ONLINE SCIENTIFIC DISSEMINATION OF KNOWLEDGE BLENDED WITH FACE-TO-FACE LEARNING
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ABSTRACT
Danish seed scientists want to disseminate their knowledge to the Danish seed industry to educate consultants, growers, and students and to improve their skills and knowledge about seed production. Interviews and workshop activities have been conducted to analyze both the current information flow between the seed scientists, seed consultants, and the seed growers, and the requirements for a knowledge website for learning new seed science. This paper describes the specification requirements set for the required website including taxonomized hierarchical meta-tagging, RSS, legal matters, together with limitations and potentials. However, selecting online communication media as a dissemination tool for a community comes with a challenge – among other things it risks creating a learning divide between fast and slow learners. According to the theoretical framework “Diffusion of Innovation”[1] innovation is experienced differently throughout a society due to fast and slow adopters. Blending online learning with face-to-face experience will strengthen the learning curve among the targeted users and ensure a faster dissemination of knowledge and thus learning to the entire community.

KEY WORDS
Online dissemination of knowledge, learning divide, blended learning, communities of practice

1. Introduction
In today’s information society where one is continuously bombarded with information via all kinds of information media, it is not so much a question about knowing all about the universe but more a question about knowing where to find the knowledge about the universe that one needs.

Knowledge, innovation, information, learning, dissemination, diffusion, and communication are all keywords in a recent Danish research project on communicating seed science to practitioners. Danish seed scientists find themselves in a unique situation when compared with other agronomic scientists, in that their links to the seed practice (i.e. seed consultants, seed advisors, and seed growers) are based on a particularly close relationship.[2]

A current Ph.D. project, which objective it is to strengthen seed practitioners’ learning uptake of scientists’ knowledge dissemination, emphasizes on improving the knowledge collaboration even further by introducing new dissemination technologies. Based on interviews obtained in 2010 and a workshop in 2011 a web-based knowledge portal has been designed, developed, and launched. It is the aim of this paper to describe the considerations and reflections that have gone into the creation of this new website.

One of the reasons for setting up the Ph.D. project has been to blend current knowledge and learning research within the platform of a “normal” website, and through the literary journey providing new insight into an improved use of scientific dissemination – i.e. via electronic media such as the Internet.

In 2010 we conducted 26 explorative interviews with members of the Danish seed industry. They included scientists, company consultants and advisors, as well as growers. The aim of the interviews was to investigate how scientific knowledge was disseminated in the network.

Viewing the Danish seed community from Wenger’s Communities of Practice’s (CoP)[3-5], the industry can be described as a constallation of CoP interweaving between one another[6]. Scientists constitute one CoP, consultants another, and growers a third. In addition, the network dialogue between scientists and consultants can also be seen as a CoP together with the growers’ experience exchange groups constituting another. However, despite this interweaving web of CoP, only scarce amounts of scientific knowledge were disseminated directly between the scientists and the growers.

We discovered a divergence in knowledge dissemination among the growers – an innovative group of growers with a high demand for new scientific knowledge versus a majority of growers who were content with the level of knowledge provided by the consultants. ‘Time’ was recognized as an important parameter as only the innovative growers prioritized time allocation for additional knowledge search.

We concluded that face-to-face knowledge dissemination works well in Danish seed communities of
practice between growers and consultants and between consultants and scientists. The interviews revealed that the majority of Danish growers’ demand for knowledge on seed production is well covered and one of the reasons for this success can be attributed to the current knowledge setup between growers, consultants, and scientists, where consultants act as mediating change agents who quickly respond to the growers’ requests.

To improve scientific knowledge dissemination and interdisciplinary collaboration among Danish seed communities of practice, our recommendation was a combination of face-to-face and online communication processes.

In 2011 we organized a workshop with participants from the Danish seed industry with the purpose of discussing the future of Danish seed science dissemination. During our project workshop, the participants recognized trends and characteristics from Rogers’ theoretical framework Diffusion of Innovation (DoI) in the Danish seed community and argued for more collaboration between scientists and practitioners. This can be done by implementing learning via an online website, but it needs to be assisted by face-to-face learning to lessen the risk of a digital knowledge divide within the community.

The outcome of the workshop was a rough draft of the specification requirements of a future website portal. In 2012 the specifications were analyzed and rearranged with current parameters including available data sources, CMS, together with a realistic time schedule limiting the site production to a prototype for future work.

The research question we want to focus on in this paper is how to ensure optimal learning and dissemination of knowledge via an online seed science database to a broad divergent target group consisting of people of all ages and backgrounds.

2. Result
2.1 Probing the Danish seed industry
The intended target group – i.e. the Danish seed industry – consists of approximately 20 seed scientists, 50 seed consultants, and 4,500 seed growers. These three professions work on several levels of close collaboration:

Scientists and consultants meet several times a year. Especially during the annual meetings where the scientists first present the actual scientific research and experiments that are taking place in the research fields in the summer, followed by a winter seminar, where the scientists present in-depth data resulting from the last 12 months of research. Furthermore, the scientists and consultants regularly meet to discuss new scientific projects throwing light on upcoming problems which have occurred in the growers’ fields.

The seed consultants regularly meet their seed growers for a walk through the growers’ seed fields. This way the consultants get a good first-hand experience of what is going on in the Danish seed fields. The seed companies have contracts with the seed growers for the coming seed harvest; thus it is imperative for the consultants to provide the best knowledge for the growers’ possible challenges to secure a high return on investment for all parties.

The seed growers generally work alone but regularly meet with their colleagues in regional experience exchange groups. The seed growers may be characterized as specialized growers focusing on seed production, which is a more sensitive crop than for instance corn or wheat. They have to be very well informed and aware of even rather subtle changes in growth conditions as for instance one day’s gusty winds around the time of harvest can be devastating for their entire crop yield. The seed growers learn about scientific innovation through either their designated consultants or their neighboring experience exchange groups. In addition they learn about the innovation through the news media, with the limitation that the publishers decide what to publish and what to leave out. Only very few growers have time to search for knowledge on the Internet and so far very limited scientific information on seed production is directly available online to practitioners. However, when compared with one another, the growers are unique in their preconditions to growing seeds (e.g. family heritage and experience), and in the size of their production. Furthermore, they were also diverse in the way in which they used their designated consultants as some growers had blind faith in the consultants’ advice, where others were either more critical and hesitant to use the advice straight away, or already knew the answers, but preferred the reassuring confirmations from their consultants.

With the current knowledge model the seed consultants act as intermediary change agents disseminating the scientific knowledge and diffusing it to their growers when and where needed. However, as the growers become more specialized and better educated, this picture may change as some of the involved growers (both during interviews and during the workshop) expressed that they felt themselves distanced from scientists when they preferred to be in close contact.

Thus, we look at how Rogers’ DoI could be used as a model to an improved diffusion of scientific knowledge. DoI reflects on how an innovation is communicated to a society via media channels over time and divides the user segment into five groups ranging from innovators and early adopters to early majority, late majority, and laggards. The first two groups constitute
the phase when an innovation is being introduced into a society. Typically the innovators hear about the innovation first and quickly make a decision as to adopt or reject the innovation. The early adopters come next in line of adopting (typically constituting esteemed people, opinion leaders with high social status). The early majority is thoughtful people, who are ready to accept change more quickly than the average, and they also mark the tipping point (critical mass) where the remaining two groups will adjust accordingly \([1, 14, 15]\).

With this model in mind, it is evident for us that if we want to improve the speed at which scientific knowledge is disseminated into the agricultural society we must focus the scientific communication to the primary decision makers, in this context being the innovators and the early adopters. If they can be influenced to adopt the innovation the remaining growers will be quicker at reaching their decision on whether or not they themselves should adopt a given innovation.

We then analyzed the available scientific information on seed production and decided that if we could provide a single database in which all this scientific content was gathered and made available, the growers and consultants would be able to easily obtain the information they searched for. As to being able to understanding lexical scientific content we further defined growers’ and consultants’ academic level by stating that people typically belonging to the first two DoI groups constitute higher than average academia and thus being able to understand and diffuse the knowledge to their respective networks.

### 2.2 Designing seed knowledge

The Danish seed scientists produce knowledge primarily into double blind peer-reviewed A-journals. Furthermore they participate in international conferences and seminars where they meet with fellow scientists with whom they share their specialized knowledge. As mentioned previously they also meet with consultants during their annual summer and winter meetings where they also provide the audience with an annual preliminary report of the year’s findings. To meet the growers’ interest they are invited to write articles into the Danish farmers’ magazines and are invited speakers at the annual plant congress with 2,000 participants – the latter a potentially good meeting place for disseminating and diffusing scientific knowledge, but the focus for the agricultural forum is too wide for a specific seed knowledge collaboration.

If we list the available scientific knowledge, it can be summarized as follows:

- Science reports (from 1987 to present)
- Annual preliminary reports (in paper form from the mid-1980s to 1999, and in electronic form from 1999 to present)
- International peer-reviewed publications
- Danish trade journal articles
- Information about ongoing science projects

However, one of the main differences between the various sources of information is found in the high credibility that is provided with the double-blind peer-review system in comparison with the annual preliminary reports. The Danish seed science peer-reviewed articles handle evaluated analyzed scientific data repeated over at least a three year period. This is done to account for natural parameter variances such as weather abnormalities and varying seed qualities, and thus to ensure that the conclusion can take into account any futuristic situation.

### 2.3 User group scenarios

If we turn our attention to the possible users of an online seed science database, five groups of people are in play:

- Seed consultants
- Seed growers
- Seed scientists
- Students
- Politicians

The seed consultants constitute the first group of interested users as they fill out the important role as mediating change agents between the scientists and the growers. Both during the interviews and the workshop the

<table>
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<th>Table 1 An overview of situations in which potential users would use an online seed scientific database.</th>
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<td><strong>Situation</strong></td>
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<td>Quick search in indexed publications (either via PC or mobile)</td>
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<td>In-depth understanding of research in preliminary reports</td>
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<tr>
<td>News robot alerting users with new information</td>
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<td>Overview of scientific activities</td>
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We divide the seed growers into two groups – the innovative and curious growers versus the hesitant and skeptical growers. According to DoI the first group is the one that can make or break a scientific innovation, and this is the group that will spend most time searching for answers in as well face-to-face networks as in printed information and online websites. Thus, if we can provide these growers with quick answers or clues as where to find more information, they will be able to adopt this knowledge into their seed production and thereby diffuse the innovation to his/her agricultural neighborhood. The second group of growers (the hesitant and skeptical growers) will have access to the same kind of information as the first group of growers but may not have time to search for information or be able to fully comprehend the scientific information. For these growers face-to-face communication is critical for learning about the “scientific innovation”. Either they discover that their neighboring expert and opinion leader is doing something different from norm, and they ask him/her why is this so, or they ask their allocated seed consultant as to who can provide them with the answer they need. As growers are getting better educated today and from childhood are accustomed to using computers and searching the Internet, we believe that in the long run more and more growers will be able to attain, understand, and thus learn from online scientific information.

The group of scientists (national as well as international scientists) will be able to use an online scientific website in part as a reference to interested people (e.g. consultants and growers) who may have questions to specific problems. Furthermore, the owners of the website will be able to use it as a historical reference to their work when applying for new projects and refer to an updated, dynamic online platform. In addition, international scientists will be able to follow their Danish colleagues work asking for RSS feeds on their publications, which will shorten their search time significantly and thus improve possible collaboration.

Students at any form of agricultural school of education will be able to benefit from a specific seed science website as this source of information will include all relevant seed scientific knowledge on seed production. It is then up to each individual to use the information together with a high degree of source criticism – has this piece of information been validated or is it in the process of becoming valid proof? Furthermore, by training the students to use this online science knowledge portal, for future reference they will know where to search for information.

Politicians constitute the last group of potential users of an online science website. They will be able to evaluate passed and current projects both in terms of following up on awarded grants and in being able to evaluate new project proposals consulting the website’s information on previous projects’ completion and progression including collaborators.

To sum up, Table 1 lists the various situations in which the potential five user groups will be able to use an online seed scientific database.

### 2.4 Web design

With the designing of a new website we looked into new methods that could strengthen online content and we decided to focus on developing a meta-tagging system that works with multi-level taxonomy trees. One of the
greatest challenges when searching for information was to
know what to search for. A well-designed multi-level
taxonomy tree is one way of solving this challenge in that
it provides meaningful relations between concepts.
Another aspect was to make extensive use of RSS feeds,
making sure that content only needed to be maintained in
one place. A third aspect was legal matters as we were
about to release data that in some cases had not been fully
proven yet through datasets from triennial trials.

2.4.1 Taxonomized hierarchies
When one searches for content online, one needs to have a
fair idea of the vocabulary (and language) used by the
authors. If one searches for “tomatoes”, and the author has
referenced his/her content with “red vegetables”, then in
most cases one would come up with an empty search
result (unless in some cases where the webmaster has set
up a synonym stating that “tomatoes” are synonymous
with “red vegetables”).

A solution to this challenge is to look into the use of
taxonomy trees – in itself being a well-known method
used in for instance menu structures in many online
content management systems (e.g. Drupal and Joomla). Our
idea is to combine meaning with hierarchical
structure, so that content, given one single keyword, will
have value added meaning to the content thanks to
external taxonomized hierarchical trees placing the given
keywords into a larger interpreted meaningful
understanding. See Figure 1 for an example of such a
structure.

With the example illustrated in Figure 1, this gives us
the benefit of setting up a search structure associating
fruits and vegetables with plants, and apples with the
colors red and yellow.

Having said this, it is not easy to set up such key
structural hierarchies as there are countless ways of
structuring such meaningful hierarchies. With regard to
the current online solution our advice to the scientists has
been to take one step at a time; to start with one
meaningful area and slowly expand the knowledge tree
when needed.

2.4.2 RSS feeds
The scientists at Aarhus University store all their
publications in one single publications database. From
here the data are displayed on various sites via RSS. We
were able to design a special RSS filter for our purpose,
stripping all irrelevant information from the original RSS
feed. Thus we have been able to set up an automatic
synchronization, importing and updating relevant
publications focusing on seed production.

In essence RSS feeds contribute almost all content
coming from either the Aarhus University publication
database or annual RSS feeds with the latest preliminary
reports together with appertaining weather data.

2.4.3 Legal declarations
Legal declarations are not commonly found on knowledge
sites, but in this case we decided that it was necessary for
us to issue a legal declaration approval for all visitors who
wanted to gain access to the scientists’ preliminary
results. This way we ensure that the users accessing the
preliminary results are aware that these results need to be
read with caution, in that they do not display wrongful
data, but more importantly they are only images of that
year’s specific results and are displayed as part of several
years of testing results.

2.5 Limitations and potentials
Once the specification requirements for the site were laid
out, it was necessary to decide on a prototype version. In
order to comply with the overall project boundaries, we
scaled down the site from a Web2.0 to a Web1.0 site
solution. Once successfully introduced, the new site will
create awareness and result in feedback and suggestions
to new web features, at which point we may consider
implementing new Web2.0 features into the site.

It would be interesting to copy the current face-to-
face network between the consultants and the growers
into the site, in which the growers may interlink site
knowledge between one another together with asking
clarifying questions of their designated consultants, who
in turn may forward the request to the scientist.

Other interesting Web2.0 social features would be to
look at online learning networks between scientists,
consultants, growers, and students, together with
introducing implementations with twitter technologies,
smartphones, and tablets, and interaction with portfolios
residing in learning management systems.

3. Discussion
It is remarkable to notice, that something as commonly
used today as the Internet is not a very old media of
communication (the introduction of the world wide web
dates back to the 1980s) when compared with other
communication media over time – e.g. books and
magazines. However, the Internet is the media of all times
that has had the greatest impact on the way human beings
learn from each other. It is true that face-to-face learning
has always been present and that scholars in ancient
Greece and Egypt began to note down what they knew
about the world. But with the introduction of the Internet
as an information source, instant access to knowledge has
suddenly become everyman’s right. In many ways it has
revolutionized human learning, but with the introduction
of the Internet, we now face new challenges of distributing online knowledge and learning.

Diverse access to the Internet (e.g. Internet speed, political right of access, and computer power) has made scholars talk about the Digital Divide where people with fast Internet access are more advantaged than people with slow Internet access.\[8-13, 19-21\] The digital divide characterizes the gap that exists between populations advantaged by digital technologies and those who are relatively disadvantaged.\[8\]

Norris\[12\] describes the digital divide as a multidimensional phenomenon encompassing three distinct aspects. “The global divide refers to the divergence of Internet access between industrialized and developing societies. The social divide concerns the gap between information rich and poor in each nation. And finally within the online community, the democratic divide signifies the difference between those who do, and do not, use the panoply of digital resources to engage, mobilize, and participate in public life.” \[12\] In particular in this case with the Danish seed industry, the social divide is an interesting aspect as data from an interview project in 2010\[22\] revealed that seed growers’ Internet use was not so much a question of age and generation but more a question of access to the Internet and the quality of their access. However, Internet technologies are getting improved day by day, and even in geographically remote places in Denmark fiber cables are now being laid out. Thus probably within 10 years Danish seed growers will all be able to surf the Internet experiencing equal speeds and quality.

This brings us to Norris third aspect of digital divide, the democratic divide, being the personal adoption of Internet use. What will be the impact of digital technologies in the public sphere? \[12\] Internet culture cannot be forced upon growers but will be developed and formed by them. Thus as Internet technologies become fused into growers’ everyday life, they will form new ways of communicating, and even more prominent, they will form new ways of learning from one another.

As people learn about new innovation over a period of time this creates a fourth dimension to the divide gap, namely a ‘learning divide’ or a ‘knowledge divide’ between early learners/adopters and late learners/adopters. \[8\]

It is unrealistic to believe that we will ever be rid of digital, learning, or knowledge gaps between people in a society. There will always be fast innovators utilizing the latest communication technologies, compared with late movers who will put off adopting the technologies until they have been outdated by new inventions, and there will always be people who are quicker learners than others. One useful solution is awareness and acceptance of this fact of societal inequality. Being aware of for instance quick and slow learners may assist communication strategists in formulating special programs to better support the slow learners.

One method could be to blend digital online learning with face-to-face learning. In a ‘Blended learning’ approach computer-mediated learning is combined with face-to-face education.\[22-29\] Scholars talk about the central role of change agents.\[12, 15, 22, 23, 25, 30-34\] The general concept of a change agent has many similar synonyms – e.g. mediators, boundary spanners, and opinion leaders – and is in short personalities who want to make a change in their community and educate through motivation and inspiration.

When looking at the case with the Danish seed industry, it is clear that the seed consultants take on a great responsibility when they assist their seed growers with implementing new innovations. Growers know that the consultants by definition are up-to-date with the latest seed scientific discoveries, but the main risk-takers are the growers themselves changing practice and thus risking a financial deficit. Thus, the growers will be more convinced to make a change if they experience other fellow seed growers adopting the innovation successfully. These early adopting seed growers act as opinion leaders as they run the initial financial risk before any other seed grower, and as inspirational ‘light-houses’ as their innovative work will become known among their neighboring colleagues. Consequently, the opinion leading growers are just as important targets for the scientific disseminations.

One conclusion from the two research activities (interviews and workshop mentioned earlier) was that the Danish seed scientists should use the Internet as a communication source for their scientific results. However, research on online e-learning suggests that one should not rely on a single source of information to ensure an effective learning assimilation, but look at blending quick and slow dissemination media, such as combining online learning with face-to-face communication.\[12, 24, 29\]

The Danish seed scientists have read the interviews from 2010 and a workshop in 2011, and as a result they are now planning to involve the seed growers in future annual activities. One challenge will be to find a proper method for selecting among the 4,500 registered seed growers. One method would be to nominate ‘opinion leaders’ but this leaves the question of how to define what is an opinion leading seed grower.

Another effect caused by the reports is that the scientists are considering organizing a new annual seed conference, not only for scientists and consultants but also for growers, students, and politicians.
4. Conclusion
When producing new knowledge media – such as a scientific website – we argue that it is impossible to disseminate learning and understanding of an innovation to all people in a community all at once. Therefore, if one wants to strengthen the learning curve among the targeted users one should not rely on online learning alone, but accept diverging learning styles, and thus blend online learning with face-to-face activities to ensure a quick dissemination of knowledge to the entire community.

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References