Optimal

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

Output 8: Adaptation and implementation of learning materials, methods and tools for use within courses.

"Testing, evaluation and validation of the RPL-tools and methods in VET classes"

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Executive summary

The Guri Kunna Upper Secondary School in mid Norway first developed the 'Recognition of Prior Learning' (RPL) in order to improve class-room pedagogy for large groups of mature learners from industry with a range of experience. The benefits of RPL, supported by Response Technology (RT) pioneered in Norway, were subsequently shared with Scottish partners for application within the Aquaculture Modern Apprenticeship (MA) work-based delivery system.

Following an analysis of the Aquaculture MA knowledge requirements, the initial Scottish Optimal VET partner, Polaris Learning Ltd., commenced work with PLI to configure their Moodle VLE platform to support delivery to Scottish salmon farming company trainees. Following a recruitment failure by Polaris Learning, PLI initially teamed up with Guri Kunna (mid Norway) in the second year to assist their resource development and then subsequently Inverness College in the Highlands of Scotland, in the third year, working with them as an Associated partner. An 'interactive fish' learning object and multiple-choice assessment banks were developed for Guri Kunna to select from and pilot within their classroom based RPL system.

Subsequently, the multiple-choice resources and associated learning episodes were piloted with Inverness College learners using RT as opposed to the Moodle VLE as originally planned with Polaris Learning Ltd. As the project matured the activities developed and piloted in each country were complementary, thereby increasing the relevance of the lessons learned regarding RPL and APL to a wider pool of VET practitioners, whether applying work-based, classroom-based or both forms of VET delivery within a blend.

During the project, feedback from learners, VET providers (teachers) and industry, reflect the progress made with the incorporation of RPL/APL by Optimal VET providers in Norway and Scotland and enabled improvements for the future to be specified. These pilot results and the evaluations and subsequent analysis will ensure that RPL/APL can be more readily developed and adapted to benefit a 'broader church' of European VET providers, inspired by the benefits of RPL/APL as demonstrated and disseminated by the Optimal partners.

Resources and pedagogy shared by partners during the project have been disseminated more widely to other VET providers and industry as the project neared its conclusion. The tangible outputs, including multiple choice question banks, learning episodes and some interactive resources have been made available to all European VET providers, and are in the public domain.

Table of Contents

1. Adaptation and customisation of methods and tools

One of the biggest challenges in vocational education and training is the possible lack of interaction during teaching in heterogeneous classes, as some of the learners with less industry experience may become passive listeners rather than active participants in the teaching. It is well known that active participation leads to deeper learning. Application of response systems as a concept is an aid to create an opportunity for the learners to actively engage in the problem-solving process, and to create interaction between the teacher and the learners.

The single most important aspect when using response systems is that it is framed as a learning activity, and not as a test of performance. This entails that learners should be encouraged to use the opportunity within the response system methodology to verbalize and to gain formative feedback on their reasoning, be it from peers or from the teacher. Teachers must encourage learners to discuss concepts with their peers and present their rationales in group situations. During the plenary discussion teachers must be able to acknowledge the learner's contributions, for instance by trying to elicit their reasoning, and not simply by deeming their views as correct or incorrect.

Engagement is a necessary, but not in itself sufficient, component with regard to learning. If the teachers' sole or primary aim is to introduce an element of "academic entertainment", entertainment is probably the impression that the learners will be left with. Note that competitive engagement may also leave an impression of the learning activity as mere entertainment.

A fruitful way to perceive variations in teaching is to consider switching appropriately between presenting content in an authoritative manner on one hand and allowing the learners to discuss and apply the content on the other hand. Application of RPL methodology provides the teacher with information about the current state of knowledge within the learner cohort at the level of the group/class. Note that the aim of providing feedback to the teacher should go hand in hand with the overall aim of enhancing the learners' learning.

Recall of factual knowledge represents the most basic level of understanding with reference to Bloom's taxonomy (see Output 6 section 1). It should be noticed that the RPL methodology in combination with application of response systems, encourages dialogue and discussion. This calls for multiple-choice questions beyond mere recall of factual knowledge. Moving up the ladder on Blooms taxonomy, it is possible to check whether the learners can apply taught material in a context, which is not identical to the ones they have already been exposed to. On the same level, it is possible to check whether the learners can explore the consequences or limits of a model or law. Furthermore, it is possible to check whether the learners can synthesize recently taught material with (expected) established knowledge or combine information from different modes of representation (statistics, graphical, etc.).

When introducing a new topic, or starting a new course, using a dedicated response system tool to check the learners' prior knowledge related to the subject matter can be an effective way of getting learners "up to speed". The method provides the teacher with information about the state of

knowledge amongst the learners, which the teacher can act upon subsequently.

The learners' conceptions about the physical world, which they have constructed consciously from everyday experience, are frequently not congruent with the theories of science. Such misconceptions may also occur when the learner misunderstands what she/he has been taught and can be intentionally addressed by using response systems. Alongside the typical misconceptions that a teacher has detected, the literature on misconceptions in vocational education is extensive. By deliberately including known or suspected misconceptions in the list of alternative answers, the teacher will be able to engage learners and get information about possible reasons for their conceptions or misconceptions during a plenary discussion. This may inform the future teaching of the material in question.

The aim of any VET teaching and learning activity should be to support, guide or enhance the learners' learning, whereby the aims of using response systems are interrelated. The combination of RPL methodology with application of response systems encourages discussion, and therefore, conceptual questions are generally more suitable than problems limited to correct or incorrect alternatives.

In vocational education and training, the application of knowledge refers to a process in which the learner makes sense of what has been taught in a reasonable way. This process can be perceived as the learner trying to make links between new information and prior knowledge. This requires time, and can be enhanced through timely dialogue, either with peers and/or with the teacher. The forming of opinions and meanings may be enhanced by dealing with several modes of representation, or several sources of information (e.g., peers may offer an argument which makes more sense than the one the teacher made). Through these various interactions with learners, staff, people and artifacts, interpretations are verbalized, compared, negotiated, corrected, or confirmed. Since the RPL methodology encourages peer and plenary discussions, response systems could be appropriate for supporting the learners' as they construct knowledge and form opinions.

1.1 RPL/APL technologies and tools

The methods and tools developed and piloted during the Optimal project within Norway and Scotland are described, highlighting where resources were shared, despite differences within the VET pedagogy in each country.

The Optimal project rationale during the bid development phase was based on the application of Response Technology (RT) through the deployment of the 'One2Act' software developed by NTNU (mid Norway). It offered better functionality than other RT tools, many of which are freely available. Virtual Learning Environments (VLEs) were not a part of the original thinking. However, during early exploration with the Scottish Optimal VET partner Polaris Learning Ltd, (who left the project in the second year), it became clear that the Moodle VLE should form the centre delivery platform in Scotland, as opposed to RT. Work started on Moodle VLE configuration but did not progress very far. Thereafter, Inverness College, who joined the project as an Associated Partner at the start of the third year, were receptive to RT as they lacked access to a VLE system that was configured to suit their Aquaculture MA. In addition, their learning technologies manager was encouraging teaching staff to pilot the Socrative RT system. Following some research into different RT options and their

functionality, Socrative was adopted by the Scottish Optimal partners to support the multiple-choice assessment at the heart of the Scottish Optimal RPL/APL system.

In principle, 'Socrative' and 'One2Act' are similar, and although One2Act offers more functionality, both can provide immediate, or rapid feedback on individual and/or group responses to multiple choice questions. Data can be accessed by the tutors and they can control what is shown to learners and made public during group work. The group response can be analysed and used in classes in a live and dynamic way to stimulate discussion, without learners being fearful of their weaknesses being exposed. This in turn can encourage greater engagement in class and interaction between the teacher and learners and learners with their peers. The results of multiple-choice assessments can be stored, which is a particularly important to APL in Scotland, as described below (see 2.3.2)

The application of RPL to teaching and learning in the class-room situation was demonstrated by the lead partner at the start of Optimal in year 1, and the other partners gained some hands-on experience to help them devise their own approaches as the project progressed.

1.2   Multiple-choice

Multiple choice questions were used by both Guri Kunna and Inverness College within their respective classroom and work-based learning approaches. However, as Guri Kunna, had no need for multiple-choice questions to Accredit Prior Learning (APL) they had more freedom regarding the type of questions asked and their application. Their emphasis was on the application of RPL to support teacher led and peer learning in a classroom setting.

Multiple choice by its nature, is compatible with automation, as learners are expected to select from a given set of possible responses that can be presented via a range of learning technologies. Contrary to the pre-conceptions of some practitioners, well designed multiple choice can assess knowledge and understanding comprehensively, within a spectrum of increasing difficulty that can start from the learner demonstrating straightforward 'factual recall' and progress to a deep level of understanding of a subject and its nuances. The degree of difficulty depends on how the multiple-choice questions are designed and by paying attention to Blooms Taxonomy, question sets at the right EQF level can be created. However, the development of good multiple-choice questions is a skill that must be systematically developed by teachers, supported by feedback from peers and learners within a culture of continuous improvement (see Output 7 report). These skills must be particularly well tuned and precise when developing question sets for APL and when devising question sets to assess 'deeper understanding'.

Two main question types were used within Optimal; concrete questions with only one possible correct response and questions with multiple correct responses.

(a) Concrete questions

Concrete questions were firstly developed by PLI for use by Guri Kunna within their classroom based RPL process as previously described. The questions were devised with reference to the Norwegian NQ analysis which led to Learning Outcomes agreed with the Guri Kunna teaching staff (See Output report 6). Initially, there was some scepticism that it would be possible for a Scottish partner to

develop question sets that were useable by a Norwegian College working within a different national VET system. However, the multiple-choice questions were well received and a selection of them used to good effect, along with others developed by Guri Kunna, for use prior to the start of their course, and each new subject within. The teaching staff found that the learners' answers to the concrete questions revealed a lot of useful information about their level of knowledge and understanding, helping them to better organise and prioritise topics within their classes.

Subsequently, PLI returned to the Scottish Aquaculture MA analysis and selected questions from the question banks previously developed for Guri Kunna, which were then mapped to the MA for consideration by Inverness College. Some questions had one correct response only and were generally the least challenging. Many of the questions were designed to have more than one correct response and learners were required to select all the correct responses, requiring a greater depth of knowledge and confidence. As the question sets were to be used for RPL and APL, they were subjected to comprehensive quality assurance internally by PLI and subsequently by Inverness College staff, in relation to the MA knowledge requirement. This was to ensure they could satisfy SQA in the event of an External Verification visit to check standards are being applied correctly and consistently within internally verified assessments.

Initially a selection of text based concrete questions for Nutrition and Growth were piloted by the Inverness College, following a revealing debate and a rigorous selection process (see section 3.2). In addition, Inverness College requested questions on small boats as one of their priorities. These were developed, using images and text in order to provide a much wider menu of approaches for assessing the learner's prior knowledge of small boats and accessories, to precisely match the knowledge specified in the MA, thereby providing a reliable route to APL and the 'fast tracking' of NQ assessment. Most of the MA small-boats knowledge requirement was covered by the multiple-choice questions developed and quality assured by Inverness College for application with a cohort of 13 MA learners.

As APL was part of the Inverness College's initial intentions, the multiple-choice assessments were undertaken during routine review visits, so as the tutor could invigilate. The learners found the experience beneficial and their feedback has been gathered and evaluated more fully (see section 3).

(b) Questions with multiple correct responses

Unlike concrete questions above, this question type cannot be used for APL purposes within an automated RT system. However, they are often better than concrete questions for stimulating debate and getting learners to formulate and express an opinion in a classroom-based group learning situation. In addition, questions that address concepts embracing a wider range of topics can be explored more readily if set up and presented within the RT.

Gurr Kunna teachers used 'concrete questions' to establish the 'knowledge profile' of the group, prior to the start of each new topic, followed by questions during class that had many different responses and were open to opinions being expressed, discussed and validated by the teacher.

Occasionally a teacher would formulate an opinion-based question during the class and pose it 'there and then', which is the most dynamic and fluid use of RT within a group learning situation.

Attitudinal questions that have no right or wrong answer can be used to gauge learners' opinion of a topic before, during or after teaching, or for evaluative and quality assurance purposes. These were applied occasionally within Optimal and supported some of the evaluation and feedback by learners.

1.3   Targeted learning

The use of RPL allowed learning to become more targeted, thereby gaining time efficiencies as well as increasing the effectiveness of learning. The general concept of RPL is applied in very different ways within the classroom and work-based delivery scenarios that Optimal embraced.

1.3.1 Classroom-based group learning

The RPL process applied by Guri Kunna teachers prior to the start of each new subject allowed the limited time learners spent in class by to be utilised more effectively, due to the knowledge of the groups' strengths and weaknesses gained by the teachers. Therefore, learning activities and teaching inputs could be more targeted towards the less experienced learners, helping them to address weaknesses and 'level up' their knowledge and understanding more quickly.

In addition, sub-groups of learners were set up with a random mix of experienced (and knowledgeable) learners and less experienced (and less knowledgeable) in each group. The group would then be set a problem or task requiring some discussion and feedback to the main group, providing peer learning opportunity within a 'safe', small group environment.

The classroom management described above was all informed by the results of RPL, with questions emailed to the learners on the next topic a few days before they attended the class, providing teachers the insights required to lesson plan accordingly.

1.3.2 Work based learning

The system was designed with Inverness College to capture the responses to the multiple choice delivered by Socrative RT, for two purposes; Recognition of Prior Learning (RPL) leading to a more refined 'Individual Learning Plan' and the Accreditation of Prior Learning (APL) to fast track NQ assessment for the more experienced and knowledgeable learners.

A complete set of discrete illustrated text based 'learning episodes' were developed and each was given a unique identification code to link it to specific multiple-choice questions, which were also coded. An inventory of multiple-choice questions and learning episodes was created, allowing the RPL and APL process and learning assets inventory to be managed effectively. In the absence of a VLE, the tutor used e mail to communicate the results and send the appropriate set of learning episodes to each learner, according to their RPL results.

This allowed every learner to receive a set of learning episodes that addressed every question they had not successfully answered at the start of a new topic. Following a period of 'guided self-study', informed by their RPL results, they could then re-enter for assessment for those topics they had not satisfied during the initial RPL attempt.

2.   Resources

A range of resources were developed to support RPL, APL and associated learning. Multiple choice questions and the 'interactive fish' (see 2.3) were developed by PLI for sharing by Guri Kunna (Norway) and Inverness College (Scotland) within their respective delivery systems. PLI developed resources for Guri Kunna initially during year two of the project, based on an in-depth analysis of their NQ Learning Outcomes (See Output 6 report). Thereafter, these resources were offered to Inverness College, evaluated, adapted, and quality assured by staff, and then applied to the delivery of their work-based Aquaculture MA. In the case of the multiple-choice questions, a set of questions for small boats requested by Inverness College as a high priority were developed.

2.1 Multiple choice questions

The application of multiple-choice questioning was central to RPL in both Norway and Scotland but applied differently to satisfy different VET objectives and priorities.

2.1.1 Guri Kunna

Concrete questions were developed for Guri Kunna, based on an analysis of the Norwegian NQ to derive more detailed learning outcomes. A total of 6 question banks developed, with each question provided a unique code to ensure control of the inventory:

a) Fish Nutrition and Growth
b) Fish Anatomy
c) Fish Biology and Lifecycles
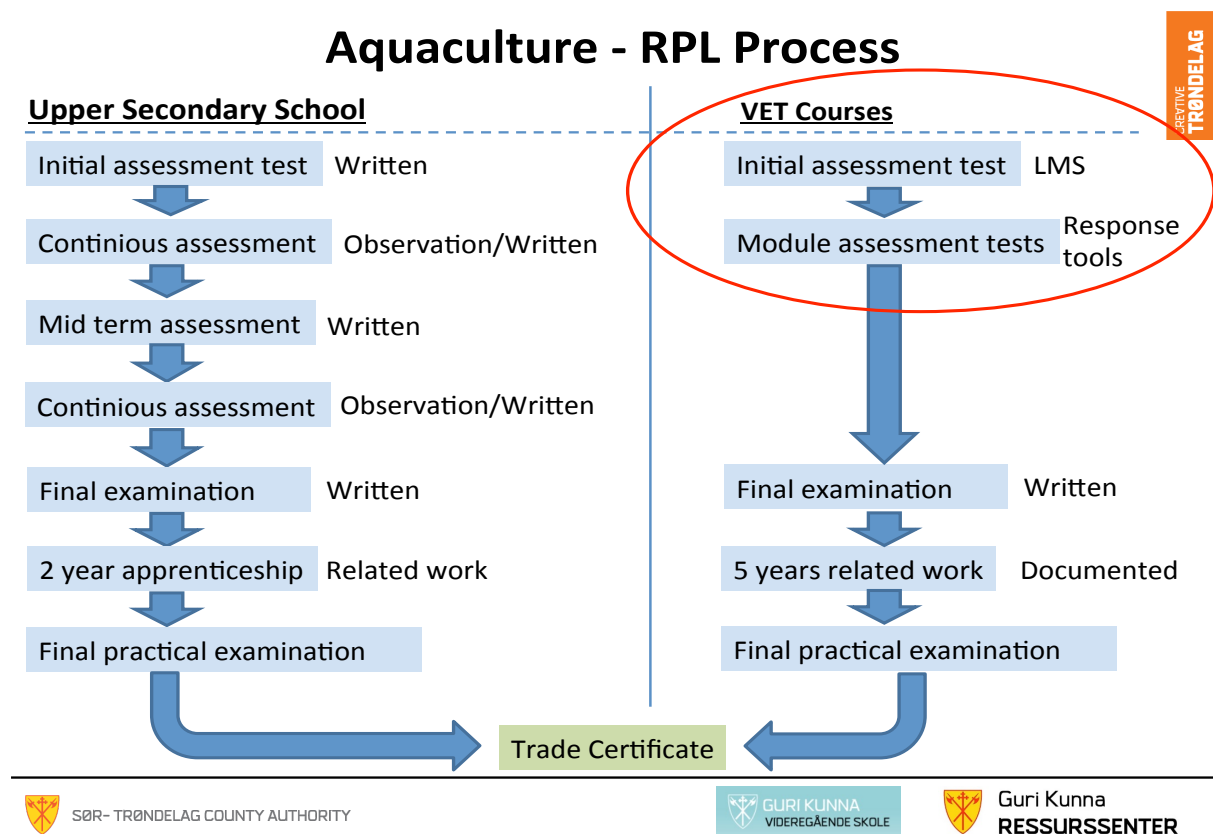d) Fish Health
e) Water Characteristics

Guri-Kunna successfully piloted selected questions for Fish Nutrition and Growth in the first instance, to establish the prior knowledge several days prior to the first class on Nutrition and Growth. (See Appendix 1 for the Nutrition and Growth multiple choice question bank sample exemplar)

Thereafter Guri Kunna combined RPL with the application of the 'One2Act' response system. The aim was to bridge the gap between the ambitions of the industry, and the current training methods that did not always suit reticent learners who were often experienced staff. Typically, despite fearing and avoiding the theoretical learning they need, they are frequently championing 'practical problem solving', but are not often encouraged to apply this ability within training courses. The Optimal project developed methods that helped to overcome this barrier and better utilise their strengths within group-based learning situations.

Initially, the aquaculture RPL process is driven by the teachers needs:

- What does the teacher need to know about the learners general level of knowledge as a group before a general course plan is determined?
- What does the teacher need to know about the learners' level of knowledge as a group for each module before lessons starts?

- How can the teacher know that the lesson has brought the learners to a higher level of knowledge for each module?

The figure below demonstrates how quick evaluations set up as informal assessments based up on multiple choice questions, are applied in the training process for staff from industry. For comparison, the figure also shows how the upper secondary based training is delivered by applying continuous assessment and tests. Both pathways culminate in the national theoretical exam, which is part of the national qualification in aquaculture that all learner undertakes at the end of their studies.

Aquaculture - RPL Process

Upper Secondary School

Initial assessment test	Written
Continious assessment	Observation/Written
Mid term assessment	Written
Continious assessment	Observation/Written
Final examination	Written
2 year apprenticeship	Related work
Final practical examination	

VET Courses

Initial assessment test	LMS
Module assessment tests	Response tools
Final examination	Written
5 years related work	Documented
Final practical examination	

Trade Certificate

SØR–TRØNDELAG COUNTY AUTHORITY

GURI KUNNA VIDEREGÅENDE SKOLE

Guri Kunna RESSURSSENTER

The RPL process for staff from industry is cyclical process, where the learners apply response tools structured like quick evaluations, to inform the teacher about their current knowledge and competence. There is one initial assessment test up front of the courses, and then several targeted assessment tests during the courses. Each was organized as a quick evaluation whereby learners could reply within 2-3 days. (It is not necessary to get a response from every single learner.) If 2 out of 3 learners reply, the teacher gets a reliable indication and overview of the level of knowledge

within the class at the group level. This information is used to target their teaching towards the most problematic areas during the classroom-based training, thus optimizing the effect of their training activities.


Aquaculture - RPL Process - Norway
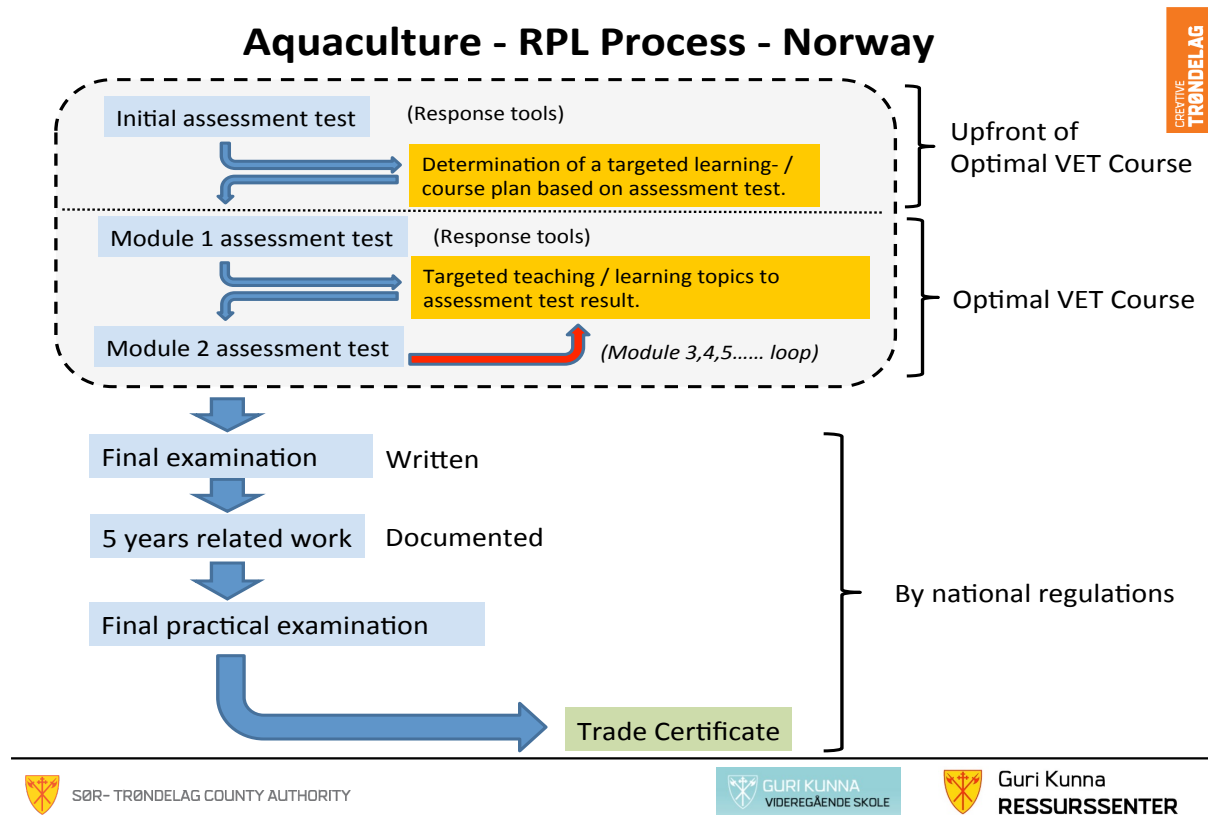
The figure above demonstrates the cyclic nature of the quick evaluation process whereby the teacher receives a wide overview of how the groups knowledge and competence is distributed.

Examples of how the students replied to these quick evaluations are shown below:

Example1: The first example below shows that most students answered correctly on all alternatives, whereby the teacher doesn't need to spend so much time on this in the class.
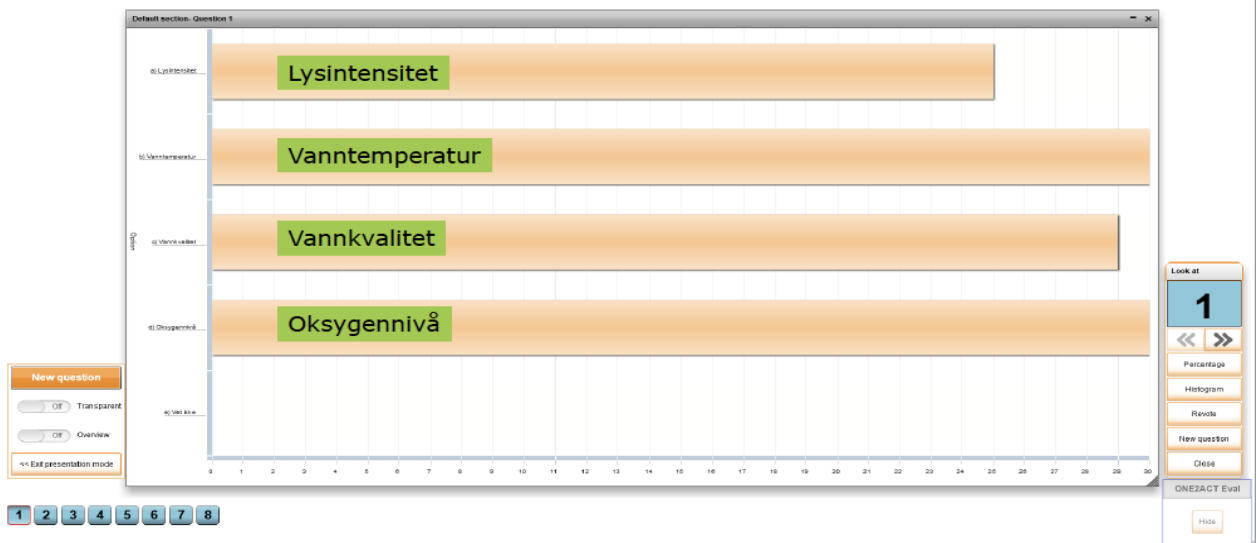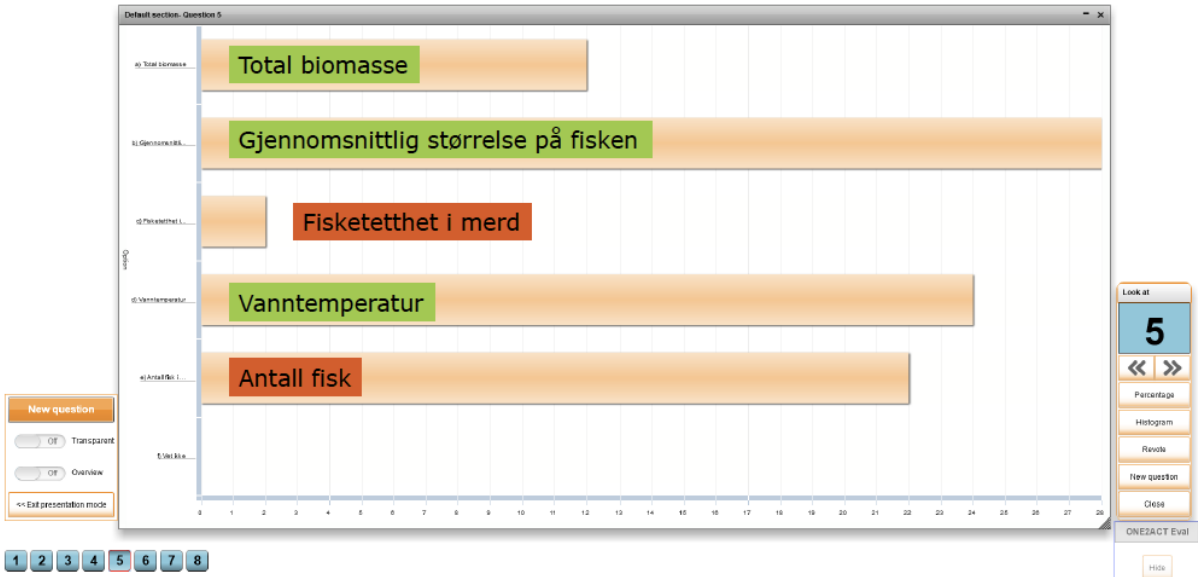
Example2: This is an example where the students answered partly correctly, partly incorrect. In this example the teacher must elaborate on two specific subject areas (those marked with red) and the upper one where approximately half the class selected the correct alternative.

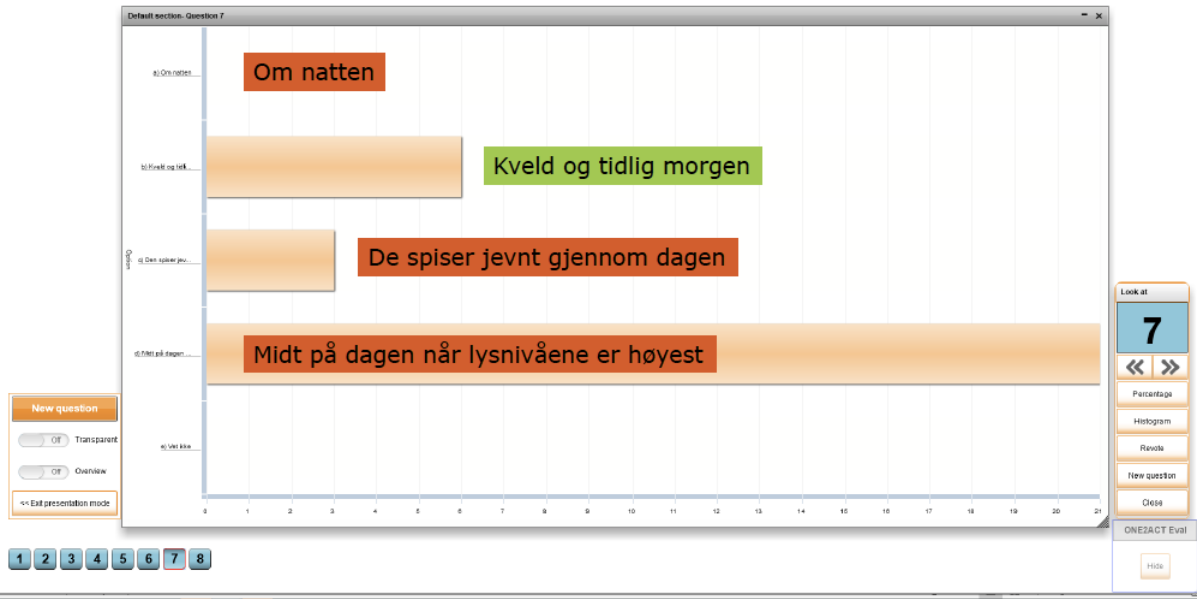Example 3: In the example below, only a few students know the correct alternative. In addition many select the wrong alternatives. In this case the teacher will need to invest time to give an in-depth explanation for both the correct (green) and incorrect alternatives (red).

Example 4: The three examples below demonstrate the improvements achieved during the aquaculture VET course. The pre-test was done before one of the training session, while the post-test was done at the end of the course. The question is shown at the top of each picture.

DO YOU KNOW THE DIFFERENCE BETWEEN A FLOW TROUGH PLANT AND A "RAS" PLANT?
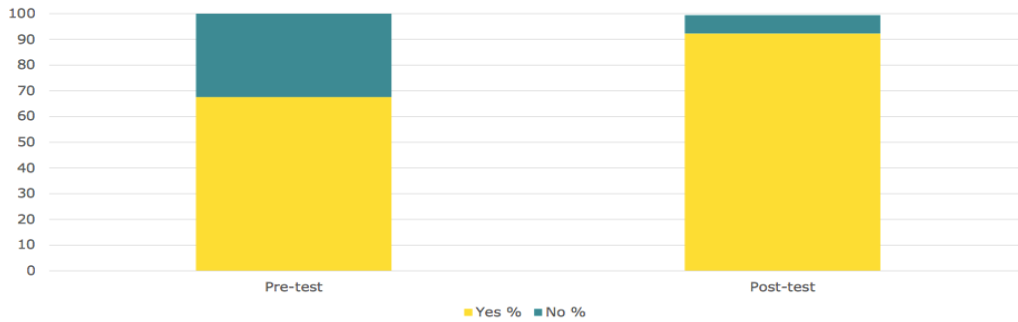
CAN YOU DESCRIBE TREATMENT MEASURES IN A "RAS" SYSTEM?

Yes % ■ No %

Trøndelag County Authority — Guri Kunna Videregående Skole

WHICH OF THESE DISEASES IS <u>NOT</u> A VIRAL DISEASE?

Correct % ■ Incorrect %

Trøndelag County Authority — Guri Kunna Videregående Skole

2.1.2 Inverness College (Scotland)

Subsequently, questions were selected from bank (a) above – Fish Nutrition and Growth, following a period of evaluation and quality assuranc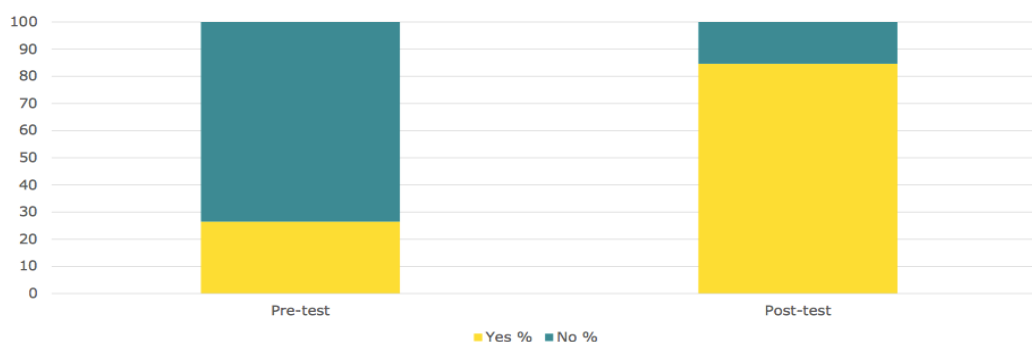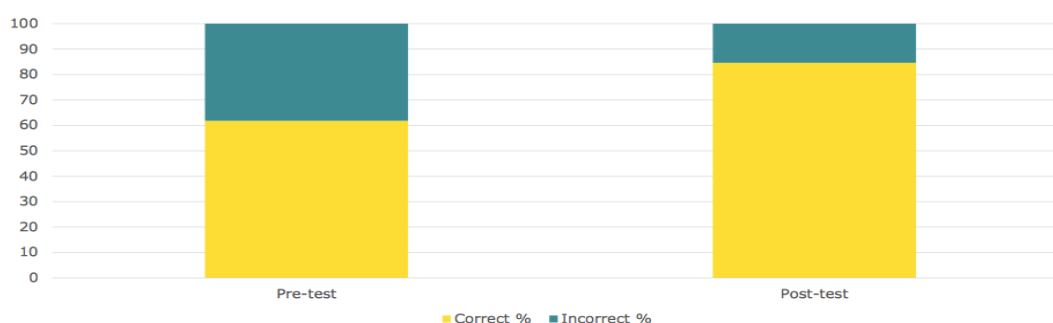e by Inverness college teaching staff. In addition, questions relating to small boat handling were developed for piloting with Aquaculture MA learners. Some modifications had to be made to the Nutrition and Growth questions in order to satisfy the Inverness College teachers different interpretation of the underpinning knowledge in the Aquaculture MA. Following amendment, these revised questions were added to the appropriate question bank. The small boats question set was developed from the MA Aquaculture knowledge requirement for this subject area, digital images originated, and diagrams sourced or developed, enabling a much more visual approach. All the other question banks were text based.

As a tangible output from the Optimal project, the question banks above (see 2.1.1), and the questions developed on small boat handling for Inverness College, have all been submitted to enter the public domain in Europe along with the multiple-choice question bank inventory. They can be used, with or without adaptation by other European Aquaculture VET providers.

2.2 Learning episodes and activities

In Scotland a discrete learning episode was developed for each concrete multiple-choice question, except for small boats, varying in length from between 1 to 3 pages of A4 text, including a range of infographics.

a)   Fish Nutrition and Growth
b)   Fish Anatomy
c)   Fish Biology and Lifecycles
d)   Fish Health
e)   Water Characteristics

Great care was taken not to exceed EQF level 3-4 appropriate to level 2MA learners (husbandry operatives). Sentences were short, bullet points applied, and simple info graphics/diagrams added. The resources were further enhanced by sourcing and adding images from the internet 'Royalty free commons' which were annotated to re-enforce the key learning points in each episode. The writing style was clear and for the more technically/scientifically demanding subjects references to general knowledge were made to make the episodes more understandable to all learners, irrespective of their level of education. This is exemplified by Nutrition and Growth, which referred to analogies derived from human nutrition (see Appendix 2 – Exemplar Learning Episodes).

The learning episodes developed were piloted within the Scottish work-based Aquaculture MA as they were not applicable to the Norwegian class-based pedagogy. They were provided by e mail based on the RPL information from the Socrative RT. This was a time-consuming process, leading to the conclusion that RT is not the preferred technology for RPL/APL within work-based learning.

2.3 Interactive learning

There was an interest expressed by Guri Kuna teachers in the development of interactive learning objects to help learners to learn, understand and better retain aspects of fish anatomy, including the identification and function of internal and external features and organs. During a second-year meeting between PLI and the Guri Kunna teachers this idea was explored in more depth.

The 'story boarding' methodology underpinning the development of 'interactive learning' was introduced and demonstrated by PLI to the teachers. A story board is an effective device for supporting collaboration as it enables the teachers' vision to be converted into a specification that they can approve before the learning object itself is created by the developers, in this case PLI.

This led to the development of the Interactive fish' External and Internal Anatomy story boards by PLI for approval by the Guri Kunna teachers. (See Appendix 3 for the Internal Anatomy exemplar story board). As illustrated the story boards specify the text, media (including high quality digital images provided by the Guri Kuna teachers) and the interactions required within the learning object. This was invaluable as a device for supporting collaboration between Guri Kunna and PLI during Optimal, as it enabled PLI to develop an interactive learning resource that satisfied their initial vision and requirement. The intention was for the 'Interactive Fish', presented on Power Point in the absence of an operable VLE at Guri Kunna), to be made available to learners to support their self-

study and familiarisation with fish anatomy, prior to a fish dissection practical class. It could also be applied following the practical dissection to further consolidate learning. The follow up could be either a teacher or learner led activity, depending on the chosen pedagogy.

Due to time and technology constraints, it was not possible to pilot the interactive fish with Inverness College. However, both Inverness College and the Fisheries College in Iceland have an interest in utilising the resource within their VLE based delivery systems being established late 2019/2020.

2.4 Aquaculture VET learning in Norway

The teachers at VET schools experience that companies' mange to find solutions to technical problems. It is the knowledge of the biology of the fish that is the important challenge. It is important for companies that those that have obtained a National Qualification (NQ) should be able to start working immediately after graduating without offering additional training. Furthermore, students graduating with a NQ, needs about 3 years with experience at the cages before they know how to operate all type of machines and processes.

One of the main challenges is how to combine knowledge about fish biology, fish health and the needs to train various types of technical skills in order to prepare the students to take part in work operations with various types of machines. The aquaculture curriculum could have been made wider in order to manage to do that. On the other hand, if the curriculum is increased, it is difficult for the VET teachers to have enough time to train the students - that to often don't like to attend theoretical training, but instead expect practical training - in just 2 years at the school.

In the forthcoming years, VET schools expect that farming companies must start employing staff that has various types of skills, not just aquaculture VET background. This could for instance include mechanical skills, electro skills, etc. in order to offer sufficient specialization during complex work operations out at the cages.

There is a continuous on-going discussion addressing the level of the exams in the NQ in Norway with respect to handling the fast advances in technology, while at the same time satisfying the request for farming industry needs at regional levels. Today specialist workers to a large degree carry out the various types of jobs at the farms and at the cages. This work methodology has changed during the last 5-7 years due to technical innovations and new machines. The current NQ is, however, designed to offer general knowledge within production of smolt and farming of fish, in combination with provision of a wide technological competence. The biggest companies like Marine Harvest and Salmar have developed their own quality assurance systems, while medium sized and smaller farming companies don't have resources to do this.

From the farming industry's point of view, the students must get enough knowledge and skills to carry out the day-to-day work operations and activities. In addition they would like to employ students that have got good problem solving skills, since the staff at the farms every day needs to solve new tasks and challenges that are linked to the on-going production.

Industry expects that students have got indebt knowledge about sustainable production in the farming sector. This is very important, since the production must be based up on sustainable resources in order to both survive and grow the business further. When the production is expected to increase in the near future, this becomes even more important. Thus, students should graduate

with good attitudes with respect to greening of the production and applying sustainable production methods.

Aquaculture VET should combine and give the students holistic knowledge and skills for doing the day-to-day work, enhance their attitudes towards achieving sustainable production. Health, environment and safety issues are one of the most important targets to address properly in the VET courses, in order to help reducing accidents and failures in the production at the farms. There has become a culture within the farming companies that their staff should have taken a national qualification when they start working. In 2019 most new positions announced by farming companies, requires a national qualification.

The learning output descriptions and the competence goals must be defined in a wide way in order to catch up with the fast technical developments within the industry. Every year the aquaculture VET schools need to update and adjust the curriculum to reflect the current production methods and production processes applied by industry. For instance, the teachers must teach how to apply cleaning fishes or to reduce the challenge with sea-lice, based up in the production methods applied by the farming companies every single year.

2.5 The training methodology applied and tested in Norway

There was no classroom-based learning within the delivery of the Scottish work-based MA in Aquaculture. Conversely, the Guri Kunna delivery applied classroom attendance for 16 sessions of 2.5 to 3 hours duration.

The aquaculture VET schools in Norway are distributed across a large geographical area in the rural costal zone, separated by fjords, mountains, valleys and islands.

There are in the year 2018, 12 public

- Nordkapp VET school, http://www.nordkapp.vgs.no
- Nord-Troms VET school, http://www.nordtroms.vgs.no
- Senja VET school, http://www.senja.vgs.no
- Sortland VET school, http://sortland.vgs.no
- Meløy VET school, http://www.meloy.vgs.no
- Guri Kunna VET school, http://www.blueedu.eu/vet/guri-kunna/
- Fræna VET school, http://www.frana.vgs.no/Fraena-VGS
- Ålesund VET school, http://www.alesund.vgs.no/AAlesund-VGS
- Måløy VET school, http://www.maloy.vgs.no
- Fusa VET school, https://www.hordaland.no/nn-NO/skole/fusavgs
- Austvoll VET school, https://www.hordaland.no/nn-NO/skole/austevollvgs/
- Strand VET school, http://www.rogfk.no/strand

and 2 private

- Val VET school, https://val.vgs.no
- Norsk Havbruksakademi (started in 2018), http://www.havbruksakademiet.com

aquaculture VET schools in Norway. Due to the distances, travelling is time consuming and expensive.

Some of the mature learners attending the Guri Kunna programme had a lot of practical fish production experience in industry and many could be characterized as having a high degree of 'metacognitive' abilities. Metacognition may be perceived as the skill to consciously reflect upon one's own cognition, one's own emotions, and one's own and others' utterances or actions. Thus subsequently, metacognition also includes the ability to act effectively upon these reflections. The teachers at Guri Kunna appealed to the learners' metacognition when they intend to address suspected misconceptions in the learner cohort by combining RPL with application of response systems.

Mortimer and Scott (2003), originally analyzed how teachers communicate towards science learners. The interactive or non-interactive dimension of VET simply refers to whether the teacher speaks in solitude or if there is a dialogue between the teacher and the learners. The balance struck by the teacher between 'authoritative' and 'interactive' behaviors is determined by the role they adopt as the gatekeeper/judge/courier. They may only allow one correct industry perspective, or alternatively if they act as a facilitator of the discussion, they may allow several perspectives to coexist. The crucial point of this model is that good teaching requires appropriate switching between the authoritative and the dialogic, and between non-interactive and interactive. RPL in combination with response systems tool can help to facilitate them teaching as it switches between these different modes and behaviors.

2.4.1 The application of 'iLike' within Optimal

The visual model in figure 1 below exemplifies the structure of using iLike during a lecture or VET session. (See description of iLike methodology below)

	Interactive	Not interactive
Authoritative	4. Teacher review	1. Presenting new material
Dialog	3. Plenary discussion in class	2. Discuss solutions to the problem or challenge in groups.

Figure 1. A schematic overview of how an iLike session in a class was organized and linked to the communication model.

The iLike approach:

- Between 1 and 2, the teacher presents the SRS problem and instructs learners to think individually and/or discuss in pairs.

- Between 2 and 3 the teacher instructs the (final) learners to cast their votes. Consider whether the results should be revealed to the learners or not.
- Between 3 and 4 after the relevant input have been presented by the learners, it is time to sum up. It is at this point it is time to reveal the results from the voting to the learners.

The teacher poses a question (typically multiple-choice) to the learners and instructs the learners to think individually and/or discuss a viable solution with their peers, before casting individual votes. Based on the distribution of responses, the teacher engages the learners in a plenary discussion, trying to elicit the reasoning behind the choices of the different alternatives, before providing a concluding summary.

For the learners, the application of response systems provides an opportunity to participate through individual thinking, through discussions with their peers, and through participating in the voting. And they may get immediate or close to immediate feedback on their understanding of the subject matter.

For the teacher, application of response systems provides an opportunity to gain information about the learners' understanding of the subject matter, or whether the posed question elicited typical misconceptions. RPL together with response systems thus provides information the teacher could use to alter their teaching.

The iLike methodology summarised:

1. The teacher poses the question in writing or by showing it on a blackboard, with some remark about the purpose. They ask whether the question is understood.
2. The learners are instructed to think for themselves for 1-2 minutes and then vote.
3. The learners are instructed to discuss their views with their peers. For practical reasons, it is most appropriate with pairs of peers or in small groups of 3 to 4 learners
4. When there is a notable "dip" in the sound level in the group, it is typically time for the teacher to instruct the learners to cast their vote as a group.
5. After the learners have cast their votes, the teacher reveals the distribution of answers
6. Further action depends on the distribution of answers. (See below)

If the answers are evenly distributed, the learners are engaged in a plenary discussion. The teacher asks the learners about their reasoning, typically starting with the alternative, which got the most votes. After this discussion, the teacher makes a concluding summary, providing a rationale for both the correct and wrong alternatives.

If most of the learners have chosen the correct alternative the teacher asks learners to explain their reasoning and then to address the incorrect alternatives and comment, before providing a concluding summary.

If *everyone* has chosen the correct alternative, the teacher conducts a quick check to see whether

their reasoning is appropriate, before moving on. This may indicate that the question has been too easy.

If most of the learners chose the wrong alternatives, the teacher considers:

- If there is reason to believe that the learners hold known misconceptions, they can be asked to explain their reasoning. The teacher needs to take time to explain all the alternatives.
- If a significant number of learners have signaled this may indicate that the question has been posed prematurely, in which case the teacher should consider leaving the question for the time being, and to pose it again later.

As a note of caution, it could be argued that revealing the distribution of answers may affect the subsequent plenary discussion negatively, depending on how the learners have answered.

The learning resources applied in class by Gurri Kunna teachers consisted of cases and examples presented on power point presentations. The teachers use these to give an integrated presentation that targets all the 3 main areas in the curriculum. They try to avoid applying cases and examples that illustrate only one or two areas in the curriculum. These learning materials are organized in a separate file. In addition, the students were provided some learning exercises to work on in-between the classroom-based sessions.

3.   RPL/APL pilots

The resources, technology and pedagogy developed for RPL and APL were piloted within the classroom and work-based learning in Norway and Scotland respectively.

The main pilot group in mid Norway were 50 mature learners from industry who were employees of several local salmon farming companies in the Mid-Norway area. They undertook 16 classes of 2.5 to 3 hours duration during evenings. Feedback was gathered regularly after classes and some of it recorded as videos. (See the project web site stimuli)

In Scotland there were three groups representing a total of 18 learners providing formal and informal feedback to Inverness College teachers within various phases of the work-based learning RPL/APL pilot. They were part way through their Aquaculture Modern Apprenticeship which is concluded by each individual learner, whenever their final 'portfolio of assessment evidence' has been submitted and validated as complete and satisfactory by the Inverness College Assessors and Internal Verifiers.

The feedback gathered from learners and teachers in both countries has been analysed, ultimately leading to an improved specification for RPL and APL (See Output 9 report)

3.1 Feedback from work-based learners in Scotland

3.1.1 Multiple Choice

Learners provided feedback to their MA program lead tutor informally and formally. This were gathered by the lead tutor and returned to PLI. The full analysis is available in Appendix 4 and the data returns are presented on the Optimal project web site – Stimuli.

The commentary derived from the data is provided in this report (see appendix 4 -Feedback from MA learners).

The learner's comments were both helpful and insightful and the results of the quantitative analysis can be summarised as follows:

   a)   On-line multiple-choice technology and question sets

Most learners found the online quiz to be stimulating and enjoyable. One commented that it was a 'refreshing change' and a 'good use of technology'. Others enjoyed the idea of "doing it on my phone" and "liked using the technology".

 It was a little difficult for one learner to read the Feed Table image on their mobile phone. The image was set at 1046px × 390px so it is more likely that the size of the phone screen is the limiting factor. An important point to note given that all attempts were carried out on a mobile phone, not a laptop or tablet.

Interestingly, the learner least comfortable with the use of multiple-choice questions were the highest qualified (Degree in Aquaculture/ SVQ level 3 and currently studying MSc). Their feedback was on question structure as they felt that some questions didn't provide enough options to select from – as there were more correct answers than given and multiple choice gave no way to explain your answers and so may not reflect the learners' actual knowledge. As someone with Higher Education experience, it seemed they longed for the opportunity to elaborate and display the full depth and extent of their knowledge. However, the multiple-choice questions had been devised to

reflect the Aquaculture MA knowledge requirement precisely as prescribed and therefore did not provide this opportunity. As there was an APL ambition, to do so would have led to assessment beyond the level of the NQ, contravening the Awarding Body (SQA) standards.

Generally, based on most of the feedback, the questions appeared to do their job for all but one (who had just started the MA and had only been working in aquaculture for 8 months) they were clear and easy to understand and they were relevant to all and made learners think. In general, they were perceived to be at the right level and a fair test, although interestingly, the individual identified above found the questions too challenging.

One learner with 23 years' experience in aquaculture, previously working in the feed industry, felt that some questions seemed very similar i.e. about feed conversion or fish growth. He also highlighted an error in an answer that referred to an outlawed pigment no longer added to fish feeds.

b)   Multiple answer type questions

The fact that 'multiple answer' type questions were not sufficiently differentiated from other types was highlighted by one learner. Unfortunately, Socrative does not use the standard convention for this type of question i.e. square buttons rather than round buttons for the selection. The learner suggested the wording should be BOLD as well as the question itself. Fair point. The wording in all cases where the number of selections was not specified was: Select as many as you believe to be correct. (One or more may be correct.) ALL correct answers must be selected. NO MARK is given if there are any mistakes.

The wording usually used for this type of question confirms that 1 to …. (whatever the full number of options is) may be correct. Regrettably, this more confirmatory wording 'that all may indeed be correct,' could not be used because of the limitations of the Socrative software highlighted above. One candidate, who has just started the MA but has been working in aquaculture for 8 years, commented that he found some questions difficult, because he 'wanted to put all the answers down, but 'thought it was trying to catch me out'.

The first two questions did indeed have all options as correct answers. This illustrates the importance of learners having the confidence to believe that they may be correct by selecting all responses. However, many learners will shy away from making such a bold choice, highlighting the need for 'practice' tests to get used to the software and the method of assessment. It also illustrates once more, the need to use software that is truly up to the task in hand. (See staff feedback 3.2.1)

c)   Feedback request

One learner said that it would have been good to know what he got right or wrong during the assessment. Unfortunately, several questions were 'sequential' so that feedback, even right/wrong for one, may have helped to answer the next. Sadly, Socrative does not have the capacity to simply say correct/incorrect. By default, it also gives the correct answer! So, feedback in Socrative was 'out as it was intended to use the results to support APL claims. Other quiz types e.g. Moodle VLE quizzes could be set to indicate right/wrong with no indication of the correct answer.

d)   Marks allocation

One learner said that it would be useful to see how many marks were available for each question. In other software, e.g. Moodle quiz, this is within the question screen by default. This is not the case with Socrative and it would have had to be added into the question text. This was a fair point – it

should be either specified in each question or stated at the start of the quiz that all questions are worth one mark. One question was answered correctly by everyone. It could be regarded as 'Extremely easy' but still a question you need to ask.

3.1.2 Learning episodes – work-based learners Scotland

Informal qualitative feedback on learning episodes delivered to learners was all positive, and they found that they were able to address their knowledge gaps in a well targeted manner, informed by the Socrative RPL/APL multiple choice result. They appreciated the clarity, brevity and style of the learning materials and found them to be a beneficial addition to their programme.

Learners found that this RPL driven delivery of knowledge and understanding complimented their Aquaculture MA as it was not based on farm specific assessment evidence gathering, but provided a wider aquaculture curriculum and a more diverse learning experience.

As a result, the Inverness College teachers are incorporating selected learning episodes within the development of their VLE/e-portfolio development during 2020, which will link RPL to learning and the gathering of related 'evidence of performance' (practical skills and competence)

3.2 Feedback from Guri Kunna learners in mid-Norway

A pilot for NQ Aquaculture was conducted during the period 2018/2019 and 50 participants participated in the course with 48 of them again signed up for the national theory exam. All 48 passed this exam with a mean score of 3.5 at a scale from 0 to 6 (best). During the previous 3 years, 53 learners passed the exam with a mean score at 3.2.

During the course, as well as using the response systems to obtain an overview of the group's prior knowledge, leading to discussion and engagement on various topics, it was used to periodically gather feedback from the learners on learning methods and their attitude towards the course as they progressed.

3.2.1   Documented feedback from the learners during the course:

1. How do you experience cooperation in planning and completing the course and course sessions?
    a. Excellent – 7,1%
    b. Good – 64,3%
    c. Medium good – 28,6%
    d. Bad – 0%
    e. Very bad – 0%
2. Has the course, as a whole, been useful in relation to academic content?
    a. Excellent – 6,7%
    b. Good – 80%
    c. Medium good – 13,3%
    d. Bad – 0%
    e. Very bad – 0%
3. Has the learning material been useful in relation to academic content?
    a. Excellent – 6,7%
    b. Good – 80%
    c. Medium good – 13,3%

d. Bad – 0%

e. Very bad – 0%

4. The teachers' academic competence in relation to the course's subjects?

   a. Excellent – 20%

   b. Good – 73,3%

   c. Medium good – 6,7%

   d. Bad – 0%

   e. Very bad – 0%

5. Teacher's ability to facilitating learning?

   a. Excellent – 6,7%

   b. Good – 73,3%

   c. Medium good – 13,3%

   d. Bad – 6,7%

   e. Very bad – 0%

6. The ability of the organizer to facilitate learning.

   a. Excellent – 6,7%

   b. Good – 80%

   c. Medium good – 13,3%

   d. Bad – 0%

   e. Very bad – 0%

3.2.1 Structured interviews

In addition, structured interviews were conducted and recorded with 3 learners. Major findings include this:

Learner 1:

- The discussions that arise after using the iLike take place between staff from different farms and between staff from different companies. The staff from the farming sector learns a lot from those working in the hatcheries, and vice versa.
- The fact that the iLike voting is anonymous engages and motivates learners to participates and provide feedback. This led to more discussions. Giving feedback through the iLike response system create engagement and stimulates discussions. It would be more challenging for the teacher to achieve this without applying the response tools.
- By applying the iLike response tools you lose some teaching time offered from the teacher. However, I feel I recover the lost teaching time by quickly collecting the feedback from my peers, thus creating an overview of the important parts of the curriculum. The collaborative development of the key words through the iLike response tool is very helpful when preparing for the exam.
- My experience with the iLike response system in the class is very good. The group can share or express their view, and you can apply it in your own learning process.
- The application of the iLike response system helps initiating discussions in the class. It collects the view from the class as a group.
- Since learners have different experience, skills and knowledge discussions arise.

Learner 2:

- The benefit with this kind of teaching is that it is not boring. It creates engagement and discussions in the class. Everybody participates, thus reducing the one-way teacher lead training.
- The iLike response system is very helpful to me because you understand what the other learners know. If I tried to do this alone, I may be found 3 words. By using the iLike response system I learned 20 words in a few minutes.
- I learn from those who are experienced, and I have a good plan for how to pass the exam, even though I feel I lack some experience.
- I receive the questions on my cell phone and may give feedback anywhere. During a lunch break, at the bus or at home. The iLike response system stimulates discussions about the key features. You learn a lot by discussing the key subjects in small groups or in the class.
- I have learned a lot during the course from the experienced staff that participates in this course. I especially learn a lot by applying the iLike response system. It lets the class share their experience and knowledge. It is anonymous such that the learners can answer without worrying about what the other, more experienced, learners may think.
- We have used the response tool, "Eval", to give feedbacks to the teacher. This gives the teacher an overview of what the learners know, and don't know.
- Compared to ordinary classroom-based training this method is not boring as I get engaged and everybody in the class participates in the discussions.
- There are more discussions in the class and they have replaced the "traditional" one-way teacher lead lecturing, whereby inexperienced learners learn better from their experienced peers.
- The tool is very easy to use and you answer with your cell phone. Giving feedback does not take more than 5 minutes.
- By using the feedbacks from the class, the teacher will know what to focus on during the lecture.
- It is important that the tools and method is easy to use.

Learner 3:

- The teachers can more fully facilitate the course plan by "reconnoitring the terrain" relative to what we did know in advance of the course and each lesson.
- There were not many questions and it didn't take a long time answering.
- The questions were specific, and the application was easy to use, indicating your competence, and the lessons have been facilitated based up on our feedback results.
- You receive a message on your phone a few days before a lesson starts. When I have time available, I may access the evaluation and complete the survey. If I get the message at work, when I am busy, I can just reply to it when I am back at home. It only takes a few minutes to reply.

In addition, the organizer of the VET course has received several very positive oral feed-back on the pilot from several site managers at the participating sites. This has created attention among the farming companies in Mid-Norway. Movi Mid-Norway (previously Marine Harvest Mid-Norway) has during the summer 2019 requested if Guri Kunna could train every staff that still lacking a NQ in aquaculture.

4. Summary evaluation of learner feedback

The feedback from the learners involved in the Optimal pilots in Norway and Scotland presented above were of paramount importance to the evaluation of Optimal by the teaching staff and partners and the formulation of conclusions (Output 9). It was overwhelmingly positive.

The work-based learners in Scotland, with one exception, liked to use of the Response Technology (RT) Socrative, and had no operational difficulties. As the results of the multiple-choice questions were to be used to support an APL claim, the RT activity was invigilated by the tutor during their routine farm visits, which helped to build their confidence.

Despite having no assistance with the use of their One2Act Response Technology, the Gurri-Kunna learners, the system was intuitive, and they had no difficulty completing un-invigilated multiple-choice questions on their phone, several days before their next classroom attendance. They used the same devices and One2 Act system in the classroom as an integral element of their course. They appreciated being able to undertake the multiple-choice questions at their own convenience and supported the idea of limiting the number of questions presented to 10-12 at any one time.

In Scotland the use of 'concrete questions' to support both RPL and APL was well received, with most enjoying the experience and finding the 'level of difficulty' of the questions about right. However, it appeared that some may have been were inhibited, due to risk aversion, when multiple correct responses to a question were required. The Inverness lead tutor was surprised by some of the results, as some more knowledgeable and experienced mature learners would often miss one of the correct responses and therefore fail to complete the task fully and accurately. They clearly needed more practice RPL to get used to the idea that many, or even all the responses may be valid in order to confidently make their selection.

Despite the restrictions of the Socrative RT system in Scotland, the learners appreciated the discrete 'learning episodes' delivered vi e-mail, following RPL and based on their results. They supported guided self-study and helped them to target their efforts in the key areas of weakness. They found this method of RPL and learning delivery complimented their paper-based portfolio system and was a step towards a better blended learning delivery mode.

All the RPL applications to the classroom-based pedagogy at Gurri Kunna (pre-testing and in class activities) were acknowledged as positive aspects of the course by learners. The less experienced appreciated the peer learning opportunities. The sharing of 'group knowledge' was especially valuable as an assistance to integrating knowledge across subject boundaries, towards the end of the course when preparing for their final examination.

Appendix 1   Multiple-Choice Questions (Fish Nutrition and Growth sample)

Nutrition and Growth

A series of questions relating to fish nutrition in general. These questions are not specific to salmonids

Title: NG Bank 1 Nutrients role ID1

Which of the following nutrients can be used as an energy source by fish?

Select as many nutrients below as are correct

*a) Proteins

*b) Carbohydrates

c) Minerals

d) Vitamins

*e) Fats

f) Don't know

Title: NG Bank 1 Nutrients role ID2

What is an essential nutrient?

Select as many statements below as are correct

*a) A nutrient that cannot be synthesised by the fish or substituted and must be consumed

b) A nutrient that can be metabolised to provides an energy source to the fish

*c) A nutrient that must be consumed to avoid nutritional deficiency diseases

d) A nutrient provided in manufactured fish diets to boost the immune system

f) Don't know

Title: NG Bank 1 Nutrients role ID3

Which of the following can contain essential nutrients?

Select as many from the list below as are correct

*a) Proteins

b) Carbohydrates

*c) Minerals

*d) Vitamins

*e) Fats

f) Don't know

Title: NG Bank 1 Nutrients role ID3

What is the main role of protein in manufactured fish diets?

Select as many statements below as are correct

a) To provide an energy source

b) To provide a source of pigments

*c) To provide essential nutrients

*e) To provide the resources for muscle growth

f) Don't know

Title: NG Bank 1 Nutrients role ID3

What is the main role of carbohydrate in manufactured fish diets?

Select as many statements below as are correct

*a) To provide a low-cost energy source

b) To provide a source of pigments

c) To provide essential nutrients

e) To provide resources for muscle growth

f) Don't know

Title: NG Bank 1 Nutrients role ID3

What is the main role of fats in manufactured fish diets?

Select as many statements below as are correct

*a) To provide an energy source

b) To provide a source of pigments

*c) To provide essential nutrients

e) To provide resources for muscle growth

f) Don't know

Title: NG Bank 1 Nutrients role ID3

What are the benefits of optimising the balance between proteins and fats in manufactured diets for carnivorous fish species?

Select as many statements below as are correct

*a) Expensive proteins are not metabolised as an energy source

*b) Fish growth rates can be maximised

*c) Less expensive nutrients provide the fish's energy requirement

*e) Ammonia excretion polluting the aquatic environment is reduced

*f) Food is converted into growth more efficiently

f) Don't know

Title: NG Bank 1 Nutrients role ID3

From the following list of minerals, select the two that are needed in fish diets in the highest quantities

Select two of the minerals listed below

a) Sodium

b) iodine

*c) Phosphorous

e) Iron

*f) Calcium

f) Don't know

A series of questions relating to salmonid feeds specifically

Title: NG Bank 1 salmonid feed ingredients ID1

Which of the following ingredients provide a source of protein in salmonid diets?

Select as many below as are correct.

*a) Blood meal

b) Fish oil

*c) Fish meal

*d) Wheat meal

*e) soya bean meal

f) Astaxanthin

g) Don't know

Title: NG Bank 1 salmonid feed ingredients ID2

Why are some of the marine oil and protein sources being replaced by alternative non-marine sources in salmonid diets?

Select as many reasons below as are correct.

a) Many marine oils and proteins can cause taint the flavour of fish flesh

*b) Marine oils and proteins are finite and limit aquaculture expansion

c) Marine oils and proteins contain high levels of toxins damaging to fish health

*d) Marine oils and proteins could become very expensive

e) Marine oils and proteins contain high levels of toxins damaging to human health

f) Don't know

Title: NG Bank 1 salmonid feed ingredients ID3

Which of the following salmonid feed additives pigment the fish flesh?

Select as many below as are correct.

*a) Canthaxanthin

b) Minerals

*c) Shrimp meal

*d) Astaxanthin

e) Fish oil

f) Don't know

Title: NG Bank 1 salmonid feed ingredients ID4

What happens to grain meal during the extrusion process when manufacturing high energy pelleted salmonid feeds for marine growing stage?

Select as many below as are correct.

*a) The carbohydrate becomes more digestible by salmonids

b) It is converted into essential minerals

c) The proteins are made more available

*d) The carbohydrate expands to create a porous pellet

e) Don't know

Title: NG Bank 1 salmonid feed ingredients ID5

What are the main advantages of **extruded** pelleted feeds as opposed to alternative pelleted feeds for salmonids?

Select as many statements below as are correct.

*a) The carbohydrate becomes more digestible by salmonids

b) They are cheaper to produce than any other pellet

"c) More oil can be added to create high energy feeds

*d) They can float or sink at a reduced rate

e) Don't know

A series of questions relating to fish growth specifically

Title: NG Bank 1 Fish Growth ID1

What environmental factors can influence fish feeding activity and growth rate?

Select as many statements below as are correct.

*a) Dissolved oxygen levels

*b) Light intensity

*c) Water temperature

*d) Water quality (purity)

e) Don't know

Title: NG Bank 1 Fish Growth ID2

What fish physiological factors influence feeding activity and growth rate?

Select as many statements below as are correct.

*a) Size

*b) Smoltification

*c) Health status

d) Flesh pigmentation

*e) Sexual maturation

f) Don't know

Title: NG Bank 1 Fish Growth ID3

Which of the following fish stocks would consume the highest percentage of their own biomass?

Select the correct answer.

a) Salmon par in a hatchery averaging 5 Grams

b) Salmon in sea cages averaging 1 Kilogram

c) Salmon in sea cages averaging 2 Kilograms

d) Salmon in sea cages averaging 4 Kilograms

*e) Salmon fry in a hatchery averaging 1 Gram

g) Don't know

Title: NG Bank 1 Fish Growth ID4

What is the optimum temperature range for marine cage farmed Atlantic salmon feeding and growth, assuming fish stocks are healthy and dissolved oxygen levels are 100% saturation?

Select the temperature range that is correct.

a) 18 -23 Degrees C

b) 8- 14 Degrees C

*c) 14-18 Degrees C

d) Above 23 Degrees C

e) 2- 8 Degrees C

f) Don't know

Title: NG Bank 1 Fish Growth ID5
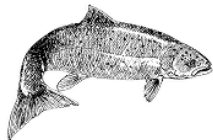
What happens to the oxygen requirement of the Atlantic Salmon after it has been fed?

Select the correct response below.

a) It reduces

b) It stays the same

*c) It increases

f) Don't know

K13 **Fish nutrition and growth**

Which nutrients in food provide energy for fish?

Introduction

All living organisms, plants and animals, require energy to maintain life. In most plants this is obtained through a process called 'photosynthesis'. Here plants create their own energy store (glucose) from water and carbon dioxide using the energy from the sun.

Animals obtain their energy needs from the food they eat. The energy from food is released through the oxidisation of molecules, which breaks food molecules into smaller molecules which can be absorbed in a process called digestion. In animals this process is carried out in the digestive system.
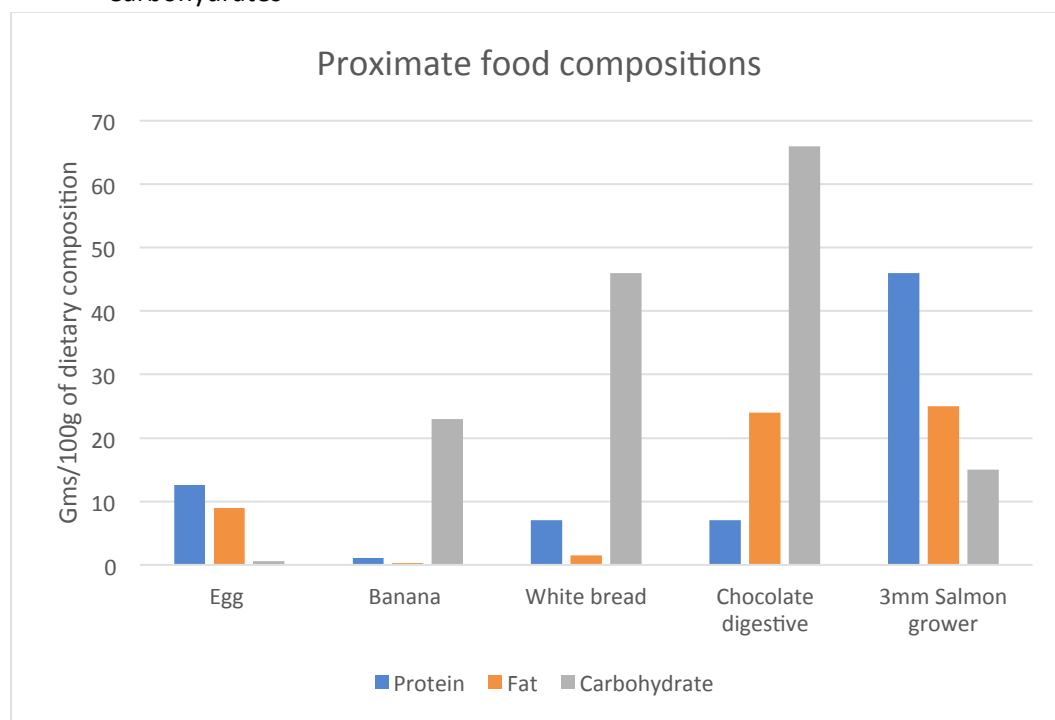
In fish farming, we need to know that the fish are receiving the energy they require to grow and maintain a healthy condition.

First of all, we should understand where energy comes from. This is what we are looking at here.

Sources of energy

The sources of energy in food are:

- Fats
- Protein
- Carbohydrates

Proximate food compositions

This graph shows the % composition of familiar foods compared to salmon feed.

Energy is derived from different sources. There are very obvious differences in the % composition in each of the food items.

- It is important to notice the high protein content of the 3mm salmon grower diet. This is required in a healthy balanced diet for Atlantic salmon because they are carnivores. (However, not all of the protein supplied will be sourced from animal protein. Some will come from plant proteins.) Being carnivores, salmon are not efficient at utilising carbohydrates as an energy source. Hence the low carbohydrate content.

Interestingly you will also notice the high carbohydrate content of some of the foods we eat. This is because we are omnivores and can cope with a more varied diet than carnivores. Similarly, fish that are considered omnivores or herbivores can utilise carbohydrates more readily and so do not require diets with a high protein content.

How do the fish use the energy supplied in a diet?

Not all of the energy supplied in a diet is utilised as an energy source for growth because some is lost through other essential functions.

The table below shows where energy losses occur.

Energy used	Essential function	Approx % lost
Digestion	Breaking down food molecules	5-10
Heat production	Oxidising food molecules	10-20
Faeces	Waste and undigested food	20-30

After these functions have been completed the remaining energy can be utilised by the fish for body maintenance and then growth.

Each of the steps described is usually displayed on the feed labels of the bags the fish feed is supplied in. They are broken down and shown as abbreviations, similar to the table below:

Abbreviation	Name	Description
GE	Gross Energy	The total potential energy available
DE	Digestible Energy	The total potential energy the fish can digest
ME	Metabolisable Energy	The potential energy available after digestion and losses from heat
M	Maintenance	The energy required for all basic functions
RE	Retained Energy	The energy remaining that can be utilised for growth

So to recap the energy sources in food come from proteins, fats and carbohydrates. These are the main ingredients in fish diets. These are known as 'macro' nutrients.

How do we measure the energy in food?

- The amount of energy available in fish food is measured in joules (usually kilojoules = kJ).

What is the energy in a joule equivalent to?

One joule is equal to the energy required to lift a medium-sized tomato (100g) up 1 metre (3 ft 3 in).

Most people are a more aware of 'calories' than 'joules'. So what is a calorie?

Calories are a measure of energy that you will normally see written as a kcal (kilocalories = kcal = C).

A Calorie is a larger measure than a joule: 1 Calorie (1 kcal) is equal to 4.18 kJ (4184 Joules)

What is the energy in a Calorie equivalent to?

1 Calorie (1 kcal) is the energy required to raise the temperature of 1 Kg of water by $1^{0}C$

It can be easier to appreciate energy needs when shown in the context of human requirements for activities as shown in the table on the next page.

All figures are based on an adult weighing 70kg. Calorie requirements are approximate as figures will vary and depend on a range of factors.

Description	Calorie requirement
Woman	Daily maintenance – 2000 kcal/day
Man	Daily maintenance – 2500 kcal/day
Lifting weights	180 kcal/hr
Walking 3-4 miles/hour	300 kcal/hr
Swimming	360 kcal/hr
Running 6 miles/hour	600 kcal/hr
Working at computer desk	80 kcal/hr
Sleeping	40 kcal/hr

The energy used by fish is more difficult to establish. It is also dependent on a range of factors e.g. maximum growth is influenced by water temperature, size/age of fish, diet composition and nutrient availability.

What is the energy value of commercial fish feed?

- The energy content of fish feed is normally shown on the feed bag label as MJ/Kg of pellets. The diet used in the following examples is a salmon grower 3mm pellet with an approximate 23 MJ/kg. This is 23000 kJ per kg of fish feed.

How does this compare to some foods we are more familiar with?
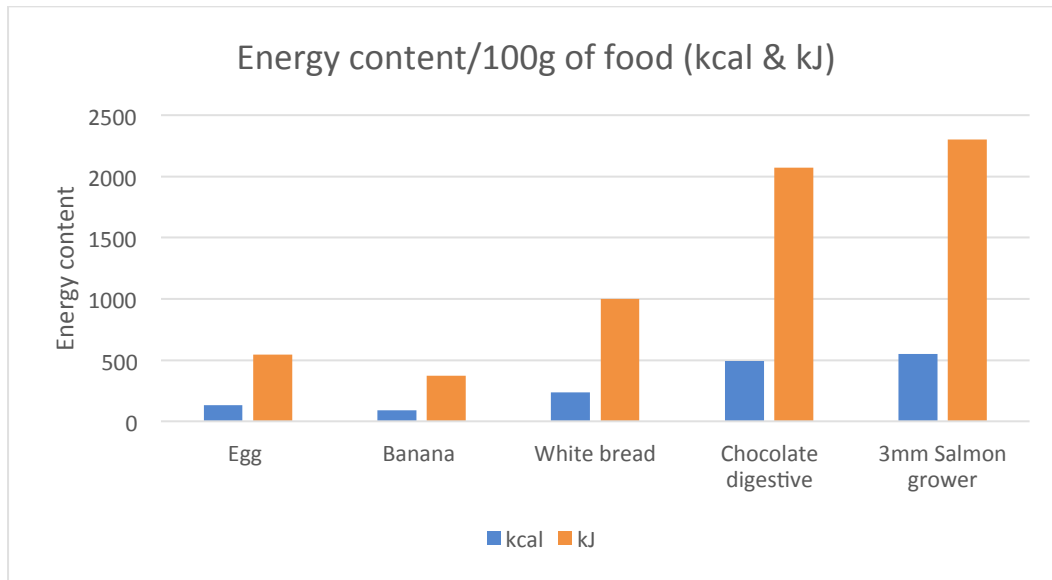
It is obvious that 100g of the 3mm salmon grower diet contains the highest calories count, over 4x that found in 100g of eggs. It is also interesting to note the second highest calories count is in 100g of chocolate digestives. But remember, the energy distribution in all of these food items varies considerably, as we saw in the first graph.

K13 **Fish nutrition and growth**

What are carbohydrates?

What do carbohydrates do?

- Carbohydrates provide energy for omnivorous and herbivorous fish

However, not all fish are efficient at utilising carbohydrates over other energy sources. Carnivorous fish, such as Salmonids, will more readily convert proteins and fats into glucose/energy at the cellular level.

What are carbohydrates made of?

- Carbohydrates are long chains of sugars, which are molecules formed from carbon, oxygen and hydrogen atoms.

Most people have heard of carbohydrates as everyday food items like sugar, bread, potatoes, rice etc. However, carbohydrates are more complex than the generalised description of food items.

Carbohydrates can be found in four states:

Carbohydrate	Common name example	Use or function
Monosaccharide	Glucose	Commonly used as an energy source in living cells
Disaccharide	Sucrose	Used by plants to transport sugars around the plant
Oligosaccharide	Glycans	Commonly attached to proteins and located in cell membranes with an important function in immune response
Polysaccharide	Glycogen and Starch (cellulose)	Glycogen commonly stored in animals as an energy source, or starch stored in plants for structural use.

Carbohydrates in the diet

Carbohydrates are the cheapest source of energy in fish diets. However, carnivorous fish will more readily convert proteins and fats into glucose at the cellular level. Herbivorous fish can cope with higher levels of carbohydrates and will use them as the primary source of glucose.

Even though carnivorous fish are not efficient convertors of carbohydrates, there is still a requirement for them to be added to commercially produced fish feed diets. The carbohydrates used in commercial diets is commonly starch, sourced from wheat.

- The main function of carbohydrates in most fish feed diets is to act as a binding agent for other components, which stabilises the feed pellet.

Appendix 3   Interactive Fish Story Board

Title: Internal Anatomy of the Salmon	Completion Date: 15 August 2018
Responsible person (teaching): Kare Romuld/Jon Ivar Theordorsen	Edited/Validated:
Instructional design: Christine Dudgeon/Martyn Haines	Tested:
Date: 29.5.2018	Launched:

Introduction: *This Powerpoint development is for people involved in aquaculture working towards a vocational qualification. (in Norway, this is the Journeyman Certificate in Aquaculture. In Scotland, this is the SVQ2 in Aquaculture.) They are required to apply knowledge across a wide subject scope. This interactive activity is to be trialled in Norway where it supports classroom work, including practical salmon dissections and question & answer sessions involving the One2Act voting system.*

Who is it for?
The Journeyman Certificate in Aquaculture in the Upper Secondary School of Guri Kunna, Froya, Norway is undertaken by both young learners (16+) taking a vocational qualification in aquaculture, without necessarily any prior experience of the industry and mature learners already in the industry who need to gain this qualification. Both groups attend Guri Kunna but are in separate classes.

Aim of the Powperpoint development:
1. To support the learner in learning to recognise the main features of the internal anatomy of the salmon
2. To support the learner in learning the function of each of these internal features
3. To be an interactive activity where learners can work at their own pace, separately or in groups
4. To be an interactivity that can be used by the teacher on the whiteboard to teach/generate discussion
5. The learning object should be 'stand alone' not requiring to be hosted on a VLE and be able to be easily uploaded on to each learner's laptop

Internal anatomy features:
- Liver
- Kidney
- Swim Bladder
- Intestine
- Spleen

- Stomach
- Pyloric caeca
- Heart
- Gills
- Ovaries
- Testes
- Brain

Software: Microsoft Powerpoint, exported as a Powerpoint Show
Powerpoint may also be converted to HTML5 by processing it through Captivate

Powerpoint set up:
Slide size: standard (4:3) to allow for general whiteboard size and ratios, tablets
Images: work to highest resolution during Master development and compress through Powperpoint prior to Powerpoint show export
Main slide: pale blue background
Custom shows: pale green background. Image to fill screen. Text to the right of or below the feature if at all possible.
(For Powerpoint settings, see end of Storyboard)

Page	Text	Media – graphics, video, diagrams, illustrations etc – (define file format, resolution required etc)	Notes and Interactions
Slide 1

Introductory page | **Internal anatomy of the Salmon**

Learn about the internal organs and what they do.

Click on the salmon to begin. | Photograph of salmon: salmon2_trans.png, width at least 1920 px

Cut -out to show fish only on transparent background | Image of whole fish is hyperlinked to slide 2, to fit approx. on the whole fish then fade again to final image of

20180507_103449.jpg

At a larger size without whole fish as |

			background.
Slide 2 Main page	Hover your mouse over each feature to show its name. Click on each feature to find out about its function. (Click again to return to this page.)	20180507_103449.jpg Cut -out to show fish only on transparent background	Fade from slide 1 to slide 2
Slide 3 Liver	The **liver** is the largest organ in the fish's body and is part of the digestive system. It is essential for maintaining chemical and blood sugar levels in the blood (just as it does in mammals). It stores, synthesises and secretes essential nutrients. Bile is produced by the liver then stored in the gall bladder and released for the break-down of fats. Finally, the liver is a cleansing organ. It removes metabolic wastes from the blood and aids the recycling of old blood cells. (Click anywhere to return to the whole fish)	Photograph: 201180507-103507 width at least 1920 px	Custom Show Liver
Slide 4 Kidneys	Salmon have two **kidneys** joined together positioned under the spinal column. The front kidney produces red blood cells and the back kidney cleans the blood. Urine is collected by ducts near the vent. The kidneys have a critical osmoregulation role to play within smoltification. They allow the young salmon to safely transfer from fresh to salt water. (Click anywhere to return to the whole fish)	Photograph: 201180507-103957 and 105854 width at least 1920 px	Custom Show Kidneys 103957 (Kidney cross section 105854 in situ
Slide 5 Swim Bladder	Salmon fill their **swim bladder** with air for the first time as swim-up fry. The air provides buoyancy, allowing them to hold their position in the water column without using so much energy. They can adjust the gasses in their swim bladder to allow them to alter their holding depth. (Click anywhere to return to the whole fish)	Photograph: 201180507-104339 width at least 1920 px	Custom Show Swim Bladder

Slide 6 Intestine	The **intestine** extends from the pyloric caeca to the anal vent and is relatively short compared with mammals and herbivorous fish. As a carnivore, the natural diet of salmonids is high in protein and low in carbohydrates. Therefore most of the digestion occurs in the stomach. (Click anywhere to return to the whole fish)	Photograph: 201180507-104732 width at least 1920 px	Custom show Intestine Note this image is stomach pyloric caeca and then intestine
Slide 7 Spleen	The **spleen** is a storehouse for blood. It helps to control the amount of blood circulating through the body by creating a reserve pool that can be released during severe bleeding. This helps to improve circulation and oxygenation. The spleen also recycles worn-out red blood cells. (Click anywhere to return to the whole fish)	Photograph: 201180507-103521 and 104159 width at least 1920 px	Custom Show Spleen 103521 spleen in situ 104159 close-up
Slide 8 Stomach	The **stomach** is a 'U shaped' sac-like digestive organ receiving food from the oesophagus. It contains enzyme secreting glands within a folded internal wall. The stomach is relatively muscular in salmonids. It can compress the high protein food to aid digestion. The muscles can also relax, to allow more food to be brought in during periods of intensive feeding. The stomach's pH is 5. This pH is required by the protein digesting enzymes (proteases) such as pepsin that start the protein break down process. (Click anywhere to return to the whole fish)	Photograph: 201180507-104647 width at least 1920 px	Custom Show Stomach Top half of image near hands
Slide 9 Pyloric caeca	The **pyloric caeca's** function is not well understood, but it is thought to secrete digestive enzymes and have a nutrient absorption role. Since it takes the products of digestion into the blood stream for internal-transportation round the body, it can be likened to the small intestine in mammals. (Click anywhere to return to the whole fish)	Photograph: 201180507-103456 and 103515 width at least 1920 px	Custom show Pyloric caeca 103456 (mid view in situ)103515 (close up)
Heart Slide 10	The heart is connected to gills by the ventral aorta and drives the blood round the body via a 'single circulatory system'. Once the blood has been pumped to the gills to absorb oxygen it then passes round the rest of the body. This is not like mammals, where the blood returns to the heart before being pumped round	Photograph: 201180507-104126 and 104138 width at least 1920 px	Custom Show Heart 104126 in situ

	the body within a 'double circulatory system'. (Click anywhere to return to the whole fish)		104138 close-up
Slide 11 Gills	Healthy gills are red because they are filled with oxygen rich blood. They take oxygen from the water by diffusion and expel carbon dioxide into the water. The gills contain lamellae which are fine, branched structures only two cells thick, to provide the greatest possible surface area. They perform the same function as alveoli in the mammalian lung but do so more efficiently. (Click anywhere to return to the whole fish)	Photograph: width at least 1920 px	Custom Show Gills No image but they must have one, ideally a close up of lamellae
Slide 12 Ovaries	The female reproductive organ which produces eggs.	Photograph: 201180507-105829 width at least 1920 px	
Slide 13 Testes	The male reproductive organ which produces milt containing sperm.	Photograph: width at least 1920 px	May be harder to source
Slide 14 Brain	The control centre of the nervous system.	Photograph: width at least 1920 px	Need to ask. Must be available from dissections

Appendix 4   Feedback from Scottish Aquaculture MA learners

Evaluation of the Socrative Quiz for Accrediting Prior Learning June/August 2019

Response to the Quiz Results and to Candidate Evaluation

1. Running the quiz

a) Socrative

The major concern with the Socrative quiz was the Multi- answer multiple choice question type.

In such a question, the software allows as many selections as there are correct answers. So, if there are 3 correct answers out of 5 options then only 3 options can be selected rather than the usual situation where you can select as many as you believe to be correct (i.e. potentially all of them but get penalised for incorrect selections).

This meant that what would normally be a much more challenging question type became a potential weakness if the candidates caught on to it. Two questions where all options were correct were used at the start of the quiz to 'put them off the scent'. Also candidates were not allowed to go backwards and forwards through the quiz and change their selections.

It would appear from the results and comments that only one learner realised this weakness 'Be allowed to select all options if you think they apply.'

Until the Socrative software improves (which it is hoping to do in the near future as there has been more than just our feedback on this limitation), Socrative should be used for questions where they are asked to select a specific number of answers e.g. 'Select ONE' or 'Select TWO'.

Socrative describes itself as a 'classroom app for fun, effective engagement and on-the-fly assessments.' It can be used either in the classroom or with learners who are learning remotely. It works on computers, laptops, tablets and phones. It is primarily Response Technology for formative assessment, ideally in a classroom. It was pushed it to its limit with APL but its ease of use and being so readily accessible, with no accounts required but still recognition of individual learners, proved its worth.

b) Technology Interestingly, 12 out of 13 used a mobile phone, 1 used a computer; 12 out of 13 had access to broadband, 1 used 4G with their mobile phone. There were no technical hitches.

c) Level of questions The questions appeared to do their job: to all but one (who had just started the VQ and had only been in working in aquaculture for 8 months) they were clear and easy to understand; to all they were relevant and made the candidates think. In general they were considered by the candidates to be at the right level and a fair test, though the candidate identified above found the questions too challenging.

2. Candidate feedback

Most found the online quiz to be stimulating and enjoyable. One commented that it was a 'refreshing change' and a 'good use of technology'. Others 'Enjoyed the idea of doing it on my phone' and 'Liked using the technology'.

Their other comments were both very helpful and insightful.

a) It was a little difficult for one learner to read the Feed Table image on their mobile phone. The image was set at 1046px × 390px so it is more likely that the size of the phone screen is the limiting

factor. An important point to note given that all attempts were carried out on a mobile phone, not a laptop or tablet.

b) The fact that Multiple Answer Multiple Choice type questions were not sufficiently differentiated from other types was highlighted by one candidate. Unfortunately, Socrative does not use the standard convention for this type of question i.e. square buttons rather than round buttons for the selection. The candidate suggested the wording should be BOLD as well as the question itself. Fair point. The wording in all cases where the number of selections was not specified was: Select as many as you believe to be correct. (One or more may be correct.) ALL correct answers must be selected. NO MARK is given if there are any mistakes.

The wording usually used for this type of question confirms that 1 to …. (whatever the full number of options is) may be correct. Regrettably, this more confirmatory wording that all may indeed be correct could not be used because of the limitations of the Socrative software highlighted in 1a. One candidate, who has just started the VQ but has been working in aquaculture for 8 years, commented that he found some questions difficult because he 'wanted to put all the answers down' but 'thought it was trying to catch me out'. The first two questions did indeed have all options as correct answers.

This highlights the need for candidates to have 'practice' tests to get used to the software and the method of assessment. It also illustrates again the need to use software that is truly up to the task in hand.

c) One candidate said that it would have been good to know what he got right or wrong during the assessment. Unfortunately, several questions were 'sequential' so that feedback, even on right/wrong on one may have helped to answer the next. Sadly, Socrative does not have the capacity to simply say correct/incorrect. By default, it also gives the correct answer! So, feedback in Socrative was 'out'! Other quiz types e.g. Moodle quizzes could be set to indicate right/wrong and no indication of the correct answer.

d) One candidate said that it would be useful to see how many marks were available for each question. In other software, e.g. Moodle quiz, this is within the question screen by default. This is not the case with Socrative and it would have had to be added into the question text.

Fair point – either specify in each question or state at the start of the quiz that all questions are worth one mark … and so on.

e) The candidates least comfortable with the use of multiple-choice questions were the highest qualified (degree in aquaculture/ SVQ level 3 and currently studying MSc). Their feedback was on the structure of the questions: some questions didn't give enough options to select from – there were more correct answers than given; multiple choice gave no way to explain your answers and so may not reflect the candidate's actual knowledge.

3. The questions themselves A candidate with 23 years' experience in aquaculture, previously working in the feed industry, felt that some questions seemed very similar i.e. about feed conversion or fish growth. He also highlighted an error, in a no longer legal 'correct' answer.

One question was not answered correctly by any of the candidates. It was a multi-answer question that many got partially correct. This question needs to be examined to find out: • Is it a poorly written question? • Is it a question no one needs to know the answer to? • Has it identified a significant knowledge/understanding gap?

One question was answered correctly by everyone. It could be regarded as 'Extremely easy' but still a question you need to ask.

Although there are only 13 candidate results, it is a helpful start on the analysis of the questions to look at them through Moodle's consideration of the Facility Index (the percentage of candidates who got that question correct). At this stage: 9 of the 14 appear to be about right 2 of the 14 are moderately difficult 1 of the 14 is difficult 1 of the 14 is extremely easy 1 of the 14 is either extremely difficult or something is wrong with the question

4. Points to note If using Socrative in the future: • The Multiple Choice questions should only be used for questions where they are asked to select a specific number of answers e.g. 'Select ONE' or 'Select TWO' etc. • Indicate the mark for each question.

Development of online objective tests requires a team effort (including current industry input to keep up to date) and time to test and check and review.