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1 Publishable Summary

Within FNS-Cloud, there are specific tasks (located in WP6 Dissemination, Communication & Community Engagement and WP7 Education, training & support) associated with the development of educational and professional development resources to support use of FNS-Cloud resources (data, tools, and services) but also address barrier to re-use of existing and emerging food [and] nutrition security resources including lack of (1) awareness and (2) confidence; (3) disparity in access; and (4) fragmentation. These activities have, in themselves, required innovative use of social and practice-based learning. In D7.4 Publication: Case Studies and Innovative User Cases, we describe two such innovations within FNS-Cloud.

The first is a reflective paper on design and development of an online community of practice platform and its use as a collaboration tool by the consortium during the project and preparation for the platform as a key exploitable result, i.e., a sustainable resource hub for FNS-Cloud user communities. A critique is offered that allows for improved design and use of such platforms in future large multidisciplinary projects.

We will never know if myFNSCloud might have fulfilled its potential sooner and more easily if face-to-face meetings had continued as normal, or a Google (shared) drive had not dominated as a route for collaboration and exchange, meaning the imperative for myFNSCloud was not clear and engagement minimal. Latterly, because face-to-face events were possible, value was delivered through training and personal development opportunities as well as providing a repository for education and training resources, increasing awareness and engagement. Now, the role of the platform as a knowledge hub has been clarified and there is an appreciation of its potential to add value for user communities.

The second use case considers distribution of funds for practice-based learning and how these can be administered through a competitive scheme in a clear and transparent manner to support work within a large multidisciplinary and multinational research and innovation project. It is presented as a handbook, providing a background on practice-based learning, process for running such a scheme, criteria for assessment of such grants, and reflective reporting by recipients, which will be published via the FNS-Cloud Zenodo Community to encourage re-use and further development of practical learning schemes.

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2. Setting up an on-line Community of Practice within a STEM European Research and Innovation Project – reflections on design from the potential to maturing stages

2.1 Abstract

The original formulation of communities of practice (CoP) focused primarily on describing how learning, meaning, and identity within a community can translate into a sustained practice. The main proponent of COPs, Etienne Wenger, elaborated upon the concept of landscapes of practice to describe how different CoPs might interact, and belong to broader landscapes of practice, rather than rely exclusively on local practices (Farnsworth et al. 2016). We applied this perspective to an online COP (myFNSCloud) designed for Food Nutrition Security Cloud (FNS-Cloud), which received funding from the European Union's Horizon 2020 Research and Innovation programme (H2020-EU.3.2.2.3. – A sustainable and competitive agri-food industry) under Grant Agreement No. 863059, with the purpose of developing a cloud solution to fragmentation of food and nutrition security data and research across Europe. myFNSCloud was designed with two different, but sequential purposes, namely to (i) develop a community for the consortium (35 beneficiaries) from a range of disciplines in the public and private sectors and (ii) evolve into a platform open to FNS user communities, which are multi- and transdisciplinary. In this paper, we explore how the concept of CoPs can support the design and evolution of such platforms for the benefit of user communities and support realisation of Open Science.

2.2 Introduction

International collaboration amongst researchers has been the driving force of EU-funded Frameworks and Horizon Research Programmes since 1984 (Fiorini, & Vasile 2011), underpinning the European Research Area (ERA). Originally, this endeavour aimed to build technological research capacity[1] but is now more focused on innovation and growth across European Union Members States and beyond. Consequently, there has been a striking move to multi- and transdisciplinary working providing specific solutions to societal issues and challenges, which requires collaboration amongst disparate disciplines and professional practices, often geographically dispersed, and actors at all stages in the innovation cycle (Schoen et al. 2005). Simultaneously, the top-down demand for Open Science practices, with free exchange of data and other outputs is the norm, conflicts with many research assessment regimes, which measure achievement for individuals and organisations based largely on closed criteria (Bölling & Eriksson 2016). Thus, working structures and roles within the ERA need to respond or adapt to new funding patterns, introducing new measures of esteem that will support and encourage FAIR principles and Open Science (Jackson 2014). Collaboration needs not just to allow access to different experts but enhance collective research productivity. Hunter and Leahey (2008) examined trends in collaboration over a 70-year period. They found that, between 1935 and 1940 only 11% of published articles were co-authored, whereas between 2000 and 2005 almost half were co-authored. Tacke (2011) identified drivers for collaboration including growth in the complexity of research problems, which can only be addressed through multi-expert consideration. In this paper, we considered first the evolving nature of scientific knowledge production

[1] https://eur-lex.europa.eu/EN/legal-content/glossary/european-research-area-era.html

and how this is driving the changing nature of research groups, collaboration, and data sharing. The focus was on how collaboration can be facilitated and, specifically, how online communities for data sharing, repositories, and community building can be used to add value and create sustainability through exchange. The evolution of the web has enabled a range of tools to support collaboration and enabled interactions to be virtual, muti-partnered, and synchronous, and this approach was accelerated by the pandemic (2020-2021) and latterly by evolving remote and face-to-face working practices post-pandemic. Online communities are now increasingly the norm after proven efficacy in a variety of contexts (Marques et al. 2016) and we discuss the specific case of an online CoP (myFNSCloud) and its role in Food Nutrition Security Cloud (FNS-Cloud), which received funding from the European Union's Horizon 2020 Research and Innovation programme (H2020-EU.3.2.2.3. – A sustainable and competitive agri-food industry; Grant Agreement No. 863059).

2.3 The nature of scientific collaboration

Those involved in scientific inquiry have sought discussion and collaboration since the first academies, with the dual purposes of validation and exploration of discovery through critique from peers. An early example is the UK Royal Society founded in 1660, which brought together leading scientific thinkers identified as Fellows (Sandby, 1862), who chose the motto *nullius in verba* (*take nobody's word for it*). The motto and arms invoked their philosophy to discover new knowledge by first-hand experience, rather than rely on the authority of established wisdom. Often working alone, the Fellows nonetheless valued the discussion and validation with others of their work, i.e., production of science was a collective activity. Since then, professional bodies/ associations/ networks have become increasingly common for many professions, areas of expertise, methodologies, and disciplines (Fillery-Travis & Collins 2017). They form the gatekeepers to communications with peers in an area of study or practice, and provide opportunities for public dissemination, critique, and acknowledgment of contributions. Many have their own journals and publishing houses providing custodianship of the '*body of knowledge*' and the '*regime of truth*', under which they operate, safeguarding established and agreed criteria for quality in the field and enhancing trust amongst stakeholders (Neal & Morgan 2000).

Whereas Fellows were usually lone researchers, the research group quickly became the custom. Based in universities as a core training vehicle for graduate and post-graduate students under the supervision of a Master in the field, these groupings also provided a ready workforce to enact experiments designed by the lead researcher. This has become the conventional model of research groups, i.e., a collection of researchers within a single or highly related area of science at different levels of development under the mentoring of a senior research leader. This infrastructure allows for training and development of junior researchers (or indeed other practitioners in different sectors, e.g., junior doctors and consultants in healthcare and pupil and barrister in law) whilst generating robust knowledge that feeds directly into under- and postgraduate curricula (MacKenzie, 2014). Such research units can also be found in industry and government as effective routes for project management and collaborative working.

This description is, in effect, a role-specific example of a group or team with a distinct hierarchical structure, based on credentials, with junior members moving upwards towards research leader (Evans 2014). Skill sharing is central to the purpose of the group and specialisation is limited to the research focus. Membership of the team is often time bound with students moving on after graduation and post-doctoral

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researchers engaged increasingly on short-term contracts linked to external funding. Outputs from the team are assessed based on the number and quality of dissemination (i.e., peer-review publications) and, latterly, communication (i.e., exchange with stakeholders) within tightly regulated frameworks and templates (Fox, 1983). There is often significant internal competition within the team for co-authorship of these outputs, as the career advancement and organisational value is dependent upon their reckoning. Thus, depending on the specialism, sharing of data is restricted to known and trusted collaborators. This means career stage is critical in the effectiveness of collaboration because research leader tends to have larger networks and their role as supervisors is to mentor junior members in such relationships (Dusdal & Powell 2021). However, such working practices are evolving across natural and social sciences in response to funding; specifically complex projects requiring scientists to work internationally and collaboratively across disciplines, cultures, language, and organisational context as well as the top-down demand for Open Science practices and FAIR principles (findable, accessible, interoperable, and reusable) (Jacobsen et al. 2020).

Considering the complexity and causation of most vexing ethical, legal, environmental, and societal issues efforts to foster greater collaboration among scientists from different fields are not just useful but essential for addressing these problems (Stokols, Hall et al. 2008). However, therein, the principals of research design and execution are also more complex and teamwork more demanding, requiring interpersonal, managerial, and professional skills that most researchers do not engage in learning during under- or post-graduate studies. The potential for misunderstanding and conflict is real and commands an appreciation of factors that promote transcendence of individual disciplinary perspectives and integration of knowledge, concepts, and methodologies drawn from multiple disciplines i.e., development of a shared conceptual framework that is genuinely transdisciplinary. A topology of contextual influences that supports such work has been proposed by Stokols et al. (2010) and identified team attributes, such as diversity of perspectives, social cohesiveness, organisational climate of sharing, positive attitudes towards sharing, and participatory leadership styles. In effect, it is not the research leader who must collaborate but also their team, and the researcher leader might not be the expert in the primary topic of interest.

Individual personality attributes required to promote formation of high-performance teams in multi- and transdisciplinary projects has been subject to study in the business community for some time, and a five-element model has emerged to be of some use. Firstly, the need to integrate knowledge and methods across subject areas to produce synergistic results puts a strong premium on openness to ideas and, unless this is a feature of a majority of the team, exploratory and creative behaviour might not be sufficiently prominent to solve the problems at hand. Secondly, these problems are difficult by definition and require team members to be, and hold one another, accountable for performance. In other words, conscientiousness is a key trait required from the members. Also, while a certain level of neuroticism provides challenge and the urgency necessary to prevent complacency, too much will disrupt team performance. Finally, teamwork is preferred behaviour for extroverts, while reflection is typical of introverts, which suggests a balance of these behaviours is ideal (Collins, 2015).

Motivations to engage in such collaboration are many and varied including access to research funds, greater visibility of research, and enhancement of reputation as well as access to research infrastructures and skills. There are more personal issues including friendship and personal advancement (Celano & Mitchell 2014) but there are also significant challenges such as the time required to nurture these collaborations, the potential to overlook junior researchers, and the risk that the research leader may not be involved as they have already moved on to the next proposal for funding. Project management or

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administration of international research collaborations is, therefore, significant with task allocation, contrasting cultural and organisational expectations and norms, distribution of labour, monitoring, and communication requirements major undertakings and pivotal in success (Dusdal & Powell 2021). Thus, the classic research group must evolve from being self-contained within an area of research with a rolling membership producing publications to something much more dynamic and capable of bringing in a range of discipline perspectives and methods to bear.

Managing and leading research clusters of this type requires not only an identification of how scientific researchers produce knowledge but also how to address potential communication challenges linked to working in different locations and speaking different native languages, whilst still using English as the *lingua franca*, and having language specific to their specialisms. These demand clear communication styles to create understanding, trust, and sensitivity, advanced social planning, and technological support (Livingston 2003).

2.4 Knowledge creation in research groups

Scientific practitioners are required to categorise, analyse, and critically engage with knowledge from a variety of settings before applying and testing their hypothesis. This knowledge - creating and - validating defines epistemic practice or knowledge producing practice. Originally constrained within scientific professions, the nature of work within knowledge societies requires recognition of epistemic practice within the activities of many advanced practitioners in a variety of contexts (Knorr-Cetina, 1999). How this form of practice impacts upon professional development and communication needs of such individuals is, therefore, essential. The first element is the highly tacit nature of knowledge that underpins individual practice. Indeed, there is an interesting definition of expertise as the '*ability to function fluently and flexibly in complex domains without being able to describe or theorise one's expertise*' (Atkinson & Claxton, 2000). The expert can affect performance negatively as soon as they become conscious of the process – their practice, somewhat like forgetting personal identification numbers when over-thinking input.

No doubt routine activity, and the knowledge that underpins it, is a significant part of research practice but it is not epistemic practice of knowledge generation and validation. In this mode, practitioners are acting out of their routines as they are confronted by the non-predictable and ambiguous. Here, the individual steps back, or becomes dissociated from the object of their practice (process, activity etc), which is problematic or incomplete, i.e., has unknowns that are complex and liable to unfold into further uncertainty. This dissociation allows for investigation and examination of the object as the practitioner seeks to know it and provides real pleasure and engagement in the exploration. Knorr-Cetina (1999) has written on relational aspects of expertise and the chain of wanting, which can form a basis for knowledge activities and provides for satisfaction experienced by experts within their practice.

Such engagement with activities provides for a significant emotional investment in the work and, as such, there is a passion for doing it well and seeking to do it better. This provides a fertile ground for collaboration, but the costs of such collaboration also need to be considered. As identified by Muldoon (2017), skills acquisition is costly at the elite end of research, just as much as related costs for equipment. The ability to offset these costs through collaborative effort is welcome, but collaboration has its costs in terms of time, effort in social engagement, travel (if necessary), loss of autonomy, and sharing of status/credit for any discovery. This is particularly true when working across disciplinary (or sub-

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disciplinary) boundaries, as discussed by Galison (1997). There might be different standards of rigor, definitions of terms, and sets of standard approaches across disciplines, and these differences add to communication costs. Generally, skills and equipment costs are fixed, but collaboration costs are variable and may vary within a collaboration as team members leave or join. Options that decrease such costs will enhance the collaboration because energy can be directed towards the activity rather than its communication.

2.5 Reducing the cost of collaboration – a community of practice.

The identification of social learning within the workplace and the role of colleagues in development of expertise opened exploration into how learning networks can and were harnessed into communities of practice (Wenger, Mcdermott & Snyder, 2002). Wenger's ethnographic study within a commercial organisation identified that practice is identified as *'both our production of the world and the result of this process. It is always the product of specific historical conditions resulting from previous practice and transformed into present practice [...]* Practice is a system of activities where knowing is not separate from doing. Further, learning is a social and precipitative activity rather than merely a cognitive activity (Gherardi, 2009). Groups of people interact regularly because they care about the same real-life problem and, on this basis, negotiate a shared practice (Pyrko, Dörfler & Eden, 2019). Since identified as operating in most realms of practice, from Xerox™ engineers to senior civil servants, there has been a wealth of studies on optimal structure and etiquette of CoPs. Central to their usefulness is discussion on practice and how this enables tacit knowledge to become explicit, be called upon in response to unexpected events (Hadjimichael & Tsoukas 2019), support decision making (Tsouhas & Vladimirou, 2001), or create knowledge (Dorflier & Ackermann, 2012).

Tacit knowledge is central to the work of the epistemic practitioner (Nonaka & Takeuchi, 1995) and there are three structural elements to a CoP: shared concern, mutual engagement, and shared practice (Wenger et al., 2002). There are also varying degrees of engagement within the core group and more peripheral members, which depend upon degrees of investment as a professional and engagement. CoPs quickly develop a 'history of learning' that outsiders find difficult to understand. These 'epistemic boundaries' are indicative of real learning within the community, which has developed into identifiable knowledge, but also create barriers to entry and participation because those wishing to enter the community spend time ‘catching up’. There are several studies that have followed development of CoPs and, through analysis of 60 business CoPs, Gongla and Rizzuto (2012) identified patterns in development, i.e., potential, building, engaged, active, and adaptive. Through revision of development stages proposed earlier, Wenger et al. (2002) constructed typical stages: potential, coalescing, maturing, stewardship, and transformation. This framework was used for an online CoP for teachers and research and Marques et al. (2016) recognised in each stage a tension between two opposing tendencies, the resolution of which allowed progression to the next (Table 1).

Clearly, there is potential for international research networks to be a channel for collaboration. Generally, these have some characteristics of CoP but are significantly looser in structure and operate without a defined common purpose. As such, the learning achieved is more diffuse and unstructured. Within a CoP, there is shared purpose and, hence, greater probability for learning to offset investment in time and effort

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(i.e., engagement with the community). There is also a perceived reduction in risk of lack of acknowledgment through established communication structures and defined membership.

2.6 Study Context and Participants.

In 2019, a consortium of 35 beneficiaries in food [and] nutrition security was brought together in a four-year project (FNS-Cloud) to create tools and services that could reduce fragmentation utilising a cloud solution and be validated in three domain-specific demonstrators (i.e., agri-food, nutrition and lifestyle, and healthy microbiome and non-communicable diseases), which would also level-up access and reuse of existing and emerging data by user communities throughout Europe. It needed the collaboration of ICT specialists and data scientists both from academia and the private sector (especially SMEs) with FNS researchers as well as experts in work-based training to build confidence and skills, science communication specialists, and those with legal experience in access and exploitation for sustainability. The scope, size and ambition of the project created significant challenges for participants and the leadership team. In terms of technological advances, the project aimed to enable ICT specialists and data scientists to co-produce solutions with FNS researchers to support FAIRification of FNS data that might, in turn, be interrogated to answer research questions in the three over-arching domains. Such an approach required multi- and inter-disciplinary work amongst groups only some of whom had worked together previously but did not have a common disciplinary culture or language, or indeed native language. Members of the consortium were invited to participate by the scientific coordinator, operating upon under the following criteria: successful collaboration in previous projects, expertise in a required area, fulfilment of EC requirements for funding (membership), and available resources. Membership was geographically diverse with EU MS including, Slovenia, Ireland, Greece, Spain, Belgium, Austria, Netherlands, Italy, and Denmark but also Switzerland and the UK, which was leaving the EU during this period. The work plan was divided into eight work packages (WPs), each with specific tasks lead by the work package leader or other beneficiaries. Project management was undertaken by a non-profit association based in Vienna (AT) with extensive experience, which set up a Google (shared) drive for project documentation. Each WP was expected to meet online for task meetings at least monthly and minutes were stored on the Google drive. The Executive Board (EB) comprised the WP leaders plus coordination staff and met to discuss operational and strategy issues, with all documentation being stored online.

The project was launched on 1st October 2019, but only managed one face-to-face meeting (kick-off, November 2019) before public health restrictions prevented in-person meetings until June 2022.

The CoP (myFNSCloud) was launched via an online community platform designed by a third party but is hosted (EuroFIR AISBL, BE) and managed (UWTSD, UK) by two of the beneficiaries. The design was developed further after consultation with the consortium to enable review of all members, their interests and contact details, and booking of events, publishing of articles (blogs), elearning, and a repository for publications as well as a diary of events. Individuals, groups, and WPs were also given a discussion space and repository for tools and outputs. Email campaigns were created for all or some of the membership as necessary, and activity can be monitored.

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2.7 Evolution of the platform

A consultation was undertaken with all task leaders in the first three months of the project using a semi-structured interview approach online, which lasted 30-40 minutes. The results were analysed for specific themes, which identified lack of knowledge about individuals and organisations in the consortium as a major barrier; this led to creation of the membership list with contact details, e.g., "*I really was concerned I didn't know the others in the consortium and who was involved in what work package*.", which could be addressed through the CoP. There was, however, a real concern about a surfeit of online platforms and networks within the community and, indeed, generally, e.g., "*I don't want another site where I must make a profile, post, check posts, etc. I already do that in LinkedIn and Twitter. I think it is an uphill battle to convince people. Is there a way to link My FNS with LinkedIn? Can I import my profile?".* The platform was launched at the second consortium meeting (June 2020), just as the extent of the impacts arising from the public health crisis became clearer.

2.8 First year of the project

Unsurprisingly, the pandemic had a significant influence on working practice and research output across disciplines. There was an understandable increase in activities and publications considering SARS-CoV-2 and a significant decrease in publications (specifically collaborative) in non-COVID research (Kim, Cho 2021). The lack of physical meetings and, for FNS-Cloud, exchange visits restricted initiation of collaborations, particularly between specialisms. The response of the consortium was similarly retreat from collaboration (Kim, Cho 2021), which seemed counter intuitive as it might be expected that an online platform could provide opportunities for engagement that was not taking place face-to-face. However, at this stage of the project, members were focused on their initial work and there was little requirement to collaborate beyond this. It was believed that individual work needed to be completed before synthesis could occur across the tasks and work packages when in fact this belief led to reinforcement of silos and pursuit of individual rather than collective goals, effectively shutting down collaboration especially across disciplines. Although 117 members joined myFNSCloud from the consortium there was little activity within the CoP. Following on from the need to 'get to know one another', the CoP team commissioned small vignettes from young researchers and senior leaders within the project. Although well received, there was no significant increase in postings.

2.9 Second and third year of the project

As the pandemic continued, there was an increase globally in online events as well as growing ease in using video conferencing software such as Googlemeet, Zoom and Microsoft Teams. At the project level, it was clear that training and education would need to progress online, which like the consortium meetings required redesign of activities to ensure outputs were engaging, encouraging, and inclusive. Interaction with areas of the CoP associated with event notification, online booking, and the repository for recorded content and elearning increased in use, allowing individuals to access training at a time that suited them and, at that stage, in the absence of face-to-face training. Workshops moved from in-person delivery to elearning content comprised of video, quizzes, signposting on existing resources online, and other online content that could be held in a repository for future use.

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At this stage in its development myFNSCloud was facilitating access to education, training, and work-relevant learning, but not acting as a collaborative 'coffee-machine' hub for discussions. Dialogue was not about collaboration but rather access to recordings and similar. The consortium started to meet in-person from mid-2022 and reflections gathered at these meetings identified that members appreciated the content but did not feel the platform could replace face-to-face interactions, which is borne out by subsequent reflective accounts from scientists provided with grants to visit collaborators, e.g., "*Even this one conversation in person brought me and the project more benefit than some of the months I spent working on this alone*", "*The whole experience made me appreciate even more the power of in-person collaboration*".

2.10 Opening the platform to user communities

In the final 18 months (2022-2023), the platform has gradually been opened to user communities, allowing individuals and organisations to access outcomes of the project. Development of the community is perhaps clearer as the focus for work – delivery of tools and services and the demonstrators with the necessary support – requires engagement with the CoP as the 'knowledge hub'. Discussion boards and team areas have been removed, and there is greater emphasis on showcasing work with FAQs and elearning, which was also always envisaged as the next stage to ensure a sustainable legacy.

2.11 Insights from practice and recommendations

myFNSCloud did not fulfil the true requirements of a CoP in the first year, although there were successful aspects in relation to development of training and resources in subsequent years. We will never know if this might have been achieved if face-to-face meetings had continued as normal.

If we compare evolution of myFNSCloud with the stages of development outlined in Table 1 then Year 1 can be clearly identified as 'potential', when the consortium was seeking to identify the added value a CoP might provide. There were shared concerns (e.g., aims of the project, cohesiveness of the consortium) and a workplan had been identified at the proposal stage, but these were facilitated largely by Google (shared) drive. Thus, the consortium did not need a CoP for this exploration and engagement. By the launch of the CoP in June 2020, there was already sufficient support for operational and management functions. This meant the CoP had to incubate a community when collaboration was occurring elsewhere, meaning the added value was not clear, required additional effort that was not perceived as necessary, and – consequently – engagement was minimal.

The next stage of development was 'coalescing' (years 2-3) and, as identified in Table 1, this is a balance act between providing value whilst still developing community. Here, delivery of value was through training and personal development opportunities as well as providing a repository for (communication and education, i.e., not publications) outputs. Furthermore, collaborative efforts were in part centred on development of tools and services (WP4) underpinning the demonstrators (WP5) as well as training, education, and support for their exploitation, i.e., using the CoP as the knowledge hub/repository. Effectively, the CoP was seen to be providing some immediate value (e.g., how to upload datasets to repositories, what FAIR principles were, understanding licensing) for using FNS-Cloud tools and services and, hence, there was good engagement with increased awareness and potential added value.

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Now, the CoP is entering the maturing stage, where expansion of membership is being sought to bring together the wider corpus of knowledge and cutting-edge issues. The role of the platform as a knowledge hub has clarified and there is an appreciation of its potential to add value for user communities.

2.12 Conclusions

The evolving research environment requires collaboration amongst highly diverse clusters of research groups and success demands clear communication styles. We have reflected on our experience in developing an online CoP (myFNSCloud) that sought to provide a resource to establish a community that supports training, education, and communication and exchange within FNS-Cloud user communities. In doing so, we recognise several elements that contribute to the success of such a COP.

Separation of operational or management elements from the collaborative workspace is a common approach for large projects and does have value in not overburdening participants with excess management chatter. However, removing it completely it from the CoP resulted in significant amounts of communication amongst members outside the platform as they set up working groups. This resulted in slower community development and collaborative interactions, as the CoP became a burden, requiring additional effort in parallel with established online meetings typified by early pandemic working.

Lack of physical or online engagement amongst ICT professionals and FNS researchers resulted in significant and ongoing difficulties in communication between individuals and organisations, e.g., understanding of the word ‘implementation’, which had at least two different meanings across disciplines when understanding was pivotal (i.e., ICT professionals means coding whilst for FNS researchers it means testing of a tool in the field). This was reinforced by the decision to assign ICT activities to WPs 2-3 whilst WP4 was responsible for developing approaches for exploiting existing and emerging FNS datasets. Consequently, initial working patterns were established without significant input from other disciplines, resulting in misunderstandings and frustration as individuals sought to fulfil their tasks without the face-to-face engagement that subsequently rapidly resolved the problems.

Technological support across tasks and understanding around the roles/purpose of each element therein was a significant barrier to progress across disciplines and work packages, e.g., purposes and roles of the CoP, FNSCloud catalogues, FAIRSPACE and SCALEFOCUS within FNS-Cloud, whether FNSCloud was also a repository and, if so, where datasets might be uploaded/hosted, and how these elements linked to “trusted repositories” outside the consortium, what constituted a trusted repository and which FNS-Cloud beneficiaries were “permitted” to use when in fact this should be signposted by the research domain.

Clearly, depending on the domain, time and space (e.g., in meeting programmes) must be accommodated proactively to encourage genuine dialogue between specialisms. Understanding and comprehension are often used interchangeably but, whilst understanding might indicate a firm mental grasp of a word/action has been attained, comprehension reflects the process of appreciating underlying concepts intellectually.

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2.13 Next steps

In this analysis, we have codified a framework for CoP structure and function in large multidisciplinary, transnational research and innovation project. This will be submitted to the Journal of Workplace Learning for publication by M48.

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2.13 Table 1 Typical activities in CoPs (Marques et al., 2016)

Stages of development	Some typical activities in CoPs involving teachers and researchers
Potential	Tension: balancing discovery and imagination.
	Teachers and/or researchers of a loose network find a potentially common interest in a domain: to promote student and teacher learning. Discovery of similar educational problems, the sharing of a passion and the possibility of Professional Development.
	Awareness of the value of the community. Negotiation of the educational topic (domain) and engaging issues, e.g., through the definition of a work plan.
	Identification with some members within the larger group, e.g., defining workgroups
	Exploration of the community's facilities (available or in development) e.g., an online platform with communication tools.
	Giving/receiving technical support, e.g., asking for orientation related to the use of a specific online communication tool.
Coalescing	Tension: balancing incubating community and delivering immediate value.
	Improvement of the community's relationships and trust, e.g., through face-to-face meetings. Official launch of the community through community events. **Discussion of the group's norms**.
	Delivering immediate value by negotiating what knowledge is useful to be shared and how to share it, e.g., to share literature references on education, to share teaching experiences, to discuss educational concepts, etc. Development of deep knowledge of the individual practice of each other. **Awareness that colleagues are resources for learning. Involvement in group discussions**.
	Giving/receiving technical support, e.g., asking for orientation related to the use of an online communication tool.
Maturing	Tension: balancing the focus on the progression of the domain and the expansion of the community's membership and perspectives.
	Focus on developing a comprehensive corpus of knowledge and on cutting-edge issues within the CoP's domain (organise, classify and identify gaps in the developed work) – higher demands of time and commitment.
	Expansion of the community's membership and perspectives. Disruption of the community's interaction, intimacy, and domain. **Common regulation of the group's behaviour. Commitment to colleagues' growth**.
	Growth of the community, through cycles of high and low energy.
Stewardship	Ownership of the developed knowledge and practice, e.g., presenting the developed work in public. **Building relationships with other communities**.
	Open-mindedness (through accepting and soliciting) to new ideas and members, to keep the relevance.
	Tension: balancing ownership and open-mindedness.
Transformation	Returning to a previous stage, transforming into a social group, division into different communities, merging with others or end of the CoP.
	Tension: balancing the let go of the community (fade away through the loss of its members) and the live on (remembering the community through its legacy).
	Possibility of returning to the community's facilities to access the built knowledge.

The text in **bold** indicates features identified in this study in addition to Wenger et al., 2002 framework.

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3. Handbook for practice-based learning in multidisciplinary projects

Insights from Practice from Food Nutrition Security Cloud (FNS-Cloud), which received funding from the European Union's Horizon 2020 Research and Innovation programme (H2020-EU.3.2.2.3. – A sustainable and competitive agri-food industry) under Grant Agreement No. 863059.

3.1 Welcome and Introduction

Welcome to the best practice guide for the use of practice-based learning grants within large multidisciplinary research projects.

By their very nature research projects are not predictable and require new skills, resources, and working patterns to be developed as researchers navigate issues of developing new knowledge and applications.

This guide has been developed to allow 'just in time' learning by collaborating partners to be promoted, managed, and supported during the project. The processes discussed and the advice provided are those that emerged during Food Nutrition Security Cloud (FNS-Cloud, Grant Agreement No. 863059).

Chapter 1 Introduces elements of practice-based learning and evidence base.

Chapter 2 Explores how we can promote experiential learning and reflect upon it.

Chapter 3 Returns to the submission and how reflection and learning can be evidenced and assessed.

Appendices 1-2 Provides templates for the application and evaluators form.

3.2 Chapter 1: Short introduction to practice-based learning

3.2.1 Nature of learning from practice

Adults may learn through formal teaching, such as university courses, and/or through independent study. Over the last two decades, there has been increasing realisation that professional learning can and is both formal and informal at organisational, group or individual levels. It was thought that everything a person needed to know for successful performance in an occupation could be specified in advance and provided formally. Clearly, this is not the case, as the practice of our work or profession is rarely 'rule following' but requires individuals to be creative and innovate from experience and expertise to provide appropriate response to a novel situations or issues.

This is a type of experiential learning, in the sense that it is gained mostly through what people do and experience. It focuses on individuals' work practices and on experience gained from their roles throughout their careers. Practice-based learning is effectively the study of how to make such learning as effective and robust as possible and be shared with others in an ethical manner.

A common definition of learning is a '*process that brings together cognitive, emotional, and environmental influences and experiences for acquiring, enhancing, or making changes in one's knowledge, skills, values, and world views*' (Ahrenkiel, Illeris 2000). This definition makes plain that learning is not only a change in knowledge and skills but can, and probably will, also impact values and worldview. Worldview is essentially an individual's ontology, describing how they see the world and what they consider to be reality.

Illeris (2013) went on to define the "*most fundamental condition of human learning is that all learning includes two essentially different types of process: an external interaction process between the learner and his or her social, cultural and material environment and an internal psychological process of elaboration and acquisition in which new [insights and] impulses are connected with the results of prior learning*" p35.

So, we not only have to have formal or informal learning experiences, but we must then 'inwardly digest' (Book of Common Prayer[2]) what it means and how it relates to what we previously knew. Most sources agree that evidence of this type of learning is change. Change can be in reference to behaviours but can also include ways one thinks about a situation or person. Historically, learning was identified mainly as a cognitive process –acquisition of new facts and understanding – but this thinking has moved on to a more holistic view in which there is a recognition that people learn by action and experimentation with new concepts. Scholars are also considering the emotional aspects of learning (Brockbank and McGill, 2006), i.e., when considering what learning is, it is important to consider the doing, thinking, and feeling aspects collectively.

3.2.2 Deep learning and reflection

Deep learning has been identified as occurring when individuals take responsibility for their learning to create constructs and meaning. They can describe the meaning they have achieved and justify how they have come to this understanding. Learning theories have identified that it is through reflection that deep and significant learning occurs. A comprehensive account of reflection can be found in Boud, Keogh and Walker (1985) and it may be helpful when considering reflection in the context of practice-based learning to consider that reflective learning is, "*an intentional process, where social context and experience are acknowledged, in which learners are active individuals, wholly present, engaging with others and open to challenge and the outcome involves transformation as well as improvement of both the individual and their organisation*" *Brockbank, McGill and Beech, 2002, p.6*

The word **reflection** in this handbook is not simply used as a synonym for 'thinking'. Reflection is a thoughtful (in the sense of deliberative), consideration of experience, which leads an individual to decide:

- What that experience means to them
- How it challenges and changes them
- What it means for their future practice

The construction and assignation of meaning to experience then gives individuals the potential to look at experiences from other points-of-view. This embodies the idea that reflection can be critical and evaluative. It is critical reflection that is needed to engage in a professional studies programme, large or

[2] The Episcopal Church (1979), The Book of Common Prayer (1979), Oxford University Press, ISBN 0-19-528713-4

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small. Reflection enables individuals to learn more effectively because it develops the ability to evaluate experiences – whether it is the experience of learning or doing daily work.

Reflection helps individuals to look at an experience, understand it better, and learn from it.

Much of the professional development in higher education is influenced by Schon's (1987) reflective practitioner paradigm. Its implementation in a variety of contexts has led to reflective practice becoming an educational orthodoxy (Clegg et al, 2002). Professional learning, achieving workplace success and gaining academic honours are about meeting and exceeding our expectations often in creative and novel ways. It will produce new learning and will often challenge conventional or traditional thinking.

3.2.3 Practical application

What are individuals being invited to evaluate, consider, or reflect upon? The answer is – their experience of work, what they have learnt from it, and how this learning has shaped how they see the world, approach work issues, and achieve within their work setting. Reflection has some key characteristics:

First, reflection involves practical and active engagement. In the list below verbs that describe what reflection means are highlighted. Individuals are considered to be reflecting when they actively:

- **Examine** and **investigate** learning and working practices.
- Ask **questions** about their experience with a view to **trying to understand** it.
- **Probe** assumptions and the values that underlie behaviour.
- **Formulate** judgements and **develop** conclusions about actions.

Second, the purpose of engaging in these reflective activities makes individuals more aware of their experience and behaviour. They help individuals to interrogate (e.g., Why did I do that?), evaluate, make sense, and give experience meaning. As individuals become more aware of why they act as they do and assumptions that underpin their actions, they are in a strong position to change behaviours if they want to. The ability to change helps individuals to grow and develop, i.e., to learn from experience.

Several models describe how people reflect on their experience. Here are three well-known ones that approach reflection in different ways.

Reflective practitioner model (Donald Schon)

There are two types of reflection in this model:

Reflection-in-action: This is where individuals reflect on their actions while they are doing them and make immediate changes to behaviour, e.g., 'Something isn't working here – how can I improve things right now?'

Reflection-on-action: This is where individuals look back over what they have done, and contemplate and review it, e.g., Why did that not go so well? What can I learn for next time?

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Reflective cycle (Graham Gibbs[3])

There are six steps to aid reflective practice in this model:

1. **Description-** First describe what happened in an event or situation.
2. **Feelings-** Identify responses to the experience, e.g., What did I think and feel?
3. **Evaluation-** Categorise what was good and bad about the event or situation.
4. **Analysis-** Explore the 'feelings' and 'evaluation' steps to help make sense of the experience.
5. **Conclusions-** Ask, what have I learned from the experience?
6. **Action plan-** Finally, plan and modify your actions based on your reflections.

Experiential learning cycle (David Kolb[4])

Reflection is a key element in successfully learning from experience in this model:

Experience- First be involved in a task in an open-minded way.

Reflection- Consider, that is reflect on, the experience, e.g., ask 'What did I notice about my experience?'

Conceptualisation- This reflection helps make sense of the experience by answering the question 'What does my experience mean?'

Experimentation- Finally, check out the adequacy of meanings by putting them into practice in the real world, e.g., ask 'What do I want to do differently next time?'

This starts a new cycle of learning as individuals immerse themselves in new experience again.

Kolb's learning cycle (**Figure 1**) is a model of the structural relations between these four modes of relating to the world, showing structural dimensions of 'grasping' and 'transformation' and resulting knowledge forms (after Kolb, 1984, p. 42).

Kolb's definition of learning is the "*process whereby knowledge is created through the transformation of experience*" Kolb, 1984, p.41

There are several critiques of Kolb's cycle (see Kayes, 2002[5]):

- it takes very little account of different cultural experiences/conditions.
- idea of stages or steps does not sit well with the reality of thinking.
- scant regard for individual learning preferences.

[3] Gibbs, G. (1998) Learning by Doing: A Guide to Teaching and Learning Methods. Oxford Brooks University, Oxford (UK)
[4] Kolb, D.A. (2014) Experiential Learning: Experience as the Source of Learning and Development (Edition 2) FT Press, New Jersey (US)
[5] Kayes, D. C. (2002). Experiential Learning and Its Critics: Preserving the Role of Experience in Management Learning and Education. Academy of Management Learning & Education, 1(2), 137–149. https://doi.org/10.5465/AMLE.2002.8509336

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It has, however, been influential in moving the focus of learning away from the 'instructor' to the learner and forms a useful way of understanding why individuals are asked to reflect on their learning throughout professional studies activities.

Kolb's learning theory argues that learning is a lifelong process in which personal development and work play as much a part as formal education. Ideally, experiential learning occurs when individuals involve themselves in new experiences in an open-minded way (have "concrete experiences") and reflect on their experiences from a range of perspectives (by "reflective observation"). By integrating their observations into theories (into "abstract conceptualisations"), individuals give it meaning that can be tested in real world problem-solving situations (by "active experimentation"), which provides concrete experiences for the next cycle of learning.

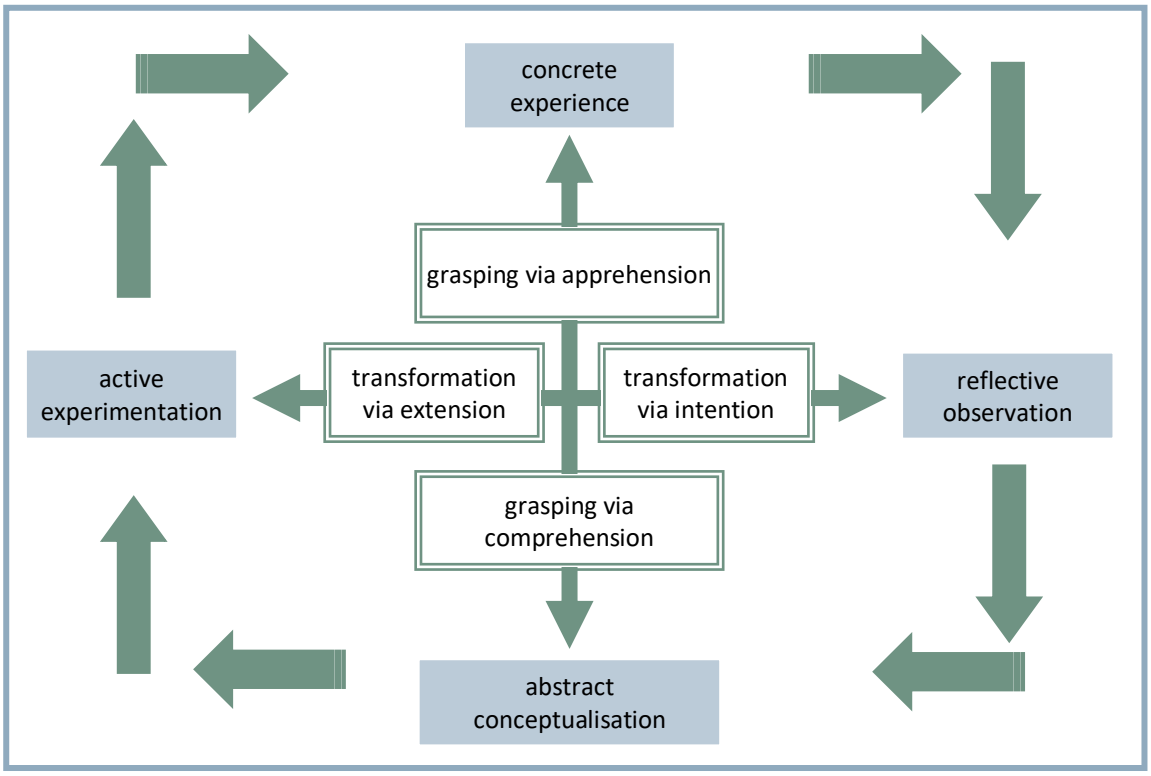

Figure 1. Kolb's learning cycle

Kolb argues that effective learning requires contrasting abilities that he modelled as opposites on two dimensions of learning. Abstract conceptualisation and concrete experience are contrasting ways of "grasping" experience. Thus, reflective observation and active experimentation are contrasting ways of "transforming" experiences that individuals have grasped in either or both ways. For example, the **internal process of reflecting** on thoughts and feelings about a particular concrete work experience (e.g., new administrative procedure implemented two weeks ago), operates on that experience and transform it through attribution of meaning (e.g., "it doesn't seem to be working as well as it should"). The **external process of acting on** the concrete experience is also a way of transforming experience, by extending it in some way (e.g., "seeing if it works better another way instead"). As this example shows, it is often

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necessary to utilise both reflective and active abilities to transform or elaborate or develop experience. In other words, for learning to occur, experience must be grasped and transformed, as described above.

This involves interaction between the four learning modes of:

- concrete experience
- reflective observation
- abstract conceptualisation
- active experimentation

3.2.4 Single- and double-loop learning and transformational learning

When people learn, they do so at several levels. It may be learning to deliver improvement of work – 'doing things right' – or they may go further and consider their work in more strategic terms and find themselves questioning established norms and assumptions – 'doing the right things'. This is identified as transformational learning (Flood, Romm 1996:10).

A good example of single-loop learning is identified in the Kolb cycle (1984), which represents an effective cycle of improvement or maintenance learning. His work on processes through which experiential learning occurs and on individual differences in styles of learning has been much used, particularly in management education, often through popularisations such as the learning styles questionnaire of Honey and Mumford (1992). However, transformational learning creates new knowledge by reconsidering assumptions or 'norms' inherent in single loop learning. Characteristically, old paradigms or ways of thinking are changed and redesigned in transformational learning, or double loop learning.

3.3 Chapter 2: Promoting experiential learning and our reflection upon it

3.3.1 Expanding our knowledge.

It follows from previous discussion that one of the most effective ways to expand learning and knowledge is to expand experience. Working practices are evolving in the natural and social sciences in response to expansion in funding of multidisciplinary and complex projects requiring scientists to work internationally and collaboratively across disciplines, cultures, language, and organisational contexts.

> "*Considering the enormous complexity and multifactorial causation of the most vexing social, environmental, and public health problems efforts to foster great collaboration among scientists trained in different fields are not only a useful but also an essential strategy for ameliorating these problem"* (Stokols, Hall et al. 2008)

It is, therefore, appropriate to facilitate collaboration but in a way where learning can be acknowledged and reflected upon for maximum benefit to the individual, their practice, and the project.

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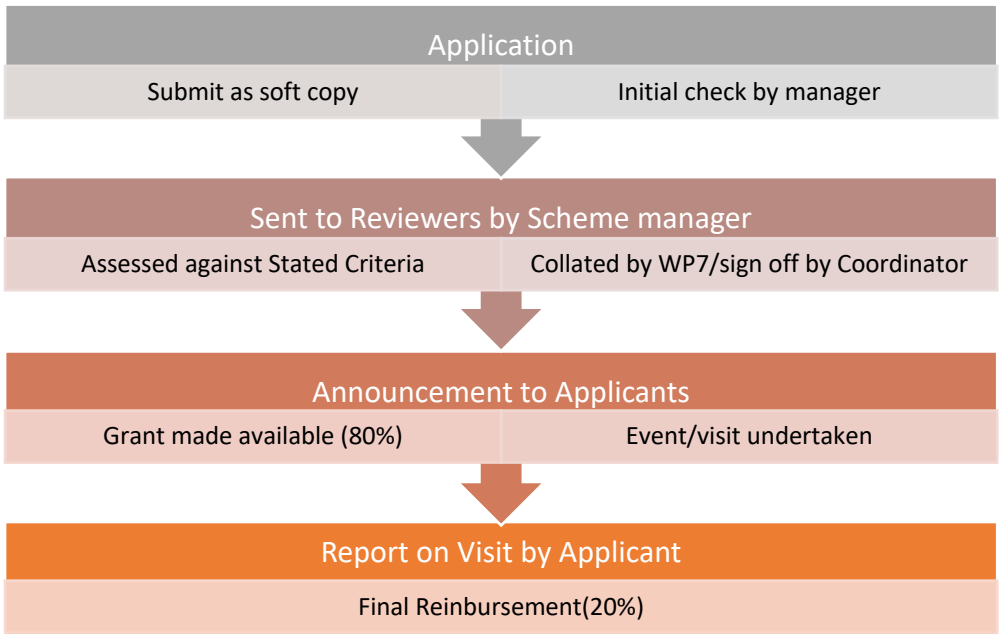
3.3.2 Format for a competitive grant scheme in practice based learning

The specific requirements needed to facilitate practice-based learning were identified as:

1. **Ability to travel and work with collaborators and experience the application of new skills or knowledge in situ.** FNS-Cloud identified a competitive scheme was appropriate to facilitate the broadest and most transparent allocation of funds.
2. **Clear identification of what the learning need is for the individual and the project - what is needed and how it can be acquired.** Learning must be planned if it is to be effective and, therefore, self-reflection by the individual on their personal development is required as well as identification of how their new learning will be applied within practice in their home institution.
3. **Reflection post -learning experience to allow explicit generation of deep learning.** Individuals must provide a reflective account of how the learning experience has developed their professional practice and contributed to their work within the project.

The process designed for the scheme considered requirements as follows:

FNS-Cloud work-based learning competitive grant scheme (WBLCG)



a. **Applicant sends a signed soft copy directly to scheme manager by email as well as posting it on a secure area of myFNSCloud.** It is important to use both approaches to ensure, as far as it is possible, that no application is missed: it would be unusual that both email and posting failed. Obtaining a signed copy is important as a means of demonstrating supervisors/ line managers/ host organisations are informed about activities of staff and students and grant permission without additional administrative burden.

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b. Scheme manager checks copy for names, sex and gender[6], contact email address, organisation and supervisor/ line manager, justification – maximum of 1000 words – costs and eligibility (i.e., FNS-Cloud beneficiary)

This check is intended only to establish the application includes all relevant information. Typical errors included insufficient words and poor justification. Inappropriate costs were excluded without reference to the applicant and these changes explained in the award email. Justifications with too few words were returned to the applicant for amendment and must be resubmitted before the deadline for applications or within 24 hours after the close of the call. Any supporting documentation was requested at this time (e.g., confirmation of additional funding from another source).

c. Scheme manager distributes applications to panel consisting of at least two WP leaders and others (as required based on type and scope of application) to score completeness of information, reasons for attending, adding value to the project and contribution to deliverables on a scale of 1-5 (1 = poor, 5 = excellent).

In collating the scores, the scheme manager must consider the status of the individual (i.e., Master or PhD student, early-career post-doctoral researcher, post-doctoral researcher/ lecturer or senior staff) since this affects all aspects of the application. Senior staff are familiar with application processes and what is needed for a successful outcome, and more likely to add-value and understand the strategic benefits of their participation for both the network and their organisation whilst PhD and Masters students are more commonly engaged in specific activities but less aware of what is required generally or how to express their needs appropriately. Outliers (i.e., scores different significantly between the panel) were reviewed and adjusted by the scheme manager, as necessary. Once the applications had been collated and the successful applications identified, they were reviewed by FNS-Cloud Coordinator for final sign off before the applicants are informed. Applicants were informed of the decision four weeks after close of submissions. Unsuccessful applicants were provided with feedback and invited to resubmit subsequently.

d. Financial information is sent to the home centre, which distributes the budget centrally

This was achieved by sending individual award emails to a nominated individual and providing a summary itemising the type of award (i.e., full, fixed value, travel only). Successful applicants were awarded 80% of estimated costs in advance to ensure ease of participation. However, 20% and any additional funding were awarded after completion of reporting and on presentation of receipts for the full costs.

e. Letters confirming awards are provided by the Scheme manager in soft copy, by email.

f. The deadline for receipts and a completed expense form, and the FNS-Cloud blog/webinar – from each recipient – is four weeks from the Monday following the final day of the training.

The aim of the blog/webinar was to encourage those receiving a grant to reflect on their learning, to describe how participation benefited them and might be employed by their organisation, and how it fits with FNS-Cloud wider goals; almost without exception, recipients find this part of the process most difficult regardless of location or seniority.

[6] Sex and gender are collected to support monitoring and help promote equality in opportunity and outcomes.

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The assessment forms for evaluation of the submissions are provided in Appendix 1. They were kept deliberatively simple to highlight the need for reflection.

3.4 Chapter 3: Evidencing Reflection and Learning

Reflection does not come naturally to some professionals, particularly those from the scientific and analytical domains. It is, therefore, critical to provide applicants with some elearning materials that help them to write their applications effectively as well as planning their learning, and in their reflective accounts after the training/visits. For example:

> *What you should aim to do when writing reflectively for assessment is to identify which aspects of a situation/critical incident or challenge are worthy of reflection. Your efforts to answer the questions raised, explore the motivations of yourself and others, and discuss the significance of unusual outcomes amount to an analysis (rather than just a description) of what happened. Such analysis is the key characteristic of reflective writing for assessment. There is a great temptation to revert to descriptive writing which details every aspect of 'the story' but the review is not a story – it is an evaluative critical analysis of your learning to date. Only provide sufficient narrative to represent a context for the learning so its depth and impact can be assessed.*

In reflecting upon a need to communicate well with large audiences, individuals may describe the context as 'giving hour-long presentations to major internal scientific conferences with an audience of thought-leaders in your field'. The reader gets a clear picture of the capacity to do this effectively without needing to know how they were invited or who was in the audience. The description is sufficient to differentiate the event from presenting to peers in departmental seminars. Having identified the context for the reader you can then go ahead to describe the learning you have achieved about giving such presentations. The context does not, however, indicate how you feel or whether new learning engendered new confidence or skills, and it is essential that reflection considers these aspects alongside factual reporting.

An important point of note is that reflection is also not about orthodoxy. It is about transcendence, going beyond what is known and seeking new innovative solution to problems. But, first, you need to reflect on the notion of what has happened; what do you understand as the phenomena you have experienced.

The difference between reflection as a dynamic purposeful activity and reflexivity or other forms of contemplation is to emphasise, positive, responsible actions based on the learning experience context. It is based on a hermeneutic interpretation of experiences from a spectrum of points of view to gain an understanding which can improve future actions. Reflection in this sense does not just explore what was, but considers what might have been, why it was not and how your personal actions can be brought to bear on similar situations to create a better outcome for all parties.

- Be evaluative and analytical rather than descriptive.
- Rather than just stating what capabilities you have developed, illustrate your claims with examples of how you have used them. For example, a statement such as, 'I have developed strong leadership skills' would need to be supported by a critical evaluation of what you determine those skills to be together with examples in which you deployed those skills.

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- Remember that the focus is on the application of your specialist knowledge within your professional context (not on areas of specialist knowledge *per se*).
- Remember that you are seeking to link past and current learning to the projects you will go on to do later in your career.
- Adhere to standard ethical guidelines, for example, by avoiding reference to named individuals.
- Back up theoretical and reflective concepts you use with up-to-date references.

3.4.1 A model to assist in reflective writing.

To help in the process of reflective writing, Cox (2005) developed a model of structured reflection for writing may be beneficial. It has four central stages, the fourth of which links with the Kolb model:

- description of experience
- reflection on action
- influencing factors
- learning

In the first section, individuals might simply describe the phenomena or critical incident in their professional life upon which they intend to reflect.

At the second stage, these types of question could form the basis of a reflection:

What was I trying to achieve?
What reaction did I get?
How did I feel about the experience as it was happening?
How do I know how other people felt about it?

The third stage considers what internal and external influences were revealed in the incident; what did they say about the legitimacy of the aims and goals of the participants plus their knowledge?

The final stage raises questions concerning practice:

Could I have done things differently?
How do I feel about the experience now?
How did it make me more self-aware of my own role?
How might I change my behaviour to enact the consequences of your reflection?

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3.5 Next steps

The format of the handbook will be refined and developed further to be easily downloadable with a full introduction to the project and where to find myFNSCloud. It will be deposited in the FNS-Cloud Zenodo Community repository allowing download and monitoring.

3.6 References

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3.5 Appendix 1 Application Form for Practice Based Learning Grant

Information About You as Applicant

Your Family Name:

Your First Name:

Your Nationality:

Your 'Home' Organisation:

Present Organisation (if different from home organisation):

Name of Supervisor at your Home Organisation:

Is this training/collaboration part of the requirements of a Work Package? Yes/No (please delete as appropriate)

Does the training/collaboration you are wishing to undertake contribute to a specific deliverable of FNS-Cloud? Yes/No (delete as appropriate)

IF yes please specify which and how this contribution will be made

Please include a Personal Reflection (minimum 1 A4 Sheet) identifying how this visit/training has been selected to contribute to your personal/professional development.

Funds Requested

Estimated budgets are acceptable, but FNS cloud reserves the right to refuse payment where there is a large discrepancy in costs

Signatures

Signature of Applicant

Date:

Signature of Head of Home Research Team or Manager

Date:

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3.6 Appendix 2 Evaluator Form for Practice Based Application for Funds

Evaluator (name, acronym, partner number)	
Application number	
Feedback on application (recommendation to amend before resubmitting)	

Criteria	Score (1-5)	Comment
Eligibility of applicant	Please indicate yes or no	
Quality of Application **Completeness of information** **Reason for applying** **Coherence of rationale for visit** **Potential impact on applicant in terms of professional development**		
Relevance to FNS-cloud **Added value to Project** **Contribution to deliverables**		
Overall evaluation	Please indicate accept or reject	

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