understand
3. Apply
4. Analyse
5. Evaluate
6. Create

It one of the most widely used ways of organizing levels of expertise and uses a multi-tiered scale to express the level of expertise required to achieve each measurable learner outcome. This framework has been applied by generations of teachers and college instructors in their teaching.

The framework elaborated by Bloom and his collaborators consisted of six major categories:

- **Knowledge** or recall of data expresses the natural urge to recall previously learned material. It involves the recall of specifics and universals, previously learned material, the recall of methods and processes, or the recall of a pattern, structure, or setting
- **Comprehension** or the ability to grasp the meaning, explain, restate ideas means understanding the basic information and translating, interpreting and extrapolating it. This refers to a type of understanding or apprehension such that the individual knows what is being communicated and can make use of the material or idea being communicated without necessarily relating it to other material or seeing its fullest implications.
- **Application** or using learned material in new situations, involves using information, ideas and skills to solve problems, then selecting and applying them appropriately. It refers to the use of abstractions and concrete situations.
- **Analysis** suggests separating items, or separate material into components parts and shows relationships between parts. It includes breaking apart information and ideas into their components. This represents the breakdown of a communication into its constituent elements or parts such that the relative hierarchy of ideas is made clear and/or the relations between ideas expressed are made explicit.
- **Evaluation** involves reviewing and asserting evidence, facts and ideas, then making appropriate statements and judgements. Evaluation engenders "judgments about the value of material and methods for given purposes.
- **Synthesis** is the highest level in this pyramid. It suggests the ability to piece together separate ideas to form new ones, or to establish new relationships. This includes putting together ideas and knowledge in a new and unique form. This is where innovations take place by putting together of elements and parts to form a whole.

There are three taxonomies. Which of the three to use for a given measurable learner outcome, depends upon the original goal to which the measurable learner outcome is connected. There are

- *knowledge-based* goals
- *skills-based* goals, and
- *affective* goals (affective: values, attitudes, and interests)

Accordingly, there is taxonomy for each. Within each single taxonomy levels of expertise are listed in order of increasing complexity. Measurable learner outcomes that require the higher levels of expertise will require more sophisticated classroom assessment techniques.

1.1 Feedback mechanisms

According to early research by Benjamin Bloom and his colleagues (Bloom, Madaus, & Hastings, 1981), the most effective comments have four essential elements.

First, they begin with the positive. Comments should first point out what learners did well and recognize their accomplishments.

Second, they identify the specific aspects of learners' performance that need to be improved. Learners need to know precisely where to focus their improvement efforts.

Third, they offer specific guidance and direction for making improvements. Along with knowing what to improve, learners need help in discerning how. They need to know what steps to take in order to make their product, performance, or demonstration better and more in line with established learning criteria.

Finally, comments should express confidence in the learner's ability to learn excellently and achieve at the highest level. Learners need to know their teachers believe in them, are on their side, see value in their work, and are confident they can achieve the specified learning goals.

An alternative is to apply grades. They are simply labels identifying different levels or categories of learner performance. When based on clearly articulated learning criteria, grades can provide valuable feedback by describing in shorthand, abbreviated fashion how well learners performed. To serve this important feedback purpose, however, grades must ensure that learners understand that they do not reflect *who* you are as a learner, but *where* you are in your learning journey—and *where is always temporary.* Knowing where learners are is essential to improvement. Informed judgments from teachers about the quality of learners' performance can also help learners become more thoughtful judges of their own work.

But alone, even accurate, task-involving grades don't lead to improved learner learning. Learners get no direction for improvement from a letter, number, word, phrase, or symbol attached to evidence of their learning. *Only* when grades are paired with individualized comments that offer guidance and direction for improvement do they enhance achievement and foster learning progress. Task-involving comments, however, provide learners with information about their performance on the learning task. They are related specifically to the performance of the individual learner and offer direction for improvement.

It is worth noting that the learners at Guri Kunna that were centrally involved in the piloting of RPL had the primary aim of preparing for the Norwegian NQ theory examination which was 5 hours long

and required them to formulate a response to a widely scoped salmon farming problem. Therefore, they were required to be able to function at a relatively high level within the Blooms hierarchy described above. As described more fully in the rest of this report, the Inverness College Aquaculture apprentices are subject to an entirely different assessment regime. These differences have had a fundamental influence on both RPL and the pedagogy applied in each case.

2. Curriculum mapping

The Scottish and Norwegian missions within their national VET systems are similar, despite significant differences in qualification structures, program delivery modes and assessment strategies. In both countries the learners were employed status with varying degrees of experience and seeking a National Qualification (NQ) in Aquaculture.

The Optimal pilots were entirely based on these work-based learners from industry, most of whom have had prior experience and learning in aquaculture, albeit informal in many cases. In Norway NQ delivery to experienced learners employed by industry was based on 18 sessions of college attendance of approximately 3.5 hours per session.

In Scotland the delivery of the Aquaculture Modern Apprenticeship (MA) is entirely work based and customised to suit the farm where the learner is employed and the learner's needs. The emphasis is on individualised learning and assessment and the development of 'portfolios of assessment evidence' by the learner, supported by their farm supervisor (employer) and tutor. (Note: The national VET systems in Norway and Scotland are more comprehensively described in Appendices 2 and 3 of the Output 3 report).

2.1 Norwegian and Scottish Aquaculture VET overview and comparison

The main similarities and differences between the two NQ systems in Norway and Scotland are summarised in the table below. Although this comparison is based on the Guri Kunna VET School experience, the recent Sector Skills Alliance BlueEDU research indicates that a similar approach is taken in the other 13 Aquaculture VET schools in Norway's coastal zone.

Different approaches to the Recognition of Prior Learning (RPL) and the Accreditation of Prior Learning (APL) in Scotland and Norway within the Optimal project, are strongly influenced by **key differences highlighted in blue font**.

Aquaculture VET Characteristics	Norway	Scotland
Established National Qualification (NQ) in Aquaculture	Yes, "fagbrev i akvakltur", awarded by the Ministry of education	Yes, the Modern Apprenticeship (MA) in Aquaculture, awarded by the Scottish Qualifications Authority (SQA)
EQF levelled Aquaculture NQ	Yes, NQ set at EQF level 5 for the operatives. (In reality, the analysis of the Norwegian NQ (see 1.2 revealed a wide range of levels)	Yes, several levels for MA from Operative, supervisory and Managerial (EQF 3-6)
NQ containing National Standards set by industry	Yes, industry representatives develop the National Exam questions in the theoretical exam and industry representatives are directly involved to assess the practical exam for young learners and mature learners.	Yes, developed by Lantra Sector Skills Council Aquaculture Committee – National Occupational Standards (NOS) and incorporated in MA Learning Outcomes

Fixed syllabus NQ	Yes, all aspects of the syllabus must be taught and assessed for fresh-water hatchery and marine on-growing. The emphasis is on the salmon and trout farming relevant to Norwegian production.	No, there is a flexible core and options NQ structure, allowing for customisation, so as the MA can be achieved by any employee, whether working on a freshwater, marine, finfish or shellfish farm
Learning Outcomes (LO) based NQ	Yes, but broadly defined LOs that amount to a 3-page summary syllabus, presented in three sections and adjusted to the regional needs at local level by each VET school in close cooperation with the farming companies in this region.	Yes, very detailed LOs, with performance criteria and assessment evidence requirements prescribed to a fine degree of detail and nationally standardised by the SQA QA system
Continuous assessment	Yes, there is a lot of continuous assessment for young learners from school, but **not** for mature learners from industry with 5 years-experience.	Yes, for all learners based on portfolio of evidence to meet set standards. There is 100% reliance on continuous assessment of performance and underpinning knowledge.
Final examination	Yes, there is a final theory and practical exam for both young learners and mature learners. They receive their NQ after passing both. They evidence their practical competence in the 2 day long practical exam.	No, although the MA system does not prohibit the inclusion of a final examination within an assessment strategy. This option is not applied by providers currently who rely on 'portfolios of assessment evidence'.
Work based learning delivery system	It is integrated into the training practices. Young learners access farms local to their college several days a week as well as in longer periods during a period of 2 years, for training and a lot of their learning occurs in a real place of work under supervision. The **mature learners learn from their employment** experience.	Yes, a total reliance on work-based learning and assessment on the job whilst in employment under contract and often supported by instruction within company training schemes.
Work based assessment of performance	Yes, for young learners, through continuous assessment and the apprenticeship system, but not for mature learners who are deemed competent following 5-years-experience.	Yes, with a strong reliance on formal 'witness testimony' processes on farm under the direction of a qualified assessor very familiar with the MA standards. The evidence is held in a carefully managed portfolio.
College classroom-based delivery	Yes, with a **lot of group work** as the norm for both the young and	No class-room attendance for any learners and remote group learning

	mature learners in classroom, laboratory settings and out at the cages.	activity is not currently facilitated.
Individual Learning Plans	Generally, no, although there is some customisation of assessment approaches encouraged to accommodate the individual needs of young learners. This does not apply to the mature learners.	The MA is based on a system of **individualised learning** and assessment planning, according to learner progress, farm needs and training opportunities.
Application of on-line learning and learning technologies	The young learners apply VLEs in all their courses, including aquaculture. There is limited usage of on-line learning applications for the mature learners. What dominates are reliance on class-room based delivery in combination with frequent practice at the farms, for the theory-based learning.	Some reliance on on-line learning by some VET providers, but most rely on informal learning and employer instruction, as the portfolio assessment process reflects farm practices.

Table 1: Summary comparison of Aquaculture VET systems in Norway and Scotland (UK)

The Norwegian NQ in Aquaculture is delivered by the public sector, but with vitally important assistance from local fish farming companies which provides the VET schools access to commercial farm sites, technology and training opportunities daily. Regular communication between farms and their local VET Schools has led to a strong working partnership and industry confidence in the public sector NQ provision.

In Scotland, public sector VET providers (generally colleges) can apply for a contract from Skills Development Scotland (SDS) to deliver the MA in Aquaculture, as well as private sector training providers, within a competitive marketplace. To secure a contract it is necessary to demonstrate a demand from fish farming companies wishing to undertake the providers programme.

During the first year of the Optimal project Polaris Learning Ltd a private sector company and training provider were planning to recruit for the Aquaculture MA as they had been led to believe that they had a demand from two large salmon farming companies. The demand for Aquaculture MA places never materialised, and they left the Optimal project to continue their focus on fish processing qualifications a major part of their core business. Subsequently Pisces Learning Innovations Ltd (PLI) were able to secure Inverness College as an Associated Partner following a change of Departmental Head, having previously declined to join as core partner during the planning stages. This enabled some meaningful piloting of RPL and APL during the third of Optimal (see Output 8 report).

2.2 Norwegian Aquaculture National Qualification ("fagbrev")

The Norwegian programme area for Aquaculture consists of three programme subjects. The programme subjects complement each other and should be viewed in relation to one another.

The Aquaculture curriculum contains a series of 'goals' defined in broad terms and interpreted by teaching staff in each of the 14 VET schools in consultation with industry. This enables each school to place the correct emphasis within the delivery of the curriculum and specific learning outcomes to suit their local employers at a yearly basis. All component parts of the curriculum are compulsory and subject to final examination, including a theory and practical for all learners (young and experienced).

2.2.1 The structure of Norwegian aquaculture VET

Basic skills are integrated into the competence aims for this course in areas where they contribute to the development of and are part of the subject competence. In Aquaculture, basic skills are understood as follows:

- *Being able to express oneself orally* in Aquaculture involves communicating with others to achieve safe and effective processes. It means explaining, substantiating and participating in discussions about various proposals and solutions. In addition, it means explaining and describing processes and products for customers, the authorities and others.
- *Being able to express oneself in writing* in Aquaculture involves reporting and documenting production, as well as presenting processes and products. It means participating in digital communication and information exchange.
- *Being able to read* in Aquaculture involves using operating manuals and HSE data sheets, reading and understanding regulations and keeping oneself updated about the industry through specialist press and other media.
- *Numeracy* in Aquaculture involves using numbers in calculation to find volumes, areas, biomass, growth-rate and density. It also means being able to understand budgets and accounts. It involves taking simple measurements of physical and chemical parameters, setting up and interpreting tables, diagrams and basic statistics.
- *Digital literacy* in Aquaculture involves producing and presenting calculations and processed information digitally. It involves using specialised instruments for measuring, monitoring and controlling processes and production such as feeding, water temperature, salinity, pH, oxygen and light. In addition, it means using digital tools to plan production and register growth, mortality and feed factor. The use of digital maps is also included.

In addition to the basic skills above, which could be described as transferable or transversal, there are the following competence aims organised within three programme areas; Operation and production, Construction and technology and Aquaculture and the environment.

A. Operation and production (17 sub goals)

The aims of the training are to enable the apprentice to:

- carry out work at a fish farm in line with current regulations and ethical guidelines
- register feed amounts, mortality, average weight, density and environmental parameters
- calculate feed amounts and feed farmed organisms
- explain the importance of optimal feeding

- observe organisms and environments and evaluate changes in relation to the species' normal appearance and behaviour
- plan, implement, evaluate and document the cleaning and maintenance of boats, engines and equipment in the aquaculture industry
- carry out sorting, weighing and transport of farmed organisms
- assess risk in work operations and implement measures to reduce the risk of injury or damage to personnel, farmed organisms and equipment
- prepare routines for safeguarding the quality of processes and products in the fish farming industry
- carry out work at a fish farm in accordance with relevant environment, health and safety regulations
- plan, implement and evaluate a production schedule with numbers, growth rate, biomass, density, water and oxygen requirements and feed consumption
- elaborate on regulations that regulate the fish farming industry, and retrieve essential information related to the establishment of a new fish farm business in a specific area
- describe the organization of an aquaculture company, starting with type of organization and an organizational chart
- explain the difference between a budget and a financial statement for operation and investment in an aquaculture business, and highlight any disparities and the possible reasons for these disparities
- explain connections between input factors and finance in an aquaculture firm, with particular emphasis on the significance of their own work
- describe how the market for fish-farmed products has changed, and discuss possible future prospects
- give examples of the market's demand for quality and choice of fish-farmed products

B. ***Construction and technology (9 sub goals)***

The aims of the training are to enable the apprentice to

- describe the construction and function of facilities for egg, brood, table fish, algae and shellfish production
- use the correct tools and equipment based on the situation, the equipment's construction and mode of operation
- clean, inspect and maintain a facility and equipment based on the materials' properties and application
- choose ropes and chains according to purpose and connect them together using appropriate methods
- operate modern fish-farm boats in line with relevant regulations
- use digital tools in production control, environmental monitoring and documentation
- use a truck in accordance with relevant regulations
- carry out stropping, hooking, rigging and signalling in accordance with relevant regulations with the use of a quayside crane or boat derrick

- use modern radio communication equipment and follow emergency procedures

C. Aquaculture and the environment (10 sub goals)

The aims of the training are to enable the apprentice to

- plan, implement, document and evaluate optimal operations based on the biology of the farmed species
- describe chemical and physical properties in water and elaborate on the most important environmental factors in the aquatic environment
- carry out routine measurements of relevant environmental parameters and assess the results based on the species' environmental requirements and tolerance limits
- carry out work in line with relevant regulations for preventive health work, animal welfare and hygiene
- identify environmental problems linked to aquaculture and discuss how they can be prevented locally and globally
- propose damage limitation measures for an incident at a fish farm
- recognise normal behaviour and appearance in fish farm organisms and elaborate on common diseases and parasites
- handle and use chemicals correctly in accordance with information in an EHS data sheet
- elaborate on breeding targets for actual fish-farm organisms
- discuss how an aquaculture business can be run in co-existence with other commercial interests, preservation and leisure activities

2.2.1 Mapping learning outcomes within the Norwegian Aquaculture NQ

The Norwegian NQ (Journeyman Certificate) was examined during a working party in the second year attended by Guri Kunna lecturers and PLI staff to analyse its structure and content. The aim was to develop a common understanding of the learning outcomes within each of the stated goals, which were then documented.

See Appendix 1 – Aquaculture Journeyman Certificate Learning Outcomes

This allowed multiple-choice questions to be devised by PLI in Scotland subsequently, to support classroom based RPL in Norway, based on a more detailed set of Learning Outcome definitions.

2.3 Mapping the Scottish Aquaculture Modern Apprenticeship (MA)

The work based Scottish Aquaculture Modern Apprenticeship is available at three academic levels:

- Level 2 Operative — SCQF 5 and EQF 4
- Level 3 Supervisory Management — SCQF 6/7 and EQF 5
- Level 4 Management — SCQF 8/9 and EQF 7

At each level the Award structure includes mandatory and optional Units allowing a large choice to ensure any employee on any finfish or shellfish farm can achieve it.

During year 1 of the Optimal project, a coherent set of the Level 2 Units of Scottish Aquaculture MA typifying the requirements of a typical cage farming husbandry operative were analysed in order to identify opportunities for the recognition of prior learning.

See Appendix 2 Aquaculture MA Level 2 knowledge for the results of the full analysis for each of the MA Units currently being delivered.

2.3.1 Conclusions from the analysis of MA knowledge requirements

As a general observation, although the knowledge statements are specific, they are written in generic terms that are applicable to both finfish and shellfish sectors.

There was noticeable potential to rationalise the assessment of the MA as the knowledge statements in the various Units overlapped (21%). This had some implications to RPL/APL as it was possible to gather some evidence of prior knowledge that applied to the NQ requirements in 2 or more Units in some instances.

In addition, it was noted that by design, a significant minority (<10%) of the knowledge requirements were farm/company specific or had a 'farm specific dimension' to them, as illustrated by the following examples of knowledge requirements prescribed in the MA Units:

a) *site procedures for maintaining effective hygiene and biosecurity*
b) *how to deal with factors that can disrupt the gathering process within the limits of your own authority.*
c) *how hazards and risks relevant to the work site are documented*
d) *health and safety legislation and organisational policies and procedures*
e) *the relevant health and safety requirements associated with the preparation of holding units*
f) *the importance of disposing of waste according to site waste management procedures*
g) *the equipment, methods and expertise used to maintain and repair aquaculture facilities*
h) *site procedures for the disposal of chemicals and treatments*
i) *the legal and site requirements for maintaining records of treatments*
j) *site procedures for maintaining effective hygiene and biosecurity*

The above farm specific requirements imply that learners must demonstrate their knowledge of the operational protocols in place on the farm they are exposed to and must comply with, making the company Standard Operating Procedures (SOPs) particularly influential within training and assessment. The SOPs are central to assessing practical competence. Although the assessment of practical competences fell outside of the Optimal scope for RPL/APL by design, it is a subject of great interest to Scottish Aquaculture VET providers as they make moves towards a 'smarter' and more automated digitally driven training.

However, most MA Unit knowledge requirements (> 90%) are not site or company specific and it was concluded RPL/APL approaches could be applied. These are exemplified by the following abstracts:

a) *how to maintain the health and welfare of fish/shellfish during the stocking process*
b) *causes of fish/shellfish loss during stocking activities and how this can affect the environment*
c) *how legal requirements control the movement and receipt of fish/shellfish*
d) *the advantages and disadvantages of different grading methods*
e) *legal requirements that control the dispatch of fish*

f) *how and why fish are conditioned in preparation for harvest*
g) *how feeding rates are calculated*
h) *the component of foodstuffs and their role in the development of fish*
i) *how food conversion rates are calculated for fish stock, the factors that affect it and its importance to the production process*
j) *the financial significance of feed costs in the production of farmed fish*
k) *why it is important to maintain environmental conditions within holding units and how changes in environmental conditions can affect fish/shellfish*

Following the MA analysis, it was concluded that some of the knowledge statements are short, specific and unambiguous, whereas others are longer, broader in scope and far more open to interpretations by different teachers/assessors. This may be an issue within the Scottish MA system that has not been recognised by VET providers or the Scottish Qualifications Authority.

For example, from the above list, knowledge statements (g) on how feed-rates are calculated, is clear and unambiguous and could be demonstrated by a learner within a single sentence as a response to a direct question. Whereas knowledge statement (h) encompasses the entire subject of fish nutrition, leaving the 'real work' of subject definition (comprehensiveness of content, depth and level of knowledge) to the VET teaching team and assessors. Likewise, knowledge requirements for (k) addressing environmental requirements are wide ranging and in the absence of any range statement, open to different interpretations.

Although the Scottish VET system is unitised, prescriptive and generally believed to be well-regulated, some Units and knowledge statements appear to require some attention during the next MA Aquaculture revision to ensure the embedded National Occupational Standards (NOS) can be applied consistently by different Scottish providers. This is an important SQA tenet, as poorly written Unit knowledge statements can often lead to standardisation problems to the detriment of learners and the industry.

Ultimately, the 'variable quality' of the current MA knowledge statements had some influence on the Optimal development, pilot and evaluation results. (See Output 8 report)

2.4 Conclusions from the mapping of NQ learning outcomes

Despite the differences in the presentation of the Aquaculture curriculum in Norway and Scotland and the radically different NQ assessment strategies applied, on examination there was a lot of common ground within the curriculum detail and subject teaching. The main variances were due to the different legal regulatory environments governing aquaculture which the companies in each country had to comply with. However, the principles driving many of the regulations were common to both countries. This was encouraging, as it indicated that collaboration between Scotland and Norway may be easier than it seemed on first viewing the NQ descriptions, which follow different formats to suit each country's VET system/regulations.

3. Development of RPL and APL approaches

The similarities and differences in the Aquaculture VET systems in Norway and Scotland summarised above in section 2.1 and described in more depth from a VET systems and regulatory perspective in the Outcome 3 report provided the context within which the Optimal project had to be established. As indicated above, some of the differences at the regulatory level determine or strongly influence how VET is delivered and inevitably 'shape' the approach taken to RPL/APL development within each country.

3.1 RPL and APL definitions

There are several definitions of RPL in use within Europe, each with a different meaning or emphasis that required recognition, clarification and differentiation at the outset so as each VET partner could consider their approach within a wider European context:

(a) Recognition of existing qualifications

RPL is a term often used to signify the recognition of prior learning, 'evidenced' through qualifications previously gained by a learner, within their current NQ framework. With flexible programming, this can lead to a reduced and customised program for the individual learner based on recognition and transfer of their existing qualifications. This type of RPL requires cooperation between the respective Awarding Bodies and the application of common frameworks, such as the EQF (European Qualifications Framework) can facilitate recognition and transfer, in the learner's best interests.

(b) Recognition of prior learning (formative assessment)

Prior learning can be recognised through various 'formative assessment' processes, in order to provide the learner guidance regarding any gaps in their knowledge and understanding. This allows them to target their studies, thereby improving their focus and the time efficiency of their studying as they prepare for summative (final) assessment within their NQ.

Depending on the mechanism applied, the same information can inform teachers and assist them in the planning and management of their teaching and learner support at the class level. This concept has been applied and developed by Guri Kunna within the Optimal pilot.

(c) Accreditation of prior learning (APL)

It is possible for the evidence of learning recognised through any legitimate assessment process, to be gathered and presented as 'evidence of assessment' that satisfies the standards prescribed by in the NQ by the Awarding Body. Robust mechanisms for 'assessment evidence gathering' must be developed and implemented for this purpose.

This allows the more experienced learners to;

- 'fast track' assessments, and
- identify gaps in their knowledge and understanding to inform the development of individual learning and assessment plans.

The Recognition of Prior Learning (RPL) and the Accreditation of Prior Learning (APL) are easy to confuse, and although RPL can by design lead to APL, this is a choice and not a necessity, within any NQ assessment strategy.

3.2 The philosophy and purpose of Aquaculture VET

The philosophy and purpose of Aquaculture VET in each country influenced both the expectations and receptiveness of teachers and learner the start of the Optimal journey. A VET curriculum needs to balance the development of practical skills with theoretical understanding, in order to prepare learners for the assessments they need to satisfy to gain their NQ. Typically, within European VET, at the operative level (EQF3/4) there is a greater emphasis within programmes on practical skills development, supported by underpinning knowledge and understanding. Both are assessed according to the requirements of the national VET Awarding Body, responsible for regulating the sector. These principles are common to both VET systems in Norway and Scotland, however, the application of RPL/APL must comply with the specific VET regulations in each country. This can be particularly challenging for APL, as the process must satisfy the same QA requirements as any other form of assessment, as whenever evidence is being presented for accreditation towards NQ achievement it must comply with the Awarding Body regulations.

3.2.1 Norway

In Norway, aquaculture is a technologically advanced and export-oriented industry based on fish production to satisfy a growing demand for quality assured sea-food products. The curriculum content is devised to develop an understanding of the market, as well as production processes and provide an insight into the industry's role in society and as an international food producer. The curriculum also lays the foundation for professional competence contributing to the industry's continued growth and development, including governance and administration.

Teaching is organized so as the individual develops their knowledge and skills in the day-to-day operation of different types of aquaculture facilities, based on an understanding of environmental requirements of the fish and the conditions under which aquaculture operates. In addition, teaching helps to develop an understanding of the relationship between fish production techniques, nature's tolerance limits and human activity. From an ecological, sustainable and ethical perspective, teaching helps to develop the ability to cooperate and to think reflectively, creatively and in an interdisciplinary manner, an ability that is fundamental to being able to pass the Norwegian national theory examination.

Programme delivery embraces the full breadth of the Norwegian aquaculture industry in terms of farmed species, types of installations and modes of operation. Learners develop an understanding of the industry through cooperation with local business, helping them to relate theory to practice. The curriculum also provides the basis for progression via the aquaculture apprenticeship pathway, or general studies in agriculture, fishing and forestry.

As a result of the nature of the Norwegian VET assessment process and regulation, most notably the high dependence on the final examination of practical skills and a 5-hour theory exam (for all learners), there is no opportunity for APL within the current system.

The curriculum content is more fully described in section 2.2.

3.1.2 Scotland

Although producing fish on a smaller scale (<20% of Norwegian annual output) unsurprisingly, as many companies are Norwegian owned, salmon farming methods and technology in Scotland are very similar to Norway. However, the current industry expectation of its public sector VET providers is markedly different. Currently, there are no VET providers in Scotland providing college-based full-time long duration (1-2 years) VET courses as was once the case until the early part of this century. Most newcomers to the industry (including todays HR managers) have no experience of this legacy that pre-dates their aquaculture career. The former full-time college attendance-based VET provision has been divested and replaced by a growing and buoyant work-based Aquaculture Modern Apprenticeship (MA) as the only available NQ. Whilst companies encourage their recruits who lack an NQ to embark on the MA, they do not insist on it or incentivise it with salary increases on successful completion, as is the case in Norway. However, they do insist on the completion of their own company staff development scheme. Considering that the MA is very 'farm specific' in nature (as described in section 2.3), a lot of common ground exists between the various company schemes and the MA requirement. Some companies are starting to realise that the support of a cooperative and well-motivated VET provider and the assistance of appropriate learning technologies, the two could be partially or fully converged in the future.

In addition, there is a growing interest from some VET providers in the reinstatement of a more broadly based and less farm specific full time VET on the Scottish mainland. The site for a new training facility in the highlands and islands region, the heart of the aquaculture industry has been selected and the funding raised for its construction. As a result of this recent stimulus, the range and availability of college-based Aquaculture NQ pathways, once thriving at the end of last century, may be poised to make a return, but in a more accessible and flexible format, with delivery supported by appropriate learning technologies. The output and lessons learnt from Optimal and any successor projects will be very informative when approaches to curriculum delivery are considered.

However, despite the limitations above and short-term weaknesses in the MA described in section 2.3, the Scottish Qualifications Authority (SQA) and MA provide a strong work-based qualification system that is very compatible with RPL and APL adoption. Currently, informal RPL processes are the norm and 'Individualised learning' is at the centre, driving the development and assessment of competence and underpinning knowledge.

The question that Optimal will help Scotland to answer is "whether the introduction of appropriate learning technologies, such as response systems, could make the RPL/APL process more effective, efficient and motivational for both the learners and teachers"?

3.3 RPL/APL considerations

For reasons provided below, Norway elected to develop and pilot the application of RPL within classroom-based group learning, whereas Scotland developed RPL and APL to support individualised work-based learning and assessment fast tracking. Both VET providers were working with learners of a similar profile and most had significant work experience.

3.3.1 Norway – Groups of learners

Within Europe to date, RPL has typically been used to establish and support an individual learners' learning needs within a specific subject. However, RPL may also be applied to strengthen group learning, by integrating and applying group and peer learning activities, based on the groups prior

learning. The use of RPL within group learning situation has been developed by Guri Kunna during the Optimal project. At the outset the teachers (early adopters) were helped to recognise some of the fundamental principles before getting familiar and confident with the technology itself.

When the process was initiated with the Guri Kunna staff they considered their needs as teachers' leading learning activities, as follows:

(a) What would the teacher like to know about the individual learners' general level of knowledge and skills as a group, thus giving direct input to how the course plan is organized and structured before the course starts?

- How many learners have relevant work-based experience?
- In which areas do they have work-based experience?
- How many learners have little or no relevant work-based experience?
- In which areas do they lack work-based experience?

(b) What would the teacher like to know about the learners' level of knowledge and skills as a group in relation to each section or module in the course plan, thus informing the coming lessons, training and learning activities?

- How many learners claim they have work-based experience relevant to a specific subject area?
- How many learners can provide a correct reply to aquaculture (control) questions that validate that the experience revealed above for the specific subject area has led to learning?

(c) How will the teacher monitor that the learning and training activities raise the learners' knowledge of each subject or module in the course plan to a higher level?

- How could the learners know that they have understood all the key points in the aquaculture curriculum?
- How could the learners know what is needed in order to pass the exam?

3.3.2 Scotland

In Scotland RPL and APL are both appropriate and compatible with the ethos of the assessment process applied to work based Modern Apprenticeships. Notwithstanding the concerns raised regarding MA standards in section 2.3 above, the Scottish MA system is entirely focussed on the assessment of prescribed learning outcomes. The learning and teaching process and course content is entirely up to providers to determine through consultation with the learners employer. A high level of customisation to suit individual learners and their farms is the norm. As the nature of teaching and learning is not prescribed, learning individualisation is supported from the outset. There-fore, once the necessary technology and resources are established, RPL and APL can be readily accommodated within the Scottish work-based delivery system, offering learners, employers and VET providers great potential for the enhancement of programme delivery and efficiency gains.

The main initial considerations by the Inverness College teachers in Scotland was how RPL/APL could be piloted with the consent and full cooperation of learners, so as it enhanced and in no way disrupted their learning experience. This was undertaken though careful demonstration and negotiation by the MA programme leader (tutor), to gain their consent and cooperation at each

stage. They elected to keep their existing paper portfolio based assessment process operational and to parallel this with the RPL/APL activities supported by response technology (RT).

3.3.3 Summary of influences

The approaches and resources developed (and described below) to support RPL at the Guri-Kunna Upper Secondary School in mid Norway, and RPL and APL at Inverness College in Scotland have been influenced by;

a) the national VET system and regulatory environment in Norway and Scotland,
b) the outputs of NQ mapping in Scotland and Norway and identification of 'common learning outcomes',
c) the current approach to delivery and the learning technologies in use and supported at each institution.

3.4 The evolution of RPL/APL methodology

Whilst RPL was applied in different ways in Norway and Scotland for good reason within Optimal, as a result of NQ mapping, it was possible for resources to be shared between partners, namely; multiple choice questions for common learning outcomes and also learning objects, such as the 'interactive fish', a tool devised to support fish anatomy self-study in preparation for practical laboratory classes.

3.4.1 Guri-Kunna in Norway

The most significant influence on their RPL application was the need to cater for classroom-based mature learners with varying degrees of previous experience. The target was to prepare them for their '5 hour invigilated theory exam' requiring them to address a planning task or problem within a given fish-faming scenario, by applying and integrating aquaculture knowledge gained from their course, private studies and work experience.

There-fore, the main aim of RPL was to be able to gauge the knowledge and understanding of the group and individuals, prior to the start of each new subject, allowing the teachers to adapt their teaching plans and emphasise those subjects and concepts needing most attention. In addition, the response technology (RT) was used during class in a live and dynamic way to encourage individual contributions to a problem or challenge question posed by the teacher. This allowed the group's knowledge to be pooled and discussed, expanding the knowledge of the least experienced individuals as they learnt from their peers. Using the 'ideas cloud' functionality within One2Act, this form of group 'brainstorming' could be integrated with other small group discussion and teacher led activities, increasing engagement and peer learning to great effect.

3.4.2 Scottish RPL/APL methodology

In Scotland, the most significant early influence on RPL was the need to gather 'evidence of underpinning knowledge' as prescribed in the MA (derived from the NOs), to support the learning process and create a 'fast track' towards accreditation via APL pathways for the most experienced learners.

Scottish Vocational Qualifications are designed to provide the opportunity for the 'customisation of programmes' to meet the needs of individual learners and their employers'. Typically, this is undertaken at the start of a programme through consultation between the learner, their employer and VET provider, with their prior learning evaluated, albeit informally, in some cases.

The Recognition of Prior Learning (RPL) is the formal term used to describe the process for identifying, reviewing, and acknowledging a learners' existing knowledge and understanding, gained through previous formal, non-formal and informal learning (including work experience). Subsequently, supported by appropriate learning technology, it is possible to gather and present documented evidence of prior learning for validation by an assessor and accreditation. Subject to satisfying quality assurance, this evidence can then contribute towards NQ achievement, a process commonly known as the Accreditation of Prior Learning (APL), providing in effect a fast track to assessment for the more experienced and knowledgeable.

Following the RPL stage, a better-informed individual learning plan can be formulated between the learner and their tutor to tackle the knowledge gaps. The planning process often involves the learners farm supervisor, so as they can advise regarding opportunities for skills development and learning, which can be mapped into the learning and assessment plan and complimented by the appropriate study. Consequently, synergy between farm-based skills development and learning can be generated, rather than left to chance in the absence of regular planning and progress review. At Inverness College in Scotland, several visits are made to learners each year by the MA programme tutor for this purpose.

As well as supporting 'accreditation' a comprehensive RPL system has the potential to enhance the effectiveness of learning, through regular formative assessment and immediate feedback. However, this was less of a feature within the Scottish Optimal pilot, due to technological restrictions and the limited time within which to pilot a viable RPL/APL process. This has been been taken into consideration within future recommendations. (See Output 9 report)

3.5 Response tool selection

Whilst the multitude of response technologies available are broadly similar in their functionality, the technology choices made within Optimal were inevitably shaped by what was readily available and more importantly, what could be supported (technically and pedagogically) during the development and piloting phase, to ensure teachers and learners enrolled and grew in confidence in their use of RT within RPL/APL

3.5.1 Norway SRS, iLike and Eval

One2act is the online response system used by Guri Kunna throughout the Optimal project. It uses commonly available mobile devices for collecting answers to questions. The system is based on a client-server architecture. The services are hosted on a server infrastructure and they are consumed by teachers and learners through specialized clients which communicate with the services using standard world wide web communication protocols (the services provide REST interface to the clients). The clients are tailored to specific learner or teacher use. The one2act system is designed to leverage existing infrastructure in order to allow gathering instant feedback from the classroom.

The tools are designed to help the teacher to moderate the lecture. They are designed to run on a desktop or laptop, which is usually connected to a large interactive screen or a plain projector. New sessions can be created which can be joined by the learners in order to participate and respond to the questions posed by the teacher. To run the system, one needs a desktop or laptop computer.

There are several tools in the one2act system, and their functionality is as follows:

- SRS - allows running multiple choice questions one at a time and it is designed to quickly gather feedback from a classroom during the lecture. The data entry is minimal, and the system can cater for running ad-hoc questions.
- PeLe - supports assessments comprised of many questions which can be prepared in advance. The question text can be added if desired.
- iLike - supports similar flow to SRS but it has a facility for language learning and a much larger set of question types.
- Eval - supports small surveys and evaluations - which can be prepared in advance. Multiple choice questions, rating questions and text questions can all be accommodated.

The full functionality and technical details of the One2Act system are described in Appendix 3.

3.5.2 Scotland

During the first year of the project PLI were teamed up with Polaris Learning Ltd., a private training provider and Optimal partner, with the aim of supporting the development of Aquaculture resources for their Moodle Virtual Learning Environment (VLE) to support RPL and APL with their work-based learners. Due to an unforeseen recruitment failure in year 2, this ambition could not be realised and the preparations for adopting the Moodle VEL as the technology of choice for Optimal had to be abandoned.

Therefore, during year 2 PLI teamed up with Guri Kunna to develop multiple choice questions and interactive learning resources to support RPL within their classroom-based delivery, deploying the One2Act technology outlined in 3.4.1 above and in more technical detail in Appendix 3.

The analysis of the Aquaculture MA knowledge requirement undertaken for Polaris Learning (see Appendix 2) was of value, once Inverness College joined the partnership in the third year. This enabled a large bank of multiple-choice questions developed for Guri Kunna to be mapped to the MA knowledge requirements and allowed a relatively smooth transition to RPL/APL development and piloting by Inverness College with their current MA cohorts. (See Output 8 report). As they had no immediate plans for VLE adoption to support the delivery of their MA and their head of learning was promoting Socrative RT to the teaching staff, it was reviewed along side other RT options and ultimately adopted for the duration of the third year of the project.

The Technical Details on Socrative and the development of good multiple-choice questions are provided in Output 7, which addresses staff development aspects.

4. Initial lessons learned

During the early developmental stages some useful initial lessons that could be of benefit to other VET providers entering the field and were applicable to the VET partners in Norway and Scotland.

(a) Definitions of RPL/APL

Many discussions were held with a variety of VET providers, educational experts and other stakeholders regarding the 'recognition of prior learning' (RPL) and the 'accreditation of prior learning' (APL) to understand the definition of each and how they could be differentiated in theoretical and practical terms. (see 3.1). This was followed by full consideration of how both RPL and APL may be applied and supported within each national VET system. It was concluded that the nature of the SQA work-based MA, with its emphasis on individual learning and assessment plans, was very compatible with RPL and APL within Scotland. Whereas in Norway APL was an impossibility, bit RPL a useful devise for making improvements to the effectiveness and efficiency of classroom-based group learning.

(b) National Qualification (NQ analysis)

The analysis of the Norwegian Aquaculture NQ -"fagbrev i akvakltur", was invaluable and quickly established the common ground that existed between the aquaculture curriculum in the tow countries, opening the door to collaborative sharing of resources in the short and longer term (post project completion)

Although the MA Aquaculture knowledge analysis conducted in the first year, was not applied to the development of the Polaris Learning Ltd Moodle VLE, it ultimately informed the selection of multiple-choice questions and development of 'Learning Episodes' for Inverness College to pilot during the third year. (See Output 8 report)

(c) Response Technology

Blue Competence Center staff had a great expertise in the application of response technology within teaching and learning and parallel to their work in Norway with Guri Kunna teachers, they were able to demonstrate the functionality and application of RT to the other Optimal partners, helping to accelerate their development. The thorough understanding of Response Technology (RT) gained assisted the analysis of alternative RT systems by the Scottish partners, ultimately leading to the selection of Socrative. The functionality, which is limited in comparison to the Norwegian One2Act system, was ultimately proven adequate (but not ideal) for supporting RPL and APL methodology within MA delivery. (See Output 8 report)

(d) Partner selection

The partners concluded that great caution should be exercised when selecting private training organisations for Erasmus + VET innovation projects in Scotland. Despite the recent growth in Scottish Aquaculture MA recruitment by the main public sector college provider, the planned recruitment of Aquaculture MA trainees by Polaris Learning Ltd proved to be speculative and ultimately led to the departure. This could have considerably narrowed the scope of the project and devalued it. However, this was avoided through the recruitment of the main provider of Aquaculture

MAs on the Scottish mainland which led to the opportunity to pilot RPL and APL within work-based delivery systems, complimenting the classroom-based work undertaken by Norway and ultimately enriching the project.

4.1 Norway

Optimal was implemented in Norway by a team of Guri-Kunna staff who were involved in the project throughout its three year plus duration. This provided a lot of opportunity for their personal development as teachers, and the development, application and refinement of classroom based RPL approaches, culminating in an improvement in National Theory Exam results, whereby 100% of learners who entered in 2019 passed. The mean score at the theoretical exam increased from 3.2 (learners during the period 2016-18) to 3.5 (with 50 learners in 2019) on a scale from 1 to 6.

The staff were developed systematically and heavily supported throughout, both with the operation of the RT and its application to classroom pedagogy. They were encouraged to experiment and as time progressed more teachers from within and out with the Guri Kunna aquaculture department started to take an interest in RPL delivered through RT as a 'me too' mentally was catalysed. The development process is described in the Output 7 report.

4.2 Scotland

In Scotland the Optimal project had some major challenges to overcome during the first two years. The deployment of a Moodle VLE to the of RPL/APL within the Aquaculture MA looked promising when plans were formulated during the first year with Polaris Learning Ltd. Following their departure in the second year of the project as a result of a recruitment failure, PLI supported RPL at Guri Kunna, by developing resources, namely multiple-choice questions and the 'interactive fish' presented on Power Point.

In the third year PLI recruited Inverness College in Scotland as an Associated Partner allowing RPL and APL to be piloted during a 9-month period, following the establishment of agreements between the parties. Despite a very restricted timescale, an intensive period of valuable staff and resource development and piloting occurred. Many lessons were learnt, shared and discussed within Scotland with stakeholders, as interest grew. During the Multiplier event in the third year, Scottish stakeholders (VET providers and industry) agreed a way forward regarding the development of Aquaculture MA delivery in the future (see Output 8 and9 reports).

APPENDIX 1: Aquaculture Journeyman Certificate Learning Outcomes

Program area:	**Program area description**	**Competence aims:** The aims of the training are to enable the apprentice to	**Specific topics for (concrete) questions**
Section1: Operation and production (17 goals)	The programme subject covers work processes and vocational practice related to the operation and maintenance of an aquaculture facility. It involves hygiene, health, environment and safety, equipment selection, economics and the farmed organisms' optimal weight and welfare. The programme subject deals with the use of freshwater and seawater for growing fish, algae and animals in different stages of life, annual cycles and environments. It also deals with the quality assurance of work processes and products. Regulations and framework conditions that regulate the industry nationally and	1.1 carry out work at a fish farm in line with current **regulations** and ethical guidelines	Learners need to: • know which **regulations** apply to salmon production (FW & M) • understand the significance and purpose of each regulation Context: **Regulation** of an industry with the potential to cause harm and conflict with other vested interests, if not well managed.
		1.2 register feed amounts, mortality, average weight, density and environmental parameters	Learners need to: • know which daily routines are required on a farm • know how each activity within each routine is conducted • understand the purpose and importance of each routine • maintain routine records for **feed**, **mortality**, **average weight** and **environmental parameters** Context: Salmon and Trout M&FW
		1.3 calculate feed amounts and feed farmed organisms	Learners need to: • Conduct **feed calculations** on paper with a pocket calculator • Conduct **feed calculations** using a computer • **Feed** salmon (M&FW and by hand and via computers) • Know what **feeds** are used for each stage of the lifecycle for the most significant farmed species in Norway Context: Mainly feeding of Salmon M&FW, followed by Rainbow Trout, Lumpfish and Halibut
		1.4 explain the	Learners need to:

	internationally are included in this programme subject.	importance of **optimal feeding**	• Know what rations, FCRS and daily specific growth rates are • Under stand the compound nature of fish growth • Understand the concept of **optimal feeding** • Understand how observations of feeding behaviour are interpreted when feeding finfish to **optimise** feed intake Context: **Feeding** to fixed ration Vs feeding to satiation for Salmon and Rainbow trout, with reference to the influence of the feeding strategies and production plans
		1.5 observe **organisms** and **environments** and evaluate changes in relation to the species' **normal appearance** and **behaviour** **Links to 1.2 –** measurement of environmental parameters	Learners need to: • know which **environmental** parameters are measured in M&FW • understand why each **environmental** parameter is measured and how the data is interpreted and applied • recognise **normal appearance and behaviour** of aquatic organisms • understand how changes in the aquatic **environment** can impact on the **behaviour** of aquatic organisms, including farmed finfish Context: Behaviour of all aquatic organisms relevant to fish farming, including algae, zooplankton, epiphytes growing on cage surfaces and M&FW fish species (Salmon and Lumpfish)
		1.6 plan, implement, evaluate and document the cleaning and maintenance of boats, engines and equipment in the aquaculture industry	Learners need to: • Know where to find the information needed to support **cleaning** and **maintenance** activities on a farm • Document data on **cleaning and maintenance** using the farm maintenance recording systems and farm checklists. Context: Salmon and rainbow trout

		Links to 1.2 – farm routines	M&FW
		1.7 carry out sorting, weighing and transport of farmed organisms	Learners need to: • Know how to calculate biomass, stock density, • Know how to sample **weigh** fish stocks to determine average weights and the use of technology • The reasons for **sorting /grading** fish in the context of alternative production plans • Understand why stocks need to be sampled and monitored on a fish farm • Know how fish can be safely **transported** with minimal stress Context: Marine on-growing and FW hatchery phase
		1.8 assess risk in work operations and implement measures to reduce the risk of injury or damage to personnel, farmed organisms and equipment **Link to 1.1** H&S regulations	Learners need to: • Be aware of the hazards a fish farmer can face and where they will be encountered • Know what personal protective equipment they need to use in each hazardous work situation • Understand how to conduct and document a **risk** assessment • Understand how to undertake a 'job analysis' before each task in undertaken on the farm to ensure their safety and the safety of others Context: Marine on-growing and FW hatchery phase in relation to Norwegian regulations
		1.9 prepare routines for safeguarding the quality of processes and products in the fish farming industry	Learners need to: • Understand the principles of food safety • Know how farmed fish **quality** parameters are monitored and controlled, including carcass fat composition and pigmentation.

			• Understand the importance of complying with chemical withdrawal periods • Understand the importance of farm biosecurity • Know and comply with the biosecurity procedures on the farms that they are working on • Understand why traceability is important and how this is achieved on a fish farm • Understand the influence of 'Global Gap' on fish farming practices Context: Marine on-growing and FW hatchery phase
		1.10 carry out work at a fish farm in accordance with relevant environment, health and safety regulations **Link to 1.1** H&S and employment regulations and 1.8 above	Learners need to: • Be aware of all **regulations** that influence the working environment and management of farm operations • Understand how employment **regulations** influence farm operations • Know the company rules and **regulations** governing **safety** • Understand the link between national statute and regulation and company policy and procedure governing **health and safety** Context: Marine on-growing and FW hatchery phase
		1.11 plan, implement and evaluate a production schedule with numbers, growth rate, biomass, density, water and oxygen requirements and feed consumption	Learners need to: • Understand how to **plan production** taking account of the environmental and fish production parameters influencing fish growth • Conduct basic fish stock assessment calculations with and without a computer assistance • Use fish feeding tables to calculate feed rations • Know how to **evaluate** fish production and performance

			on a fish farm by monitoring population numbers, growth rates, biomass and stock density Context: Marine on-growing and FW hatchery phase
		1.12 elaborate on regulations that regulate the fish farming industry, and retrieve essential information related to the establishment of a new fish farm business in a specific area **Link to 1.1** Regulations governing farm development	Learners need to: • Understand the importance of fish containment and the impact escapees can have • Know how the 'Baremth Watch' monitor is used to monitor and **regulate** the industry • Know the principles within the "New Tech" laws that have been introduced to improve fish containment • Understand the 'route map' to a site licence, for a **new fish farm business,** including environmental analysis and biomass limits Context: Marine phase only
		1.13 describe the organization of an aquaculture company, starting with type of organization and an organizational chart	Learners need to: • Develop an awareness of the **organisational structure** of fish farming companies • Know which workers **organisations** represent fish farm workers • Be able to interpret an **organisational chart** Context: Marine or FW phase – illustrative examples
		1.14 explain the difference between a budget and a financial statement for operation and investment in an aquaculture business, and highlight any disparities and the	Learners need to: • Know some of the key **financial** concepts within budgets and accounts that determine financial viability, including profit and return on **investment** • Understand the link between farm production strategies, plans and **operations**

		possible reasons for these disparities	• Understand how farm-based monitoring of fish production can be used to interpret disparities between the **budget** and the accounts Context: Norwegian methods of financial accounting methodology
		1.15 explain connections between input factors and finance in an aquaculture firm, with particular emphasis on the significance of their own work **Link to 1.14**	Learners need to: • Know what the cost **inputs** to a fish farm are and their relative significance • Understand how their **day to day actions** and routines can impact on the financial health of the company • Understand the sensitivity of **business profitability** to fish growth, FCRs and mortalities Context: Marine and FW phase
		1.16 describe how the market for fish-farmed products has changed, and discuss possible future prospects	Learners need to: • Know where farmed fish are sold • Be able to use the internet to find and interpret fish sales statistics • Understand the influence of economic factors such as currency exchange rates on marketing and sales Context: Marine phase only for Norwegian farmed fish
		1.17 give examples of the market's demand for quality and choice of fish-farmed products **Link to 1.16** **Link to 1.9** Traceability	Learners need to: • Understand how the market requirement can impact on fish target weights, fish quality criteria and the timing of harvests • Know the price differentials due to pigmentation and fat composition of carcasses Context: Marine phase only for Norwegian farmed fish

Program area:	**Program area description**	**Competence aims:** The aims of the training are to enable the apprentice to	**Specific topics for (concrete) questions**
Section 2: Constructions and technology	The programme subject covers the construction, mode of operation and operation of facilities, tools and equipment. This includes the use and maintenance of equipment, tools, means of access, and instruments related to work at a fish farm. It also deals with knowledge of materials and the security and maintenance of facilities. It involves the use of trucks, cranes and limited radiotelephony.	2.1 describe the construction and function of facilities for egg, brood, table fish, algae and shellfish production	Learners need to: • Understand the principles of Recirculation Systems for aquaculture (RSA). Including each component and its function • Know how RSA are maintained with reference to the monitoring and control of water quality • Know the components of a salmonid hatchery including their design and function (egg to fry or smolt) • Understand the components of a 'pump ashore' system • Know how brood stock are held and maintained • Understand how different ova incubation systems work and their relative pros and cons. • Know what facilities are needed for algae production Context: Most emphasis is on the salmon FW phase within RSA. Algae production can be linked to the culture of live feeds for lumpfish
		2.2. use the correct tools and equipment based on the situation, the equipment's construction and mode of operation	Learners need to: • Understand the function of the equipment and tools needed for each fish farming facility and their operation • Know the main knots that are used on a fish farm • Use the correct tools for the job and according to the operator's instructions

			Context: Knowledge of M&FW salmon farming, including feeding equipment, lights, cameras, oxygenation, cage nets, moorings and hatchery systems. Practical application on local farms, mostly marine on growing.
		2.3 clean, inspect and maintain a facility and equipment based on the materials' properties and application	Learners need to: • Understand the importance of **routine maintenance** and hygiene on fish farms • Undertake routine **inspection** and maintenance operations • Undertake hatchery **cleaning** and disinfection routines Context: All equipment used within the M&FW salmon farming and according to the routines of the farm sites visited for practical purposes.
		2.4 choose ropes and chains according to purpose and connect them together using appropriate methods	Learners need to: • Understand how to **select** the appropriate ropes and chains for a cage farming system according to their purpose • Be able to source appropriate technical information on rope specifications to inform rope selection • Undertake routine **knot construction** for all commonly used knots Context: All commercially supplied ropes and chains for marine phase cage on-growing
		2.5 operate modern fish-farm boats in line with relevant regulations	Learners need to: • Understand the **regulations** that apply to the operation of all categories of vessels used at sea • Operate the radios required for

			communication at sea Context: Norwegian marine cage farms. This includes radio operation but not boat operation
		2.6 use digital tools in production control, environmental monitoring and documentation	Learners need to: • Know how to the operate **digitally enabled equipment** on a fish farm • Know how to sample the **aquatic environment**, including the water column and sediments Context: Norwegian marine cage farms, including, feed control systems, cameras, environmental monitoring, fish stock monitoring and record keeping systems. Environmental monitoring- sechi-disc and core sampling
		2.7 use a truck in accordance with relevant regulations	Not included in the course
		2.8 carry out stropping, hooking, rigging and signalling in accordance with relevant regulations with the use of a quayside crane or boat derrick	Learners need to: • Know how to how to select and attach **rigs** when using hydraulic lifting (cranes) • Know safe procedures for the use of cranes • Apply routine rigging and configuration for a range of loads Context: Norwegian marine cage farms quayside and boat
		2.9 use modern radio communication equipment and follow emergency procedures	Learners need to: • Know how to use VHF radio • Know how to use Restricted Operator (ROC) Learners need to: • Know how to how to select and attach **rigs** when using hydraulic lifting (cranes)

			Context: Only one operator per boat needs ROC, but all need to be proficient in VHF

Program area:	**Program area description**	**Competence aims:** The aims of the training are to enable the apprentice to	**Specific topics for (concrete) questions**
Section 3: Aquaculture and the environment (10 goals)	The programme subject covers actual farmed species and the surrounding environment. It also involves the measurement and evaluation of chemical and physical environmental parameters, the fish's health and practice hygiene work. Feed and feeding of farmed organisms and species-specific dietary requirements are central elements in the programme subject. It also deals with ecology and the mutual effect between the fish farming facility and the environment.	3.1 plan, implement, document and evaluate optimal operations based on the biology of the farmed species **Link** to many other competences – all encompassing statement	Learners need to: • Understand how the **biology** of the farmed species influences farm production technology and regimes Context: FW& M phases focussing on salmon but including rainbow trout and lumpfish
		3.2 describe chemical and physical properties in water and elaborate on the most important environmental factors in the aquatic environment	Learners need to: • Know which **physical and chemical** properties are relevant to fish farming and why • Understand how changes in key water parameters can impact on the **aquatic environment** and organisms • Understand how changes in **key water parameters** can influence the farm operation Context: M&FW environments
		3.3 carry out routine measurements of relevant environmental parameters and assess the results based on the species' environmental requirements and tolerance limits	Learners need to: • know which **environmental parameters** are measured on a farm and why? • know how selected **environmental parameters** are measured? • understand how **environmental** conditions

		Link to 3.1	can be controlled to optimise conditions Context: Salmon, lumpfish and rainbow trout, FW&M
		3.4 carry out work in line with relevant regulations for preventive health work, animal welfare and hygiene **Link** to 1.1 (Fish welfare regulations)	Learners need to: • Understand the need for disinfection within hatchery **hygiene** and biosecurity regimes • Understand fish health and welfare and the influence of national and European **animal welfare** regulations on husbandry practices Context: Fish farming industry response to animal welfare regulations
		3.5 identify environmental problems linked to aquaculture and discuss how they can be prevented locally and globally	Learners need to: • Understand the **impact** aquaculture can have on the **environment**, including water quality sediments and aquatic flora and fauna • Understand the **mitigating measures** fish farms can undertake to minimise environmental impact Context: Regulation and mitigation of the environmental impact of fish farming, locally and globally, including sea lice on wild stocks, escapees, solid and soluble wastes.
		3.6 propose damage limitation measures for an incident at a fish farm	Learners need to: • Understand the measures proposed within 'New Tech' to ensure secure fish containment. • Know how a farm should respond to when **fish loss incident** (escapes) are suspected. Context: Containment standards and regulations marine on-growing

		3.7 recognise normal behaviour and appearance in fish farm organisms and elaborate on common diseases and parasites	Learners need to: • Be able to recognise **normal** and abnormal fish behaviour indicative of disease • Know the common **pathogens and parasites** infecting farmed species • Understand the nature of common **fish diseases** and their control and management Context: Farmed fish species - salmon and lumpfish. Pathogens and parasites - Sea lice, Amoebic Gill disease, Pancreas Disease, CMS (Cardiopathy)
		3.8 handle and use chemicals correctly in accordance with information in an EHS data sheet	Learners need to: • know how to prevent common diseases and treat fish when necessary • Know how to interpret and follow **Environmental Health and Security** regulations • Know how to store, **handle and apply chemicals** to the treatment of fish diseases Context: FW&M fish diseases and chemical treatment regimes
		3.9 elaborate on breeding targets for actual fish-farm organisms	Learners need to: • Understand the principles of genetic improvement of stocks • Know the practicalities of stock improvement Context: of an industry with the potential to cause harm and conflict with other vested interests, if not well managed.
		3.10 discuss how an aquaculture business can be run in co-existence with other commercial interests,	Learners need to: • Understand the principles of coastal zone planning • Understand the common causes of conflict of interest

		preservation and leisure activities	between different users of the coastal zone resource Context: National level coastal zone policy and practices in Norway

Appendix 2: Scottish Aquaculture MA Analysis

MA Aquaculture Level 2

Monitor the aquatic production environment for farmed fish/shellfish				19
Aqua 12	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	the relevant health and safety requirements associated with monitoring the aquatic production environment	Knowledge of the relevant aspects of H&S Legs	**Site specific knowledge**	Identify relevant Legislation to monitoring followed by multiple choice
K2	how to inspect and test holding units	Procedural knowledge of cage operations - inspection	Cage farming of salmon including containment	Learner places given stages in the correct sequence
K3 (A1 K2)	the environmental conditions required by the fish/shellfish being farmed and the actions that can be taken to maintain conditions within holding units	Factual knowledge of salmon environmental requirements and control of the rearing environment	Salmon biology	Multiple choice
K4	why it is important to maintain environmental conditions within holding units and how changes in environmental conditions can affect fish/shellfish	Understanding the interaction between salmon and its aquatic environment		
K5	the equipment and methods used to sample and assess environmental conditions	Factual knowledge of equipment and procedure for use	Farm water monitoring routines	
K6	the relationship between water temperature and dissolved oxygen	Knowledge and understanding of the dynamics of the temperature DO relationship	Anticipation of changing environmental conditions and impact on operations	Reading DO concentrations from temperature % Sat charts
K7	how legislation affects water usage and discharge	Knowledge and understanding	Licencing abstraction and discharge	
K8 (A5 K6)	why waste must be disposed of according to site procedures	Knowledge and Understanding	Disposal of common organic and inorganic farm waste	

K9	how the design and construction of holding units and handling equipment supports containment	Knowledge and understanding	Containment	Naming cage components (drag and drop). Multiple choice on function
K10(A2 K5)	potential causes of stock escapes and the actions to follow if an escape is suspected or identified	Knowledge		
K11 (A1 K5)	common pests and predators and how they are likely to affect farm stock	Knowledge and understanding	Predator ID, behaviour and deterrence/contr ols	Predator ID quiz
K12	signs that can indicate potential predator activity	Knowledge		Visual quiz
K13	relevant legal pest and predator preventative measures and devices	Knowledge		Visual quiz or multi choice
K14 (A19 K8)	types of commercially damaging species, why they need to be controlled and the action to take if their presence is suspected	Knowledge and understanding	What examples are there in the context of salmon cage farming? Jelly fish may be?	
K15 (A19 K10) (A2 K6)	how the loss of fish/shellfish can affect the environment and farm production and how the legal implications of escapes can impact on the farm	Knowledge and understanding	Containment	
K16	emergency procedures and why they must be followed when dealing with an incident	Knowledge and understanding	**Site specific knowledge**	
K17	the site back-up systems, including when and how they are used to maintain environmental conditions and deal with emergencies	Knowledge and understanding	How is this interpreted in the context of a cage farm?	
K18 (A19 K7)	site procedures for maintaining effective hygiene and bio-security	Knowledge		
K19	the legal and site requirements for maintaining records of monitoring the aquatic production environment	Knowledge		Sample of records presented digitally within Moodle

Monitor fish/shellfish health and welfare				10
Aqua 13	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	the relevant health and safety requirements associated with monitoring the health and welfare of fish/shellfish	Knowledge of the relevant aspects of H&S Legs	**Site specific knowledge**	
K2	the anatomy of a healthy fish/shellfish	Knowledge	Salmon biology	Drag and drop naming external and internal features
K3 (A2 K2)	welfare requirements for fish/shellfish and how these are maintained within holding units	Knowledge	Legislative requirements and codes of practice	
K4 (A3 K6) (A14 K14) (A19 K5) (A4 K7)	the signs that indicate stress or disorder in fish/shellfish	Knowledge	Salmon health	Images comparing normal and abnormal state. Video resource showing behaviour (normal/abnormal)
K5 (A2 K9)	why accurate mortality records are essential to the management of a fish/shellfish farm	Knowledge and understanding		
K6	how variations in mortality can be used to indicate the condition of farm stock	Knowledge		
K7	how to recognise common parasites including their different life cycles	Knowledge		Moodle drag and drop, putting life cycle stages of common parasites (including sea lice) in the correct order
K8	how to recognise common diseases	Knowledge		Images of the diseased state
K9 (A1 K7) (A11 K9)	site procedures for maintaining effective hygiene and bio-security	Knowledge	**Site specific knowledge**	

K10	the legal and site requirements for maintaining records of the health and welfare of fish/shellfish	Knowledge	**Site specific knowledge** (related to legal)	

Prepare and gather live fish/shellfish				12
Aqua 3	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	the relevant health and safety requirements associated with gathering live fish/shellfish	Knowledge of the relevant aspects of H&S Legs	**Site specific knowledge**	
K2	why it is important to modify gathering processes to reflect changes in environmental conditions	Knowledge and understanding	Pre harvest, pre-grading, sampling (non passive), moving stock, changing nets (sometimes)	
K3	why it is important to prepare equipment correctly before gathering live fish/shellfish	Knowledge and understanding	Equipment operation and maintenance. (nets, fish pumps, bio scanners)	Hyperlink to manufacurers information. Also images of preparation procedures for equipment
K4	when and how to gather fish/shellfish to minimise stress levels during the gathering process, and why this is important	Knowledge and understanding	Production cycle determining fish movement, crowding and capture. Observation of fish behaviour	
K5	the importance of monitoring the health and welfare of fish/shellfish during gathering	Knowledge and understanding	Fish biology and aquatic environment	
K6 (A 13 K4)	signs that indicate stress or disorder in fish/shellfish	Knowledge	Health	Images comparing normal and abnormal state. Video resource showing behaviour (normal/abnormal)
K7	why and how fish/shellfish are conditioned before movement and handling	Knowledge and understanding	**Site specific knowledge (**and generic salmon faming knowledge)	
K8	why it is important to monitor environmental	Knowledge and understanding	Fish biology and aquatic	

	conditions during gathering		environment	
K9	the potential impact of adverse environmental conditions on gathering	Knowledge and understanding		
K10	the equipment and methods used to gather live fish/shellfish on site	Knowledge		Video of gathering procedures
K11	the site procedure for maintaining hygiene and bio-security	Knowledge	**Site specific knowledge**	Video of hygiene procedures
K12	how to deal with factors that can disrupt the gathering process within the limits of your own authority.	Knowledge and understanding	**Site specific knowledge**	

Work safely in an aquatic environment				17
Aqua 37	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	the health and safety responsibilities of employer and employees	Knowledge	UK legislation for H&S	Hyperlink to summaries of legislation
K2	common hazards associated with working in an aquatic environment	Knowledge	Water and land based hazzards associated with cage farms	Multiple choice formative assessment
K3 (A11 K5) (A14 K2)	when risk assessments should be conducted, including the role of dynamic risk assessment	Knowledge and understanding	**Company policy** (Linked to legislative requirement)	Use of video to support scenario led mock risk assessment
K4	how hazards and risks relevant to the work site are documented	Knowledge	Recording procedure **(Site or company specific)**	Recording hazzards and risks as part of scenario led mock risk assessment
K5	the principles of accident and incident prevention and reporting	Knowledge	UK legislation for H&S	
K6	health and safety legislation and organisational policies and procedures	Knowledge	**Company policy** (Linked to legislative requirement)	
K7	the importance of protective equipment in maintaining site safety	Knowledge		

K8	the use and correct application of protective equipment	Knowledge		Illustrated procedure
K9	the risks associated with weather and environmental conditions	Knowledge	Water and land based hazards associated with cage farms	
K10	personal cold water survival techniques	Knowledge	Personal operator safety (water)	Illustrated procedure
K11	safe lifting and manual handling techniques and their importance in avoiding injury	Knowledge and understanding	Personal operator safety (land)	Illustrated procedure
K12	why permissions are required for equipment usage	Knowledge and understanding		
K13	the importance of equipment maintenance	Knowledge and understanding		Illustrated procedure
K14	the communication devices that are required at the work site	Knowledge		
K15	site emergency plans	Knowledge	Site specific knowledge	
K16	the dangers associated with lone working and how they can be minimised	Knowledge and understanding		
K17	the hazards associated with the handling of bottled gases	Knowledge	Personal operator safety (handling dangerous substances)	

Prepare holding units to receive fish				12
Aqua 1	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	the relevant health and safety requirements associated with the preparation of holding units	Knowledge of the relevant aspects of H&S Legs	**Site specific knowledge**	
K2 (A12 K3)	the environmental conditions (water temperature, quality, and quantity) required by the fish species being farmed	Knowledge	Fish biology, environmental requirements, fish tolerance and production plan	

			(including biomass/densities)	
K3	how adverse environmental conditions can affect the preparation of holding units	Knowledge	The effect of heavy weather and tidal constraints on cage farm operations	
K4	the importance of ensuring the security and integrity of holding units	Knowledge and understanding	Containment (Links directly with Aqua 12 knowledge	
K5 (A12 K11)	common pests and predators and the impact of their presence on farm stock	Knowledge and understanding	Predator ID, behaviour and deterrence/controls	
K6 (A12 K13)	the relevant legal pest and predator preventative measures and devices	Knowledge		
K7 (A13 K9) (A11 K9) (A4 K4) (A7 K6)	the importance of hygiene and bio-security for farmed fish		Generic biosecurity knowledge preceding A13 K9	
K8	the different types of holding units used		Difference cages (Scope could be extended to land based Units?)	
K9 (A2 K11)	the importance of measuring the carrying capacity of the holding units in order to ensure that the welfare requirements of the fish to be stocked are met		Volume, stock density and water/oxygen supply	
K10	how the carrying capacity of holding units is calculated			Moodle quantitative work using volume stock density to determine carrying capacity
K11	how production plans control the stocking process		Market driven production planning and	

			cycles	
K12	the different types of feeding systems used in holding units		Cage feeding systems available commercially (Scope could be extended to land based systems)	Moodle formative assessment to recognise feeding system from images

Carry out routine maintenance and repairs on aquaculture facilities				11
Aqua 11	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	the relevant health and safety requirements associated with maintenance and repair of aquaculture facilities	Knowledge of the relevant aspects of H&S Legs	Site specific knowledge	
K2	the importance of routine maintenance and repair to aquaculture facilities	Knowledge and understanding	Materials degradation, cause and remediation. Farm vulnerabilities	
K3	what a maintenance schedule is and why it important	Knowledge and understanding	Manufacturers equipment schedules.	
K4	the signs that indicate the need for maintenance and repair	Knowledge	Land based infrastructure, water based cage infrastructure. Equipment	
K5 (A37 K3)	the importance of assessing risks before commencing work		Principles of and reasons for risk assessment. Precedes A37 K3)	
K6	why it is important to minimise environmental impact during routine maintenance and repair activities	Knowledge and understanding		
K7	the difficulties that may occur and how these should be dealt with	Knowledge and understanding	Site specific knowledge	
K8 (A11	the importance of disposing of waste according to site waste	Knowledge and understanding		

K8)	management procedures			
K9 (A13 K9) (A1 K7)	the importance of bio-security	Knowledge and understanding		
K10	the equipment, methods and expertise used to maintain and repair aquaculture facilities	Knowledge	Site specific knowledge	
K11	the legal and site requirements for maintaining records of maintenance and repair	Knowledge	…. Related to legal requirements	

Prepare and treat health problems in fish			Whole Unit in the context of sea lice	20
Aqua 14	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	the relevant health and safety requirements when treating health problems in fish	**Knowledge of the relevant aspects of H&S Legs**	**Site specific knowledge**	
K2 (A37 K3)	the hazards associated with treatments and the precautions that are used to control them		Handling, storage and administration of chemicals	
K3	how fish are conditioned ready for treatment		Starvation regimes	
K4	how husbandry risk assessments are used to ensure successful treatments and maintain fish welfare		husbandry risk assessments?	
K5	the equipment and methods used to treat fish	Knowledge	Methods and equipment for each disease treatment in scope	Images of equipment
K6	how to prepare the equipment used to treat fish	Knowledge	Preparation procedures for all equipment in scope	Images of preparation
K7	the importance of fully preparing fish before administering treatments	Knowledge and understanding	Pre-diseases treatment procedures for all	

			treatment scenarios in scope	
K8	how to identify when fish are not fully prepared and ready for treatment	Knowledge and understanding		
K9	why it is important to prepare treatment according to legal requirements	Knowledge and understanding	Legislative requirements and welfare codes	
K10	how dosages for treatments are calculated	Knowledge	Disease dose calculations according to FHP	Moodle calculation exercise
K11	why it is important to administer treatment according to veterinary instructions and the requirements of the site Fish Health Plan	Knowledge and understanding	Disease treatment procedure for all treatment scenarios in scope	
K12	why it is important to control treatments to protect other stock and the environment	Knowledge and understanding		
K13	why treated fish need to be isolated and controlled	Knowledge and understanding		
K14 (A1 3 K4) (A3 K6)	how to recognise signs of stress during treatment	Knowledge		
K15	the emergency actions to take in response to any adverse effects caused by treatments	Knowledge		
K16	the purpose of withdrawal periods and how to calculate withdrawal periods	Knowledge		Moodle calculation exercise
K17	why it is important to maintain accurate records of treatments administered to fish	Knowledge and understanding		
K18	the importance of monitoring and evaluating treated fish	Knowledge and understanding		
K19	site procedures for the disposal of chemicals and treatments	Site specific knowledge	Waste disposal regulations and H&S	

K20	the legal and site requirements for maintaining records of treatments			

Prepare for the transport of live fish/shellfish				12
Aqua 19	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	the relevant health and safety requirements associated with the transport of live fish	Knowledge of the relevant aspects of H&S Legs	Site specific knowledge	
K2	legislation controlling the transport of live fish/shellfish	Knowledge	Legislation and welfare codes of practice	
K3	methods used to transport live fish/shellfish	Knowledge	Methods for live transportation of salmon, well boat	
K4	why only healthy fish/shellfish should be transported and when they need to be conditioned	Knowledge and understanding	Salmon biology and health	
K5 (A13 K4)	the behaviour that indicates when fish/shellfish are stressed or have a disorder	Knowledge		
K6 (A12 K3)	how to establish the environmental conditions required by fish/shellfish	Knowledge	Salmon biology, tolerance and optimal conditions	
K7 (A12 K18)	the importance of hygiene and bio-security when transporting live fish/shellfish	Knowledge and understanding	Biosecurity and implementation of company/site biosecurity procedures	
K8 (A12 K14)	the precautions that are followed to reduce the danger of transporting non-target species with live fish/shellfish	Knowledge		
K9	the equipment needed and how to prepare it	Knowledge	Procedure recommended by manufacturer for equipment in scope	

K10 (A12 K15)	the importance of minimising the risk of escapes	Knowledge and understanding	Containment	
K11	the need to carry out a husbandry risk assessment and how this controls the transport of live fish/shellfish		Husbandry risk assessment?	
K12	the legal and site requirements for maintaining records of transport		Site specific knowledge in response to legislation	

Stock fish/shellfish into holding units				15
Aqua 2	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	the relevant health and safety requirements associated with the stocking of holding units	Knowledge of the relevant aspects of H&S Legs	Site specific knowledge	
K2 (A13 K3)	how to maintain the health and welfare of fish/shellfish during the stocking process	Knowledge	Salmon biology, equipment operation and site procedure	
K3	how adverse environmental conditions (weather, water conditions) can affect the stocking operation	Knowledge	Site procedures and contingency	
K4	the importance of stocking density in maintaining health and welfare standards	Knowledge and understanding	Salmon biology, equipment operation and site procedure	
K5 (A12 K10)	causes of fish/shellfish loss during stocking activities and how this can affect the environment	Knowledge	Containment	
K6 (A12 K15)	how the legal implications of fish/shellfish loss can impact on the farm	Knowledge and understanding		
K7	how legal requirements control the movement and receipt of fish/shellfish	Knowledge and understanding	Legislative controls and codes of conduct	
K8	the importance of observing newly stocked fish/shellfish for signs	Knowledge and understanding	Salmon biology and health	

	that indicate stress or disorder			
K9 (A13 K5)	the importance of observing and recording mortality rates in fish/shellfish	Knowledge and understanding	Salmon Health	
K10	the site standard operating procedures that control the stocking process	Knowledge	Site specific knowledge	
K11 (A1 K9)	the site stocking plan and the relationship between stocking density and carrying capacity	Knowledge and understanding	Fish production planning influence on daily operations. Farm capacity	
K12	how to deal with factors that can disrupt the stocking process within the limits of your own authority	Knowledge	Site specific knowledge	
K13	the equipment and methods used to transfer fish/shellfish to the site		Procedures for each item of equipment in scope	
K14	site procedures for maintaining effective hygiene and bio-security		Site specific knowledge	
K15	the legal and site requirements for maintaining records of stocking		Site specific knowledge and legal obligations	

Grade Live fish/shellfish				13
Aqua 4	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	how grading equipment can damage fish/shellfish if it is not in a serviceable condition	Knowledge	Maintenance of grading equipment in scope	
K2	how live fish/shellfish are graded according to their different characteristics (specification, size, quality, condition)	Knowledge	Grading purpose and criteria for all types of grading in scope	
K3	how to deal with factors that can disrupt the grading process within the	Knowledge	Site specific knowledge	

	limits of your own authority			
K4 (A1 K9)	site procedures for maintaining effective hygiene and bio-security during grading of live fish/shellfish	Knowledge	Site specific knowledge	
K5	the advantages and disadvantages of different grading methods	Knowledge	Pros and cons for all methods in scope	
K6	the equipment and methods used to grade live fish/shellfish on site	Knowledge	Grading equipment and methodology for all grading scenarios in scope	
K7	the importance of accurate grading to the management of healthy fish/shellfish	Knowledge and understanding	The impact grading on stock management and production performance	
K8	the legal and site requirements for maintaining records of grading	Knowledge	Legislative requirements	
K9	the potential impact of adverse environmental conditions on the grading operation	Knowledge	Site specific knowledge in relation to each type of grading operation in scope	
K10 (A13 K4)	the signs which indicate stress or disorder in fish/shellfish during grading	Knowledge	Salmon biology, health and behaviour	
K11	what are the grading requirements for the fish/shellfish to be graded	Knowledge	Site and task specific...Market specification and production plan influences	
K12	what are the relevant health and safety requirements associated with the grading process	Knowledge of the relevant aspects of H&S Legs	Site specific knowledge	
K13	why fish/shellfish are graded as part of husbandry programmes	Knowledge and understanding	Knowledge of market requirements and production cycls/regimes	

Harvest fish				13
Aqua 5	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	the relevant health and safety requirements associated with harvesting fish	Knowledge of the relevant aspects of H&S Legs	Site specific knowledge	
K2	how relevant food safety legislation controls the production of fish for human consumption	Knowledge	Influence of food safety legislation	
K3	legal requirements that control the dispatch of fish	Knowledge	Welfare legislation and codes of practice	
K4	your own responsibilities under relevant food hygiene legislation	Knowledge		
K5	the requirements of humane dispatch of fish, including the different methods and techniques used	Knowledge	Methods and techniques for each harvest method in scope	
K6 (A12 K8)	how relevant environmental legislation controls the disposal of waste	Knowledge	Organic waste disposal methods in scope	
K7	how and why harvested fish are stored to maintain flesh quality including the use of ice to suit prevailing environmental conditions	Knowledge and understanding	Fish storage practices and procedures in scope	
K8	why it is important to minimise fish stress during harvest	Knowledge and understanding	Impact of stress on flesh quality and welfare considerations	
K9	why it is essential for harvested fish to meet customer and quality requirements	Knowledge and understanding	The impact of buyer/customer requirements on harvesting operation and timing	
K10	how and why fish are conditioned in preparation for harvest	Knowledge and understanding	The influence of fish starvation on stress and flesh quality	
K11	the equipment and methods used to harvest fish	Knowledge	Harvesting equipment and methods for	

			harvest scenarios in scope	
K12	K12 how to deal with factors that can disrupt the harvesting process, within the limits of your own authority	Knowledge	Site specific knowledge	
K13	the legal and site requirements for maintaining records of harvesting	Knowledge	Site specific knowledge and response to legislation	

Feed fish			Whole Unit	18
Aqua 6	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1	the relevant health and safety requirements associated with feeding activities	Knowledge of the relevant aspects of H&S Legs	Site specific knowledge	
K2	the characteristics and types of feed suitable for feeding fish at different stages of development	Knowledge	Fish feeding and nutrition for the stages of the lifecycle in scope	Fee selection exercises (Pellet size etc)
K3	the storage requirements of fish feed including the importance of effective pest control	Knowledge	Feed storage design, maintenance and stock control	
K4	the importance of following specified feeding schedules and minimising waste	Knowledge and understanding	Feeding regimes and their implementation	Reading a feed schedule. (Applied numeracy, decimal points, etc)
K5	how to recognise poor quality feed and the problems that can be caused if it is given to fish	Knowledge and understanding	Feed quality	
K6	the different types of feeder or feeding systems used on site	Knowledge	Feeding systems in scope including digital control	Identification of feeders and feeding systems
K7	why feeding is modified in response to environmental conditions	Knowledge and understanding	Feeding practices interaction with environment (temperature & O2)	
K8	normal feeding behaviour including signs that indicate when fish are full	Knowledge and understanding	Feeding to satiation whilst avoiding waste	Video coverage of observed feeding behaviour

K9	how water quality and suspended solid discharge can be affected by feeding activities	Knowledge and understanding	Impact of feeding on the environment and mitigation	
K10	how feeding rates are calculated	Knowledge	Calculation from charts and automation	Feed calculation exercises
K11	why and how feeders are set, calibrated and maintained	Knowledge and understanding	Procedures for feeding systems in scope	
K12	the systems used to monitor feed intake and wastage (including considering poor quality feed, uneaten feed and packaging)	Knowledge	Waste feed disposal	
K13	the component of foodstuffs and their role in the development of fish	Knowledge and understanding	Fish Nutrition	
K14	how customer and quality requirements influence the content of the feed used	Knowledge and understanding	Engineering diets and feed regimes	
K15	how food conversion rates are calculated for fish stock, the factors that affect it and its importance to the production process	Knowledge and understanding	Fish production efficiency	FCR calculation exercises
K16	the financial significance of feed costs in the production of farmed fish	Knowledge and understanding		
K17	the importance of good hygiene when feeding fish	Knowledge and understanding	Hygiene	
K18	the legal and site requirements for maintaining records of feeding	Knowledge	Site specific knowledge and response to legislation	

Collect information on fish growth and development			Whole Unit	10
Aqua 7	**Knowledge and Understanding to be demonstrated**	**Nature of assessment**	**Subject context**	**Potential Moodle supported assessment**
K1+A10D 1A3:A3: A11	the relevant health and safety requirements associated with the sampling process	Knowledge of the relevant aspects of H&S Legs	Site specific knowledge	

K2	the importance of collecting accurate information on fish growth and development to fish farm production	Knowledge and understanding	Fish stock control	
K3	how anaesthetics can be used to assist the collection of accurate data and to minimise the stress caused to fish, and how to ensure that the correct amount of anaesthetic is administered	Knowledge and understanding	Use of anaesthetics	Anaesthetic calculation
K4	the standard measurements that are commonly used to specify the size of individual fish	Knowledge	Fork length, weight and condition factors	Calculation exercises
K5	the importance of maintaining measuring equipment in a serviceable condition, including keeping calibration correct	Knowledge and understanding	Maintenance requirements for equipment in scope	
K6 (A1 K9)	the importance of hygiene and bio-security	Knowledge and understanding	Biosecurity	
K7	how to collect representative samples of fish	Knowledge	Passive (automated) and active sampling regimes	Video footage of procedures
K8	how assessments are used to determine performance in order to meet production targets	Knowledge	Fish performance monitoring	Scenario analysis
K9	the equipment and methods used to sample and assess fish	Knowledge	Procedures for the sampling methods in scope	
K10	the legal and site requirements for maintaining records of fish growth and development	Knowledge	Site specific knowledge and response to legislation	

Appendix 3: Current One2Act response tools

5.2 Learner clients

The learner client is a responsive web app primarily used to collect answers from the classroom, typically running on any relatively recent device capable of user input and running a standard browser. On start-up, each person in the audience joins the current session created by the teacher. Whenever the lecturer opens a question or a set of questions, everyone who joined is able to respond. The learner client indicates through appropriate feedback if an answer has been or not successfully sent to the server.

The system supports BYOD (Bring Your Own Device) as the learner client's only requirement is to run on a connected device with a standard and relatively modern browser. Thus, respondents can participate with their own connected devices to respond to questions. The learners can flag questions in their interface. The meaning of the flag is given by common agreement between the teacher and the learners.

There is on single learner client which works with all teacher clients. The learner client will display the appropriate screen depending on the type and state of the current session.

5.3 One2act SRS

SRS (Learner Response System) is a response system based on one2act technology which uses respondents' own connected devices (such as smartphones, tablets, laptops and other standard web browsing capable devices) to respond to questions posed by a teacher or a presenter during lectures or presentations. The amount of control options available in the SRS teacher interface is deliberately limited to the essentials of the intended use-case.

In a typical scenario, the teacher uses SRS teacher client to define the questions, control various aspects of the response collection and to access the results. The learners use a web app to connect to the service and reply to the answers posed by the teacher. Currently, the SRS is supporting multiple choice questions only. The teacher can provide the actual question on any desired medium as the software only requires entering of the number of alternatives.

The learners can join the session, usually at the beginning of the lecture, via a session code that is automatically generated. After they answer to the question the teacher will get an aggregated view of their choices visualized in an interactive chart.

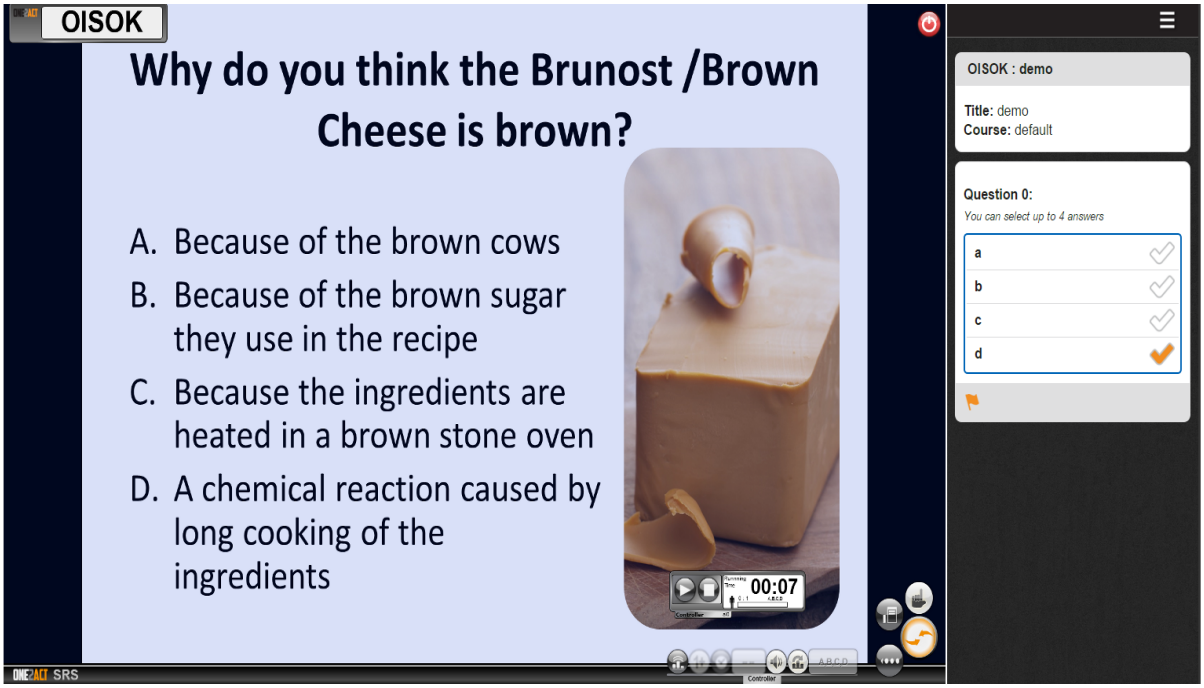

Figure 1. Depicted screenshots from the user interfaces of both the teacher and the learner clients of the SRS system.

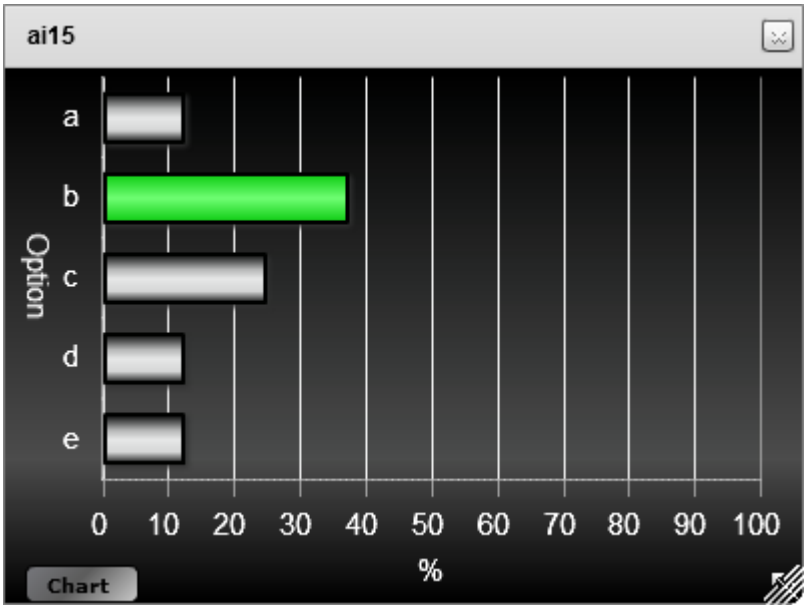

Figure 2. A typical histogram summarizing the responses is depicted. In that example, the almost 40% of the audience picked response option “b”.

The system allows a good control over how the answers are collected and displayed. The teacher controls the time the question is open for answering, if the results are shown live during the vote, automatically after the vote or only when shown explicitly by the teacher. For example, the teacher can decide to first ask the learners to give an individual answer and do not show yet the results but follow with a group discussion and then repeat the voting. Two histograms with the results of

different questions can be shown side by side in order to allow comparison. The histograms are interactive and allow the teacher to highlight the desired options while discussing it.

The teacher client features a transparent window which can be easily overlaid on presentations or other documents and media. The software provides the so-called tag-it function which allows the teacher to visually lay the alternatives over the screen (one could use for example a map or a diagram) and to define the question's alternatives this way.

5.4 One2act PeLe

PeLe (Peer Learning Assessment System) is one of the teacher clients currently available in the one2act response system. PeLe supports assessment process and its usage as a learning process tool.

In a typical scenario the teacher uses PeLe teacher client to define the questions, control various aspects of the response collection and to access the results while the learners use the learner client to connect to the service and reply to the answers posed by the teacher. The current version supports multiple choice questions.

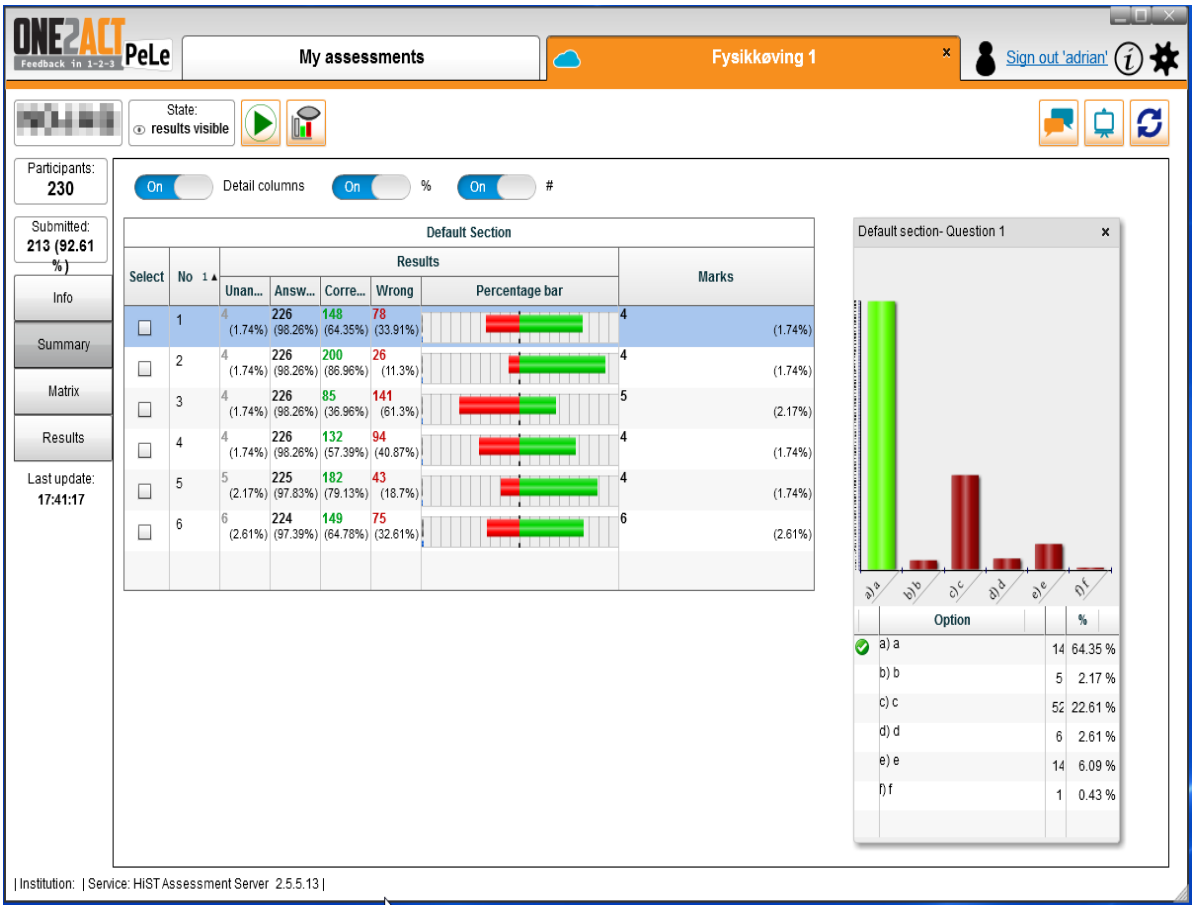

Figure 3. PeLe user interface – Assessment learning summary

Each assessment questionnaire gets a session code upon uploading onto the server. The session code is used to allow the learners to easily connect to the set of questions desired. The typical session code is 5 letters long and contains both vowels and consonants.

The answers are immediately aggregated making possible instant feedback and discussion based on the responses. Thus the teacher can dismiss misunderstandings and misconceptions very early on one hand and on the other he/she can adapt the teaching according to the feedback from the learners.
Depending on the situation, the teacher can decide to ask a re-vote on several questions or ask additional ad-hoc questions.

In figure 3 it is depicted a screenshot from the user interface of the one2act PeLe teacher client representing a summary view of the monitored assessment. This view is typically intended for the teacher's private screen as it shows information about correct alternatives and detailed counts for each alternative for the currently selected question (in the right hand side) and number of correct and wrong answers for each question along with many other details in the central grid of the view.

The software supports multiple monitor setups thus it is rather easy to bring it on the public screen only when necessary. Additionally, the views with more sensitive data (names of learners along with results or answers) do switch automatically to neutral views to avoid accidental displaying on a public screen.
The answers from the learners are available aggregated including individual learners. In the summarized view the teacher has available visualizations (percentage bars) which allow a quick overview and permit comparing questions by different criteria. For example, it is trivial to spot the question with most flags or with highest number of wrong answers.

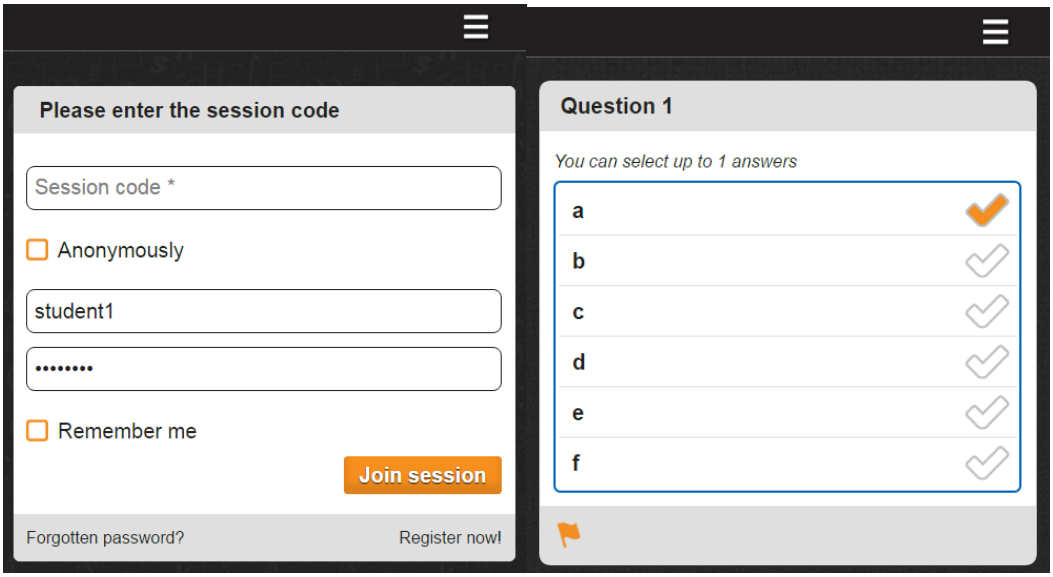

Figure 4. Learner client user interface

In figure 4 are depicted elements of the one2act learner client interface. In the left side one can see the screen that allows the learners to join a session. Depending on the session the learners can participate anonymously, or they need to login and identify themselves to the system.

In the right side a multiple-choice question with 6 alternatives is shown (alternative “a” is selected and the question is flagged). The user is informed about how many alternatives can be selected. Depending on the options selected by the teacher at the creation of the questions the learner client can show the exact number of alternatives that form the correct answer, or it can allow the user to select any number of alternatives.

The contents of the test (the text for the questions) can be delivered via the one2act system (which supports plain text for the question body and the alternatives), via printed papers or some other system. In the figure 4 (right) the assessment included only the basics (number of questions with how many alternatives and which alternatives are correct) and the text was delivered by other means.

The learners can change their minds and change answers in the assessment as long as they have not yet submitted the assessment (operation simulating turning in of an assessment in paper) and the teacher has not closed yet the assessment.

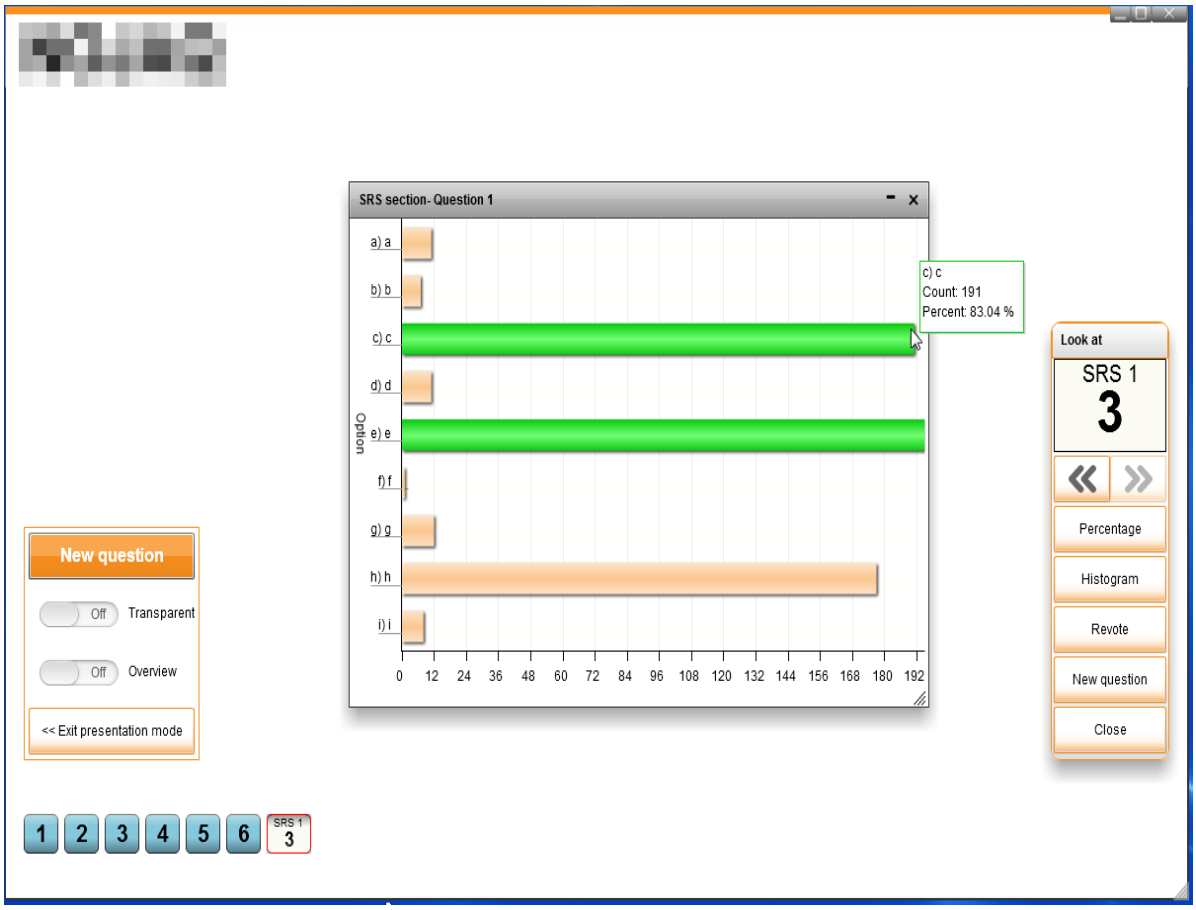

Figure 5. PeLe user interface – presenter view

In the figure 5 it is depicted the one2act PeLe presenter view which is used by the teacher in order to present and discuss the results. The teacher can control in which order to discuss the results. The histogram visualizations are with neutral colors in order to not give away the correct alternatives before the teacher wishes so. The teacher can highlight whichever alternatives he/she wishes.

In the case the teacher decides to re-vote on a question he/she can control if the results should be displayed or not right after finishing the vote. The same is available for brand new questions that the teacher might ask as part of the discussion. The window can be made transparent with a click of a button in order to show something sitting behind it (presentation slide, document etc.) which might be relevant to the discussion or the question.

PeLe also has basic capabilities for investigating a number of sessions with the so-called statistics tools. The tools allow a teacher to get a feeling for trends within the classroom by charts which indicate overall performance, individual learners or predefined groups of learners.

5.5 One2act iLike

iLike tool is based on SRS paradigm and takes it much further by adding several more question types and additional tools for supporting language learning. During testing and usage, it was apparent that specific parts of iLike can be applied to other subjects.

The iLike tool is geared towards simple response from the learners catering also to dynamic and spontaneous lectures via learner response through ad-hoc questions. iLike supports a variety of question types including open text questions.

The questions are organized in sessions which get a session code upon uploading onto the server like all the other one2act tools. The session code is used to allow the learners to easily connect to the set of questions desired.

The answers are immediately aggregated making possible instant feedback and discussion based on the responses. Thus, the teacher can dismiss misunderstandings and misconceptions very early on one hand and on the other she can adapt the teaching according to the feedback from the learners.

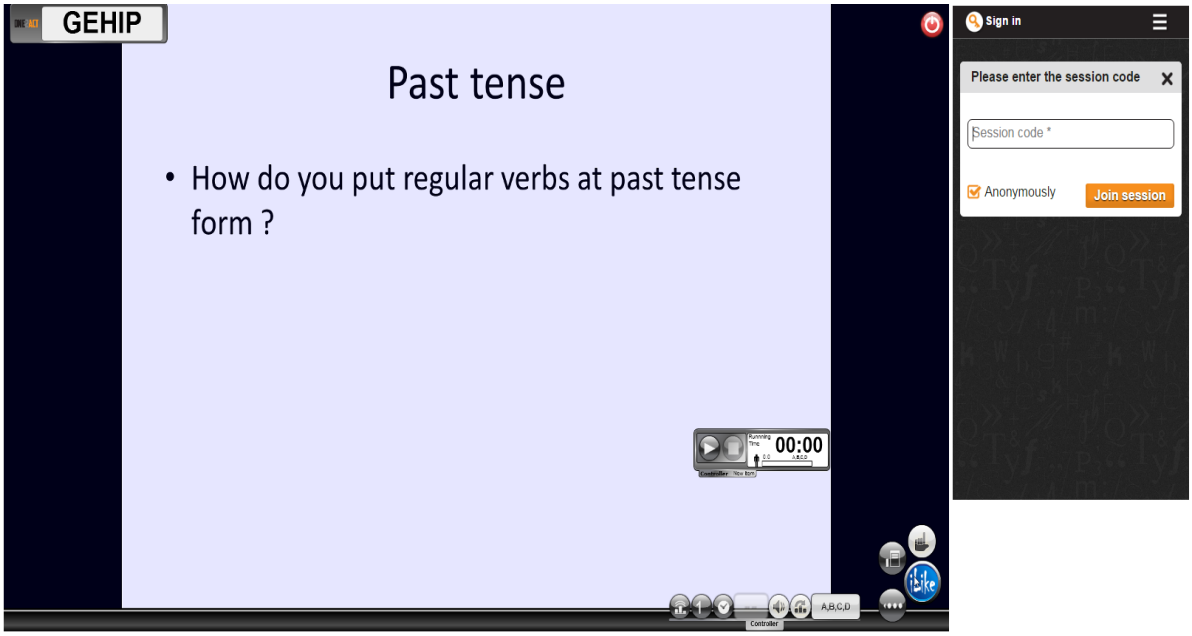

Figure 6. iLike user interface – teacher client left / learner client right

Tag-words

The tag words feature has been designed on top of the multiple-choice items from the SRS engine. We have diversified the multiple-choice items and added metadata properties to indicate how the items must be rendered on the clients. The consequences on the clients:

- the learner client needs a new interface that allows rendering of such items in a flow layout that allows selections and deselection of individual words.
- the teacher client needs an interface to allow the user to define the text to be used in the item. Additionally, it needs the visualization tools to show the data aggregated from the class. For this purpose, we have designed the "paragraph histogram" visualization

Free text

This is a new response type that has been added. The data models from both the clients and the server needed to be adjusted so that we account for more response types. The learner client requires a new interface to allow answering the free text items. The teacher client needs the modifications to create free text items and it needs appropriate visualizations for the received answers. The visualizations designed are aggregating the responses and include a frequency-based list of answers and a word cloud. Both visualizations allow interactions.

Order words

“Order words” is another new response type that has been added. The teacher needs to send a list of words that need to be ordered by the learners based on some criteria decided by the teacher. The learner client requires a new user interface control that allows re-ordering of the words received from the service. The teacher client needs the modifications to create order words items and it needs appropriate visualizations for the received answers. The visualizations designed are aggregating the responses and include a frequency-based list of answers. The visualization allows interactions like dragging an answer to designated drop targets in order to further work with the received text.

Wordpool

"Wordpool" is yet another response type that has been added. The teacher needs to send two lists of words that can be used by the learner to form the answer to the teacher question. One list is displayed in the placeholder for the final answer, while the second list is displayed in the placeholder for the word pool (words that can be included in the answer if desired). The learner client requires a new user interface control that allows managing and re-ordering of the two sets of words received from the service. The teacher client needs the modifications to create wordpool items and it needs appropriate visualizations for the received answers. The visualizations designed are aggregating the responses and include a frequency-based list of answers and a word cloud. Both visualizations allow interactions.

5.6 One2act Eval

Eval is allowing the teacher to run small scale surveys and evaluations which can be asynchronous to the lectures. In the current version there are three types of supported questions: multiple choice questions which may or may not have a specified correct answer, rating or Likert questions with scales from two to seven alternatives and open text questions.

Each evaluation or survey questionnaire gets a session code upon uploading onto the server. The session code is used to allow the learners to easily connect to the set of questions desired.

The answers are immediately aggregated making possible instant feedback and discussion based on the responses. Thus, the teacher can dismiss misunderstandings and misconceptions very early on one hand and on the other she can adapt the teaching according to the feedback from the learners.

Depending on the situation, the teacher can decide to ask a re-vote on several questions or ask additional ad-hoc questions.

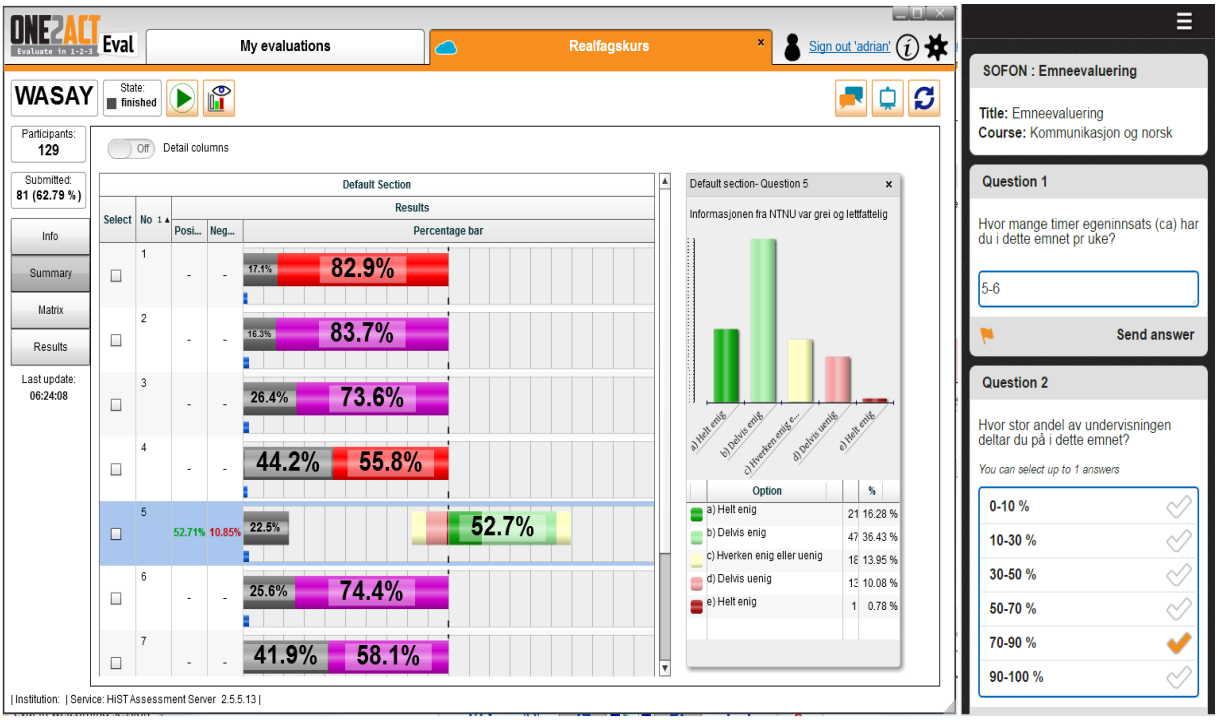

Figure 7. Eval user interface – teacher client left / learner client right

References

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Butler, R. (1988). Enhancing and undermining intrinsic motivation: The effects of task-involving and ego-involving evaluation on interest and performance. *British Journal of Educational Psychology,58*(1), 1-14.