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How can Facebook contribute to the creation of a more ocean literate society?

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Master Thesis in Learning, Communication and Applied Information Technologies

Acknowledgements

Abstract

The ocean provides countless goods and services supporting economic human activities. These goods and services are under threat as a consequence of a continuously increasing human population with limited knowledge of the ocean. It is important for citizens to take an active responsibility for ocean conservation, and therefore they need to develop ocean literacy. One challenge is that the knowledge is mainly held by scientists, often admonished for their lack of ability to communicate with the public.

The online social media have become common resources for learning, sharing of knowledge and communicating with others. This constitutes a unique opportunity and a challenge for scientists to promote ocean literacy. This study takes a socio-cultural perspective of learning and argues that participation and interest are key components of the learning process. This study investigates the potential of Facebook for scientific communication and develop best practices to maximize its benefits. Quantitative (Facebook statistics analysis) and qualitative (interviews and discourse analysis) methods were used to scrutinize the Facebook page from the Monterey Bay Aquarium Research Institute (MBARI).

From a quantitative point of view, the best strategy to optimize the reach and the followers' interactions is to post daily and use picture or movies. From a qualitative point of view, MBARI's fans seem to learn from MBARI's stories to a certain extent, but this study indicates that Facebook pages do not offer the appropriate social context to foster participation since it has only a few of the features of an arena where such practices could develop. However, the context might be more favorable for participation when the fans share MBARI's stories with their own friends. Moreover, MBARI's stories hold the potential to develop people's personal interest in marine science, supporting the learning process and enhancing their ocean literacy.

In conclusion, social media can facilitate the development of user's interest in the ocean and their ocean literacy. However, it is essential for scientists to increase their social media literacy in order to manage their pages in a more appropriate and time-efficient way, to benefit from the potential opportunities offered by online social media.

Keywords: online social media, Facebook, ocean literacy, social network site.

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1. Introduction

In order to responsibly participate in today's science and technology driven society, citizens need to be literate in various fields such as science. However, science covers a wide range of systems and disciplines with which people need to be familiar. One of them is *the ocean* which is essential for the health, life and sustainability of each individual and the societies to which they belong. In that respect, citizens need to be ocean literate in order to be able to communicate about and understand the concepts related to the ocean and marine life. The marine knowledge that is mainly held by scientists comprises of highly scientifically coded language that is quite difficult for lay people to comprehend and use. Scientists have often been admonished for their lack of engagement and ability to communicate with the public. However, the Internet has modified our expectations about what people should learn, how we share knowledge and even how we communicate with each other, especially through online social media (OSM) which offer new ways to be in touch with people from across the globe as well as to communicate with brands or organizations. The most popular OSM, Facebook, gathering a billion users, offers a unique opportunity for scientists to get their words out. This study explores how OSM can be used in the process of creating a more ocean literate society.

1.1. Empirical study

I argue that we are facing a situation where scientists and the public could learn from each other by using a common media such as Facebook. On one hand, the public in general can be understood as social media literate, but at the same time they lack scientific knowledge. On the other hand, scientists, who could educate the public about important issues society faces, may lack the skills to take advantage of the new media. This study aims at investigating the following research questions:

- Does Facebook, through interest and social interaction, have the potential to enhance the citizens' ocean literacy?

- What are the opportunities that scientists would need to embrace and the challenges to overcome in order to efficiently use Facebook to promote ocean literacy among the public?

- What are the practices that could help scientists to maximize their benefits from using Facebook?

To investigate these questions, this study combines quantitative (data analysis) and qualitative (interview and online discourse analysis) methods for studying the Facebook page of the Monterey Bay Aquarium Research Institute (MBARI[1]), a marine science and engineering organization located in Moss Landing, California.

2. Background

2.1 Literacy as a deictic concept

While literacy has been narrowly limited to reading and writing skills, the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2005) argues that "literacy involves a continuum of learning in enabling individuals to achieve his or her goals, develop his or her knowledge and potential and participate fully in community and wider society" (Ibid., p. 21). This definition of the literacy concept is based on the UNESCO's four pillars of learning; learning to (1) know, (2) do (3) live together, and (4) be (UNESCO, 1996).

Since the society in which people know, do, live and are has been radically changing through the human history, the skills embedded in the concept of literacy have also changed. Säljö (2005) describes how 10,000 years ago nomadic societies were strongly dependent on skills such as fishing, hunting, being able to distinguish edible fruits and vegetables from poisonous ones as well as communicating with each other. These specific skills could then be considered as the literacy of the Stone Age, allowing people to know, do, live together and be. The skills embedded in the term literacy has thus evolved through time from skills related to survival to skill of reading, writing and calculating in the mid-1960s. Many other additions were brought to the concept of literacy such as notion of socio-economic development in the 1960's and 1970s. This illustrates that while the definition of literacy is stable through time, what it includes is dynamic over time and culture. The meaning of the concept of literacy is dependent on the context in which it is considered; literacy is thus deictic (Leu et al., 2007). In that respect the attempt to provide an accurate definition of literacy will always be limited by the context in which literacy is envisioned. To answer the question of what it means to be literate in the 21st century, we have to take a close look at our society.

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[1] www.mbari.org
[2] http://www.youtube.com/MBARIvideo
[3] http://www.youtube.com/watch?v=RM9o4VnfHJU

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Since the industrial revolution, western societies have rapidly evolved in the fields of technology, science, health and engineering that tremendously increased human health and comfort. The way we communicate and learn has also dramatically changed with technologies such as computers and the Internet. It is through these lenses of science and technology that the concept of literacy is discussed in this study (although many other literacies are crucial in our society).

2.2. Scientific and ocean literacy

The rapidly increasing human wealth also entailed a great deal of problems (e.g., environmental, moral, ethical issues) threatening human beings on different time-scales: some issues directly jeopardize the well-being of citizens in a short-term perspective. Other issues might be a threat in a long-term perspective (e.g., climate change, overfishing). These two levels of issues require different literacy skills. The first one is on an individual level and is essential for citizens to live a healthy life on a short-term perspective, while the other one requires a more global perspective not only considering one's own well-being but the sustainability of societal actions in the world as a whole. An awareness and understanding of these issues are essential for every citizen in order to participate in political (local to international) decisions and also to behave as a responsible citizen in a democratic society. In the early 1950s the first calls for scientific literacy arose (Conant, 1951; Oppenheimer, 1954) and it recently became a buzzword in the field of education (e.g., Rocard et al., 2007).

Since the 1980's there have been many attempts to clarify how the concept of scientific literacy should be understood and several authors have provided various definitions. The Organization for Economic Co-Operation and Development (OECD, 2004) argues that scientific literacy is "the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity" (p. 40).

The National Research Council (NRC, 1996) stated that "Scientific literacy enables people to use scientific principles and processes in making personal decisions and to participate in discussions of scientific issues that affect society" (p. IX).
In 2011, Choi and colleagues compiled several lists of key elements in scientific literacy. In the Programme for International Student Assessment (PISA) (OECD, 2006), the scientific literacy abilities listed are to (1) identify scientific issues, (2)

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explain phenomena scientifically and (3) use scientific evidence. Miller (1998) includes three areas that are (1) vocabulary of basic scientific concepts enough to read competing views in media reports, (2) understanding of the nature of scientific inquiry and (3) understanding of the impact of technologies and science on the citizens and their society. Moreover, as already discussed in relation to the concept of literacy, Miller (1998) and Laugksch (2000) consider scientific literacy as socially constructed and changing with the context in which it is discussed.

I argue that a more general position should be adopted in which scientific literacy includes knowledge of science (understanding the scientific concepts and theories) combined with the knowledge about science (understanding science as a human activity with its rules, limitation and strength) acquired in order to participate actively and responsibly in a giving context.

Science is a wide field covering many different topics and playing an important role in our everyday lives. The ocean is an example of a crucial system on our planet and as Strang and colleagues (2007) argued "one cannot be considered science literate without being ocean literate" (p. 7).

The ocean, hence, plays several crucial roles for the livelihood of human beings such as:

- The ocean supplies roughly 50% of the oxygen we breathe through photosynthesis of marine phytoplankton.
- Today's fisheries provide about 15% of the total proteins consumed across the globe with higher percentage in developing countries (World Human Organization, 2012).
- The marine environment is recognized as potential reservoir of pharmaceutical products to cure diseases (Glaser & Mayer, 2009).
- The Earth's climate and weather patterns are strongly regulated by the ocean storing huge amount of solar heat, and transporting it from the equator to the poles. The ocean is also the largest long-term sink for atmospheric carbon dioxide (CO_2) absorbing about a third of the CO_2 emitted by human activities since the beginning of the industrial revolution due, for example, to the burning of fossil fuels.

The few examples above illustrate how the ocean provides huge economic, social, and environmental benefits supporting life on Earth. However, the ocean has never been so threatened by human activities:

- The accumulation of CO_2 in the atmosphere leads to an increase in the average ocean temperature and the large amount of CO_2 absorbed by the ocean changes its chemistry. This has impacts on marine ecosystems and their services (IPCC, 1990).

- The Food and Agriculture Organization of the United Nations (FAO, 2012) estimates that about 85% of the fish stocks are fully exploited, overexploited, depleted or recovering from depletion putting marine biodiversity at risk.

- The increasing social and economic pressure from the exploding human population has led to massive alteration of marine habitats (Röckström et al., 2009).

- The pollution in the ocean is mainly due to the land-based activities such as sewage and agricultural nutrient runoff. This type of pollution is responsible for the increasing number of underwater zones where the oxygen is depleted resulting in the extinction of ecosystems (Kelly et al., 2012).

This list is far from exhaustive and the modification and destruction of the marine ecosystems threaten all members of our society. As a consequence, decisions and actions must be taken at different scales and different levels in the society. At a local scale, citizens need to develop environmentally responsible behaviours and awareness, which require an understanding of the issues. On a larger scale, legislation must be enacted to protect or regulate the marine environment. These regulations may come with a cost for the citizens (cost in money or in decrease of freedom to act as one wishes). In this respect, it is important to give citizens tools to make well-informed choices and to be able to take part in public debate about ocean health. Accordingly, citizens need to develop adequate ocean literacy. Nevertheless, it is important to highlight that literacy is not the only factor influencing people's environmentally responsible behaviour (e.g., Corner, 2012; Kahan et al., 2012; Weber & Stern, 2011). Unfortunately, different studies indicate that the European and American public have a limited understanding of the threats to the marine ecosystems (Fig. 1) (Belden et al., 1999; Buckley et al., 2011; Hoeberigs & Seys, 2005).

"I don't know why I don't care about the bottom of the ocean, but I don't."

Fig. 1. © 2008 The New Yorker Collection from cartoonbank.com. All rights reserved.

Without ocean knowledge, citizens will not be able to take active and informed part in marine global and local decisions. It is thus very important to improve public ocean literacy. The U.S. marine education community defines ocean literacy as the minimal acceptable level of knowledge required for a citizen to be an effective part of the society (Cava et al., 2011). An ocean literate citizen should be able to:

- Understand the essential principles and fundamental concepts about the functioning of the ocean.
- Communicate about the ocean in a meaningful way.
- Make informed and responsible decisions regarding the ocean and its resources.

2.3. Online social media literacy

The source of the scientific knowledge that is so important for the public is mainly the science institutes. While scientists have been trapped in their ivory tower for so long (Baron, 2010), the attitude has begun to change and requirements for scientists to reach out are growing rapidly. Today educational outreach is acknowledged as a duty for scientists by the large-scale scientific funding (e.g., Framework Programme 7 or National Science Foundation funding). Thus, bridging lay people with scientific experts through communication is critical.

The ways human beings communicate has evolved through time and the World Wide Web triggered the latest communication renaissance by multiplying the channels for communication among people around the world (Bull et al., 2008).

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Today, one of the most popular communication channels is online social media (OSM). An OSM is a website or a web-based application where people can interact, share and discuss while using a wide range of media such as photos and videos (Curtis, 2011). Kaplan and Haelein (2010) define six types of OSM: collaborative projects (e.g., Wiki), blogs or microblogs (e.g., Twitter), content communities (e.g., YouTube), social network sites (SNS, e.g., Facebook), virtual game world (e.g., World of Warcraft), and virtual social world (e.g., Second Life).

Today, OSM is the number one activity on the Internet (comScore, 2011) and in the US, 66% of the population are social media users (Pew Research Center, 2012). There are hundreds of OSM applications (more or less successful) and new ones appear on the Internet everyday. These outlets offers the modalities required to create a social context of learning by enabling large-scale communication, creation and collaboration. Moreover, in an interview, Idan stated "social media have changed mass and monolithic communication to conversational and dialogic communication, from one-to-many education to many-to-many education" (Klein, 2010). This is a real opportunity for scientists to reach and communicate their science to the public at large. An effective communication between two parties depends on to relationship built rather than simply sending messages (Botan & Taylor, 2006). Since OSM is based on relationship building, it offers an opportunity to foster relationships between scientists and the public, two communities that have few opportunities to meet and bond. However OSM, as every communication channel, has rules and practices that need to be understood and respected. In that respect, using OSM is not an easy task and requires mastering a set of competencies (Kaplan & Haelein, 2010). Consequently, members of organizations eager to benefit from OSM need to become social media literate in order to take full advantage of it.

OSM is a recent phenomenon with less than twenty years of history (Fig. 2). In 1995, Classmates allowed users to find lost classmates. Two years later the very first SNS called Six Degrees was launched. This kind of website became widely popular around 2002 with Friendster. Since then there has been an explosion in the number of OSM launched such as MySpace in 2004 and Facebook in 2006 (Boyd & Ellison, 2008). In 2008, the US presidential election was the first in which candidates attempted to connect directly with American voters via SNS sites like Facebook and MySpace. Barack Obama was the most proactive candidate on OSM by embracing not only the biggest OSM outlets such as Twitter, Youtube and Facebook but also

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MiGente (Hispanic community social network) and BlackPlanet (African-American community social network). Even the website "my.barackobama.com" was designed as a type of OSM where users could create blogs, post photos, and form groups. The latest OSM milestone was the announcement by Mark Zuckerberg, the founder of Facebook, that on October 4th 2012, Facebook (currently the most popular SNS) had reached one billion regular users across the world (Schroeder, 2012).

Figure 2. Timeline of the launches and events related to the main OSM.

Facebook started in early 2004 as a social network for Harvard University students before launching a high-school version in 2005. Finally Facebook became accessible to everyone over 13 years old in September 2006. As described by its creators, "people use Facebook to stay connected with friends and family, to discover what's going on in the world, and to share and express what matters to them". Facebook is dominated by 18- to 34-year-old users (26%), by Caucasians (78%) and by female (57%) (Burbary, 2011). Apart from the private usage, Facebook offers opportunities for users to organize themselves into groups related to personal or professional affiliations and is emerging as an educational environment (Aydin, 2012).

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3. Theoretical framework

3.1. Learning as participation

The theoretical framework adopted in this study is based on the sociocultural perspective on learning and knowing. With this perspective, many influential researchers consider learning as a social activity rather than something only located in the individual minds (Säljö, 2000; Vygotsky, 1978; Wenger, 1998). From this point of view, learning is based on dialogue, both internal and social. Wertsch and Smolka argued that understanding occurs in the places where two or more voices come into contact (in Koschmann, 1999). This social dialogue implies that participation is a condition for learning. Although participation is a central concept in all these perspectives, it is described somewhat differently. For Wenger (1998) participation includes action as well as being connected with other people involved in a practice. Moore (1989) identifies three types of interaction: learner-learner, learner-teacher and learner-content. The idea of interaction between the learner and the content is also addressed by Holmberg (1989) who highlights the importance of the internal dialogue such as thinking and reflecting. In that respect, interaction and dialogue are at the center of human learning (Mello, 2012). The impacts of collaboration on the learning outcomes have been widely studied. For instance, Johnson and colleagues (2000) have run a meta-analysis including more than 150 studies highlighting various positive impacts of collaboration on achievements such as quality of report production, quality of presentation and compositions, grades, etc.

In terms of collaboration and participation, the Internet offers new venues to gather people across the world (or across the street) around common learning practices.

3.1.a. Community of practice

The concept of learning as participation is the central tenet of theories on groups of people gathered around a common endeavor. Wenger (1998) developed the concept of Community of Practice (CoP) as a group of people interacting in a common practice. CoP includes three key dimensions.

- *Mutual engagement* refers to the interaction between the members of a CoP whose meaning is negotiated with the other members.

- *Joint enterprise* refers to the purpose that connects people together providing a goal for their practices.

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- Finally, members develop *shared repertoire* of routine, words, and symbols.

Lave and Wenger (1991) argue that through legitimate peripheral participation novices in a CoP act as apprentices and become progressively acquainted with the CoP by participating in simple tasks. As they reach a higher level of expertise, they will perform more and more central activities in the CoP. In that respect, for Lave and Wenger (1991), learning is understood as the fact of becoming a more central practitioner in a CoP.

3.1.b. Affinity space

The concept of Affinity Space (AS) offers an alternative perspective to the concept of CoP. Gee (2004) suggests starting from the notion of space instead of focusing on the notion of communities. In the concept of AS, the notion of people bonding to each other does not apply. AS is defined as a "place, or set of places where people can affiliate with others based primarily on shared activities, interests, and goals, not shared race, class, culture, ethnicity, or gender." (Ibid., p.73) People in an AS do not especially have an affinity between each other but have in common an interest around which the space is organized. Gee (2004) specifies "We do not have to see an affinity space as an all or nothing thing. Rather we can say that any space that has more of these features than another is more of an affinity space than the other or is closer to being a paradigmatic affinity space." (pp. 84-85). Gee (2004) describes several features of the concept of AS that can be more or less important depending on the AS observed. Here, the features, that will help us shed the light on learning, are described. In an AS:

- People share a common interest, goal or practice around which the space is organized but they do not relate to each other according to their race, age, gender, and social class.

- Novices and experts are not separated. The whole continuum from less skilled to expert is accommodated in the very same space. But different people can have different goals and participate in different ways: some might observe while others might be more active, taking part in discussion or generating content. The level of activity is not related to the level of skill.

- Everyone is encouraged (but not forced) to contribute. Participation is thus encouraged but engaging only as a spectator is allowed as well.

- The content available is transformed through people's social interaction. Most of the content in an AS is not the product of the designers but of the ongoing social interaction of the participants.

- Dispersed knowledge is facilitated. Dispersed knowledge is defined as knowledge that is not directly available in the space itself but on other spaces.

- The roles are reciprocal. Each member can go from being a mentor to learning and then back to teaching.

- The peers provide encouragement and feedback to one another.

3.2. Learning as interest

Another key aspect in learning is the interest supporting the motivation to learn (Lin, Hong & Huang, 2012). Several authors argued that personal interest influences among other things, the level of learning (Hoffmann, 2002; Koeller, Baumert & Schnabel, 2001; Sadoski, 2001). Hidi and Renninger (2006) define interest as "the psychological state of engaging or the predisposition to reengage with particular classes of objects, events, or ideas over time." (p. 112). However, from a sociocultural view of learning, interests are generally understood as people's engagement, situational and context dependent. This way of viewing the concept of interest is shared by several authors (e.g., Hidi, 1990; Krapp, 2000; Schraw & Lehman, 2001) that describe interest as an interaction between a person (individual interest) and a specific context (situational interest). The potential interest derived from the person while the content and the environment will contribute to its development. This implies that interest is content specific rather than a predisposition that is applied across several activities (Krapp, 2000). The situational interest is triggered in a given moment by the environment, and may last (or not) over time (Hidi & Baird, 1988). The situational interest has been shown to improve level of learning (Wade & Adams, 1990) and to focus attention (Hidi, 1995). The individual interest is one's predisposition to reengage with a specific content over time which also has been shown to influence level of learning (Renninger et al., 2002) along with attention, recall and recognition (Renninger & Wozniak, 1985). This description highlights the importance of fostering interest in the field of ocean science in order to promote ocean learning and literacy.

Many scholars who have studied learning in relation to interest and motivation have grounded their research from a cognitive perspective. In this study however, the

concept of interest is to be understood in line with the situational engagement that is shown in my empirical material.

4. Context of the study

4.1. Monterey Bay Aquarium Research Institute

David Packard, co-founder of Hewlett-Packard and U.S. Deputy of Secretary of Defense during the Nixon administration was concerned that the technology for exploring and understanding of the deep-sea was not as advanced as that for space exploration. He believed that technology held the potential to offer great improvement for deep-sea marine science and that scientific progress was linked to the availability of adequate equipment. This is why in 1987 he founded the Monterey Bay Aquarium Research Institute (MBARI), a marine institute where scientists (defining the research questions) would work in close collaboration with the engineers (creating tools to answer those questions).

Packard described his vision of MBARI as such:

The mission of MBARI is to achieve and maintain a position as a world center for advanced research and education in ocean science and technology, and to do so through the development of better instruments, systems, and methods for scientific research in the deep waters of the ocean. MBARI emphasizes the peer relationship between engineers and scientists as a basic principle of its operation. All of the activities of MBARI must be characterized by excellence, innovation, and vision.

Today, the vision described by Packard in 1987 is still the driver of MBARI's work and its overarching goals are described as follow in MBARI's strategic plan (2011).

- Develop and adapt innovative technologies that allow researchers to identify and resolve important questions and advance our understanding of the ocean.
- Utilize those developments to explore and understand how natural ocean systems operate and how they respond to natural and anthropogenic change.
- Transfer knowledge gained, solutions devised, and the technology developed to communities outside of MBARI-researchers, educators, policy makers, resources managers, industry, and the general public.

By including "transfer knowledge to general public" in its goals, MBARI supports the importance of a science and ocean literate society and positions itself as responsible for disseminating the information and technology derived from its research to the public at large. The strategic plan also specifies that the diffusion of information to the public must be done in ways that engage public interest in ocean science and stimulate their imagination about the future of oceanography scientific discovery, and the importance of ocean conservation.

To fulfill its education goals, MBARI makes use of eye-catching underwater images and videos that hold the potential to trigger interest, reflection and amazement among the public such as the barreleye fish (*Macopinna microstoma*) (Fig. 3) with its transparent head.

Figure 3. *Macropinna microstoma* observed by MBARI's scientists. © *2004 MBARI*

4.1.a. MBARI goes into online social media

In the past 2 years, MBARI has joined some of the main OSM in order to evaluate their potential benefits in fulfilling MBARI's education and outreach goals. At present MBARI is active on four OSM; YouTube, Facebook, Twitter and Tumblr.

In 2009, MBARI launched its YouTube channel [2] with videos featuring underwater images from MBARI's remotely operated vehicles (ROVs) as well as videos focusing on technology developed by MBARI. Some of MBARI's videos play a crucial role in providing information about deep-sea species unknown by the public such as the video of the barreleye fish[3] that was viewed more than 3,5 million times. As of October 2012, MBARI's YouTube channel counted about 3300 subscribers and the videos have been viewed more than 5 million times.

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[2] http://www.youtube.com/MBARIvideo
[3] http://www.youtube.com/watch?v=RM9o4VnfHJU

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MBARI joined Twitter[4] in February 2009 and as of early October 2012 counted about 1000 followers. MBARI posts in average 5 to 10 tweets per day about deep-sea science and exploration, climate change and local marine news. MBARI created its Facebook page on February 2011 and started using Tumblr[5] in May 2012.

4.1.b. MBARI Facebook page

In February 2011, MBARI's division of Information and Technology Dissemination (ITD; including staff contributing to communications and web publishing, and research technicians) launched an MBARI Facebook page[6] (MFP) (Fig. 4). The primary administrator of this page is a research technician with knowledge of MBARI's science and technology. She dedicates about 10% of her time for maintaining the MFP. Since Facebook was an experimental endeavor to which a limited amount of time could be dedicated, it was decided that the MBARI staff involved would concentrate their efforts on generating high quality content on science and technology and answering only scientifically relevant questions.

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[4] @MBARI_news
[5] http://mbari-blog.tumblr.com
[6] https://www.facebook.com/pages/Monterey-Bay-Aquarium-Research-Institute-MBARI/108372732570606

Figure 4. Screenshot of MBARI's Facebook page (MFP) on October 20th.

From February 2011 until the summer 2012, the posting was frequent (several times per week) but relatively irregular with sometimes four days without a story posted and sometimes three stories posted the same day. MFP encountered a constantly increasing numbers of fans.

While some stories posted on MFP related to ocean conservation and could thus directly increase fans' ocean literacy, most of the stories related to deep-sea biology and deep-sea exploration and engineering, topics that are more difficult to relate to the ocean literacy necessary to take active part in ocean conservation decisions.

Nevertheless, MFP's stories can potentially serve as a way to improve people ocean literacy. A story about a deep-sea species could lead to discussion about its conservation, the protection of its habitat, which are central themes in ocean literacy. Secondly, MFP's stories can stimulate people's general interest in the marine environment and thus develop fans' motivation to learn more about the ocean, developing their ocean literacy.

4.1.c. The new posting strategy

During the summer 2012, MBARI decided to evaluate its Facebook presence in order to improve its OSM literacy and its Facebook practices. For this purpose, MBARI hired me as a summer intern for a 10-week period. The first step was to learn about MFP's audience, and about its expectations. MFP's administrator invited the fans to answer a short survey available online[7]. Rapidly, 37 replies were collected (out of approximately 2000 fans).

The fans were asked how MFP could be improved. The results showed that respondents mainly suggested to post more stories about what is happening behind the scene at MBARI and about the science and engineering at MBARI. Some fans were also willing to see more general marine science news, or more offers to get freebie, to read more local news, to get involved or wanted MBARI administrator to post more often. (Fig. 5).
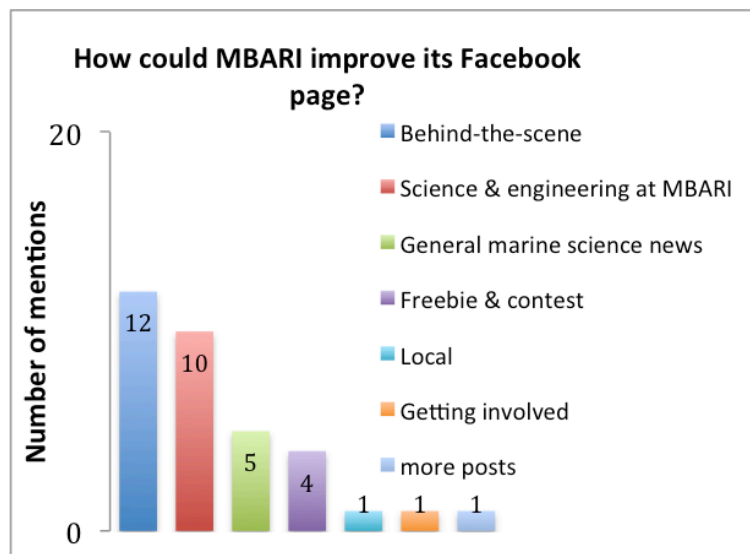

Figure 5. Number of times people mentioned the different categories concerning how to improve MFP.

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[7] http://www.surveymonkey.com/s/RC9KCM5

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Moreover, several fans expressed their willingness to learn through MFP:

Let me know what I need to know.

Was pleasantly surprised by how you have continued our education long after our trip to the aquarium.

Also more links to the public educational material.

This survey also revealed that most of the respondents were satisfied with the content (58%) while 42% declared being partly satisfied.

The results from the survey along with an online investigation of the best ways to use Facebook for a non-profit organization (see Fauville, 2012) were used to foster reflections and discussions among ITD staff members and a new posting strategy was designed. Different categories of stories will be posted:

- History[8] (category 1): MBARI celebrated its 25th anniversary in 2012 and thus it was decided to offer a retrospective of MBARI's history in 25 stories.

- Species [9] (category 2): information about deep-sea species observed during MBARI's dives.

- Technology[10] (category 3): information about equipment developed by MBARI.

- Behind the scene[11] (category 4): information about on-going projects and MBARI staff members.

- Videos[12] (category 5): links to MBARI's YouTube videos.

- General marine info[13] (category 6): links to general marine information outside MBARI.

- Quiz[14] (category 7): quiz related to a close up from one of MBARI's picture with correct answer or complete picture given the following day.

The photos appear to be the most efficient media to trigger action from the fans on Facebook (Zarella, 2012). In this respect, it was decided to associate as many stories as possible with photos. In the new strategy, a story would be posted once a day during the weekdays.

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[8] https://www.facebook.com/108372732570606/posts/365176960223514
[9] https://www.facebook.com/108372732570606/posts/359406170800593
[10] https://www.facebook.com/108372732570606/posts/355329814541562
[11] https://www.facebook.com/108372732570606/posts/360082334066310
[12] https://www.facebook.com/108372732570606/posts/338105682946375
[13] https://www.facebook.com/108372732570606/posts/267869069981690
[14] https://www.facebook.com/108372732570606/posts/357942594280284

4.2. Facebook

While most readers might be familiar with Facebook, a short introduction is provided in order to understand the further results and discussions. Let's take the concrete example of John, a new Facebook user. John starts by signing in and creating his personal profile. He can search for his real-life friends, acquaintances or family members and send them requests to become Facebook friends. John can also follow pages created by different organizations; he will then become a Facebook fan of these organizations. John can post stories that will be visible to his Facebook friends. A story can include a text alone, but it can also include different media such as a video, a link, or a picture. John can interact with his friends' or organizations' stories through several actions such as comment, share or like. Furthermore he can send private messages to one or several of his friends or directly post video, photo or text on his friends or organizations' Facebook timeline (see below for description).

There are two main environments on Facebook. The first environment is the timeline of a person or an organization where all activities are displayed such as list of friends, photos uploaded, stories posted, also stories posted by his friends directly on his timeline. The second important environment is the main page where John can find the (1) news feed column in the center of the page and the (2) ticker column (Fig. 6).

Figure 6. Screenshot of the user's main page with the news feed in the central part and the ticker column on the right hand side.

When John signs in on Facebook, the main page opens and the news feed displays the stories from John's friends and from the organizations he follows. Facebook selects the stories to display in the news feed using an algorithm assigning a

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value (called the Edgerank) to all John's friends' stories and then displays only the stories with the higher Edgerank. Falls (2012) described the three factors determining the value of the Edgerank for each story. Let's, once again take a concrete example by investigating the Edgerank of a story posted by Jane, a friend of John.

- The closeness between John and Jane is determined through the relationship the two friends share on Facebook. Do Jane and John spend a lot of time interacting with each other on Facebook? Does John spend a lot of time on Jane's timeline?

- The value of the content is determined by the amount of actions Jane's story already triggered such as comments, shares, and likes. Each type of actions influences more or less the Edgerank. For example, Facebook ranks a comment or a share as more important than a like.

- The age of each story when the user signs in. Jane's story will have a higher Edgerank if she posts it five minutes before John signs in than if her story was posted twelve hours ago.

The ticker column displays in real-time John's friends' activities such as uploading a new picture, posting a new story but also liking or commenting on someone else's story. The main difference between the news feed and the ticker column is that the latter will display the actions that John's friends took with their own friends (who John may not know). If Jane, likes a picture from an organization she follows called Mr Mondialisation (but that John does not follow), John will be able to see this organization's picture even though he does not follow it (Fig. 7).

Figure 7. Jane liked this comic posted by an organization she follows. This action appears in John's ticker column and he can see the comic. This comic virally reached John who does not follow the organization that posted the picture.

John's stories can reach users in two different ways. The first one is the organic reach including John's friends who will see his story. The second is the viral reach, including people who saw John's stories because one of their friends interact with his stories which then was displayed on the ticker column.

5. Multi-method study

The research questions in this study are:

- Does Facebook, through interest and social interaction, have the potential to enhance the citizens' ocean literacy?

- What are the opportunities that scientists would need to embrace and the challenges to overcome in order to efficiently use Facebook to promote ocean literacy among the public?

- What are the practices that could help scientists to maximize their benefits from using Facebook?

To investigate the aforementioned questions, quantitative and qualitative methods were used. Combining these two might be seen as a challenge since they both have different intellectual habits and frames of minds (McCracken, 1988) but they also shed light on different aspects of the phenomenon at stake, which are key to answer the research questions. The qualitative method seeks to shed light over the phenomenon at stake while also observing the bigger picture rather than dissecting the phenomenon into several variables (Ary, Jacobs & Razavieh, 2002). The quantitative method focuses on questions based on effect of variables that can be quantified. In that respect, as argued by Silverman (2010) quantitative and qualitative methods should be seen "as complementary parts of the systematic, empirical search of knowledge" (Ibid., p.8). Combining both methods offers a trade-off between the precision of the quantitative method and the complexity-capturing ability of qualitative ones (McCracken, 1988). In this study, the qualitative method consists of online discourse analysis (shedding light on *how* people interact on MFP) and interviews (help to understand *why* people interact they way they do on MFP) while the quantitative method includes analysis of the metrics of the users' activities on MFP (giving information about *how much* people interact with MFP). These three methods seems complementary since only the combination of the understanding of "how" "why" and "how much" will give us a complete enough picture to answer the

research questions. For example, the opportunities and challenges of using Facebook can be discussed in term of number of interaction on the page but also in term of quality of the interactions.

5.1. Qualitative online discourse analysis

This method gathers a variety of qualitative data related to the online discourse taking place on MFP (e.g., content of the stories posted by MFP's administrator, comments from the fans). It allows investigating the type of interest, learning and interaction taking place on MFP. The qualitative data used were collected from the end of June 2012, when the new strategy was implemented, until November 2012.

5.2. Semi-structured interviews

The interviews give us an insight into how the fans perceived MFP, its potential for learning and the interest it can trigger. Moreover, how the fans perceived their own, and the other fans' involvement in MFP were investigated.

The focus of this study was the involvement on MFP, therefore, it was decided to contact only the fans who had been active on MFP since the implementation of the new strategy (by liking, sharing or/and commenting). Facebook offers a list of fans who interact with each story, therefore I sent a Facebook message to the fans whose Facebook privacy settings allowed me to do so. In total 102 fans were contacted and eight people accepted to be interviewed. Six of the interviews were conducted live on the Facebook chat while two persons asked to receive the questions by email and to fill in the questionnaire. One interview was conducted in French while the rest were conducted in English.

Three test interviews were conducted to get used to this practice and also to fine-tune the questions. In total, three women and five men were interviewed. Four interviewees were from the USA and the four other were from Spain, Germany, Belgium and Sweden. The list of questions can be found in the Appendix.

5.3. Quantitative data analysis

Analysis of the Facebook data helped us understand what features triggered the most reactions from the fans which may have turned into viral reach and new opportunities to share MFP's content with new public. Since MBARI implemented a new strategy in order to increase its potential to reach more people, it was decided to compare the data before and after the implementation of the new posting strategy. While it was intended to use a period as long as possible for the analysis, a strong decrease in

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MFP's reach was observed from September 2012. This sudden decrease seemed to be due to a change in the Edgerank algorithm that occurred in September 2012 probably making MFP's stories less frequently displayed on its fans' news feed (Edwards, 2012). To avoid including data based on different Edgerank, it was decided to limit the set of data. The data covered a period of 4 months: 2 months prior to the implementation of the new posting strategy (May 27th - June 26th) and 2 months with the new posting strategy (June 27th - August 27th).

The data either were provided by Facebook or were measured manually. The data used for the analysis were:

On the page level: These parameters are calculated on a daily basis for the entire MFP.

- Number of fans: numbers of people who follow MFP.
- Daily organic reach: number of fans who have been reached by MFP per day.
- Percentage of organic reach: percentage of the MFP's fans reached per day. This was sometimes used instead of number of fans reached daily in order to avoid the effect of the increase of fans over time.
- Daily viral reach: number of non-fans who have been reached by MFP per day through their friends' actions on MFP (e.g., like, share, comment).
- Daily users' action: number of action (e.g., like, click on link, picture, share, play video) taken on MFP per day.

On the story level: these parameters are calculated for each story over a period of 28 days.

- Number of words: how many words composed the text of each story.
- Type of media used in stories: Stories of type 1 includes either only text or text and a link. Stories of type 2 include either text and photo or text and video.
- Percentage of organic reach per story: percentage of fans who were reached by a particular story.
- For the period 2 (after the implementation of the new strategy), each story corresponds to a category described above. There were seven different categories.

6. Results and discussion

6.1. MBARI Facebook page under the community of practice's lens
Wenger described three dimensions of a CoP; joint enterprise, mutual engagement, and shared repertoire. These three dimensions will be discussed in relation to MFP.

6.1.a. Joint enterprise
This first dimension refers to the purpose connecting members of a CoP and providing a goal for their practices. In order to investigate the goal(s) of MFP's fans, we need to understand their motivation to follow MFP. It is difficult to compile an exhaustive list of the fans' motivations since only a small number of fans replied to MBARI's inquiry (as shown in the online survey collecting replies from 37 fans out of more than 2000). Moreover, one can argue that only relatively engaged fans would be willing to spend time answering questions about MBARI. Nevertheless, Jahn and Kunz (2012) define three motivation areas for consumers using social media. Although MBARI is a non-profit organization and MFP's fans are not to be considered as consumers, this approach provides important insights in possible motivations to follow MFP. The first motivation area is the relation area where users are keen on staying connected and interacting with the organization. In MFP's case, some fans have studied or worked at MBARI and are willing to be updated about what is happening at the institute. This was stated several times by fans in MBARI's online survey.

I used to work with MBARI and wanted to keep up-to-date on your activities.

I am a former MBARI intern so it is fun to see what's going on there.

I became a fan of MBARI after installing and testing equipment of the Point Lobos and then the Western Flyer (MBARI's research vessels)*. I like MBARI on Facebook to keep up with what you are doing.*

The second motivation area is the content acquisition and distribution area gathering MFP's fans keen on receiving content provided by MBARI. This motivation was found among a wide range of people having an interest in marine science that varies greatly from aesthetic interest in pictures and videos to interest in higher scientific knowledge as expressed by fans during the interviews and on the online survey.

Wanted to see great photos and videos.

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I follow MBARI on Facebook because I have a genuine interest in what is happening both on and under the surface of our oceans.

As a marine biologist, I was interested in all the scientific feeds the institution can give.

The third motivation area is the self-presentation. It has been shown that Facebook users use it to consciously portray images of themselves (Peluchette & Karl, 2009). One can imagine that some Facebook users would follow MFP to shape their online identity but this would be difficult to reveal with interviews.

Highlighting three different motivations to follow MFP argues for a lack of joint enterprise between MFP's fans. Moreover, in MFP, the personal motivation does not need to be negotiated with the other members.

6.1.b. Mutual engagement

Mutual engagement refers to the fact that members of a CoP are engaged in common negotiated activities (Wenger, 1998). A fan must be included in order to be engaged. While MFP had gathered about 2300 fans by October 2012, Facebook displays MFP's stories in the news feed of only a small percentage of MFP's fans. However, fans can decide to visit MFP to see the stories that have not been displayed on their news feed. Nevertheless, some fans will not view MFP's stories in their news feed and will not visit MFP's page, therefore, these fans will not have the opportunity to interact with the content and be engaged in MFP.

When investigating the fans' participation in MFP, it is interesting to look at their positions. Lave and Wenger (1991) argued that through the process of legitimate peripheral participation novices enter a CoP on the periphery as apprentices and will progressively reach a more central position as they become more expert members (Fig. 8).
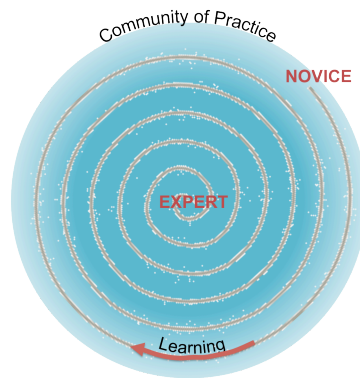
Figure 8. Illustration of the legitimate peripheral participation in a CoP where novices enter the CoP in a peripheral position and progressively reach a more central position while becoming more expert.

In MFP, the concept of legitimate peripheral participation does not seem to apply. MFP's administrator occupies the central position by providing the vast majority of the content and the answers to the fans' questions. The fans' participation will stay located at the periphery regardless of how long they have been following MFP and how expert or novice they are in the field of marine science and engineering. (Fig. 9).
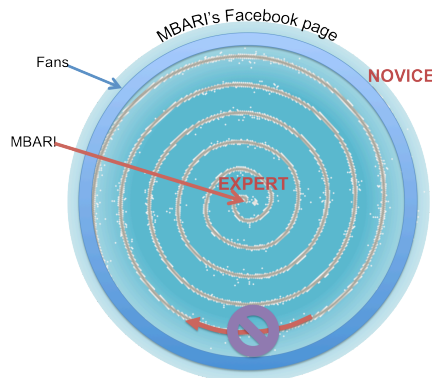

Figure 9. Illustration of the position of MFP's administrator and the fans in a CoP perspective.

The fixed positions of MFP's administrator and MFP's fans are acknowledged by an interviewee.

The general dynamics of comments are of the type question-answer, with a dominant interaction of the MBARI page administrator as the 'teacher'. This response is kind of expected, so people rely on the intervention of the MBARI administrator instead of answering a comment themselves.

This interviewee suggests a relation between MFP's administrator and fans similar to teachers and students, where the administrator will be the teacher. In the second sentence, the interviewee goes even further than just acknowledging

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administrator's central position; he explains that fans are expecting MFP's administrator to keep this central position.

Sometimes, a fan tries to reach a more central position. In figure 10, a fan (who is a marine biologist) provided a link to his personal blog with further information concerning a story posted on MFP. While MFP's administrator positively reacted to this initiative (and in this way encouraged his centripetal migration), few fans acknowledged this fan's migration; only two fans liked his comment and no one commented. This example illustrates how the fans' participation remains in a peripheral position and how MFP's administrator participation is isolated in the central position. Participation can reach the central position only if acknowledged and recognized by the members, but here the fans do not acknowledge information posted by a fan the same way they do with information from MFP's administrator. However, the lack of acknowledgement by the fans does not mean that the further reading or links provided by some fan are not appreciated or read by the others as illustrated in this interview:

Sometimes people post links that encourage further reading… and that get's me going.

MFP's administrator seems willing to let fans migrate freely between peripheral and central position to find the position that suit their participation. This is illustrated by the comments left by MFP's administrator in response to the link posted. Moreover, MFP's administrator allows fans to comment but also to post their own stories on MFP. Yet, MFP's administrator does not proactively facilitate fans' centripetal migration by clearly posting call-to-actions and inviting fans to take more ownership of the page (e.g., by organizing debate or opinion questions).

Figure 10. Screenshot of an MFP's story where a fan posted a comment with further reading.

6.1.c. Shared repertoire

The concept of shared repertoire gathers routines, words, stories or symbols that a CoP has adopted and which has become a part of its practice (Wenger, 1998). While there are some shared practices among Facebook users in general (e.g., Facebook users understand what the "like" action means), the online discourse analysis of MFP does not reveal any indication of shared repertoire between the MFP's fans. At best, sparse clues of shared stories between MFP's fans and administrator exist such as when a fan wrote a comment in the form of a private joke making reference to a news available on MBARI website (Fig. 11). However, this was not acknowledged by MFP's administrator and did not raise question among the fans.

Figure 11. Story with a comment illustrating shared repertoire with MFP's administrator.

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6.2. MBARI Facebook page under the affinity space's lens

The different characteristics of an AS aforementioned will be used as a ground to discuss the kind of social context of the MFP.

6.2.a. A common affinity

MFP's fans have various motivations to become fans but one can argue that most of them share a common interest (more or less developed) for marine science and/or engineering. This interest or affinity for marine science seems to be the main characteristic shared by the MFP's fans.

6.2.b. Participation

Any Facebook user can join MFP without discrimination based on the level of ocean literacy or expertise. Novices and experts are gathered in the same place that could constitute a fertile social context for learning. Moreover, MFP's administrator does not limit the type of participation so that fans can be inactive, only lurking or more active.

Facebook affords several ways to participate in pages like MFP. To scrutinize the different forms of fans' participation on MFP, Moore's nomenclature on interaction in the schooling system (1989) was adapted to the Facebook's environment (Fig. 12).

Schooling system (Moore, 1979)	Facebook
Learner-instructor	Fan-administrator
Learner-learner	Fan-fan
	Fan-fan's friends
Learner-content	Fan-content

Figure 12. Table comparing the three forms of interaction in the schooling system as defined by Moore (1989) and the equivalent in the Facebook environment.

"Fan-administrator" interaction

This type of interaction can take three different forms.

Fans and administrator interact in the comment section of an MFP's story. These interactions stay relatively mono-directional with questions asked by fans and answers given by MFP's administrator. This type of interaction is essential as it gives the fans the opportunity to learn something they were directly interested in about marine science (Fig. 13).

Figure 13. Fan-MFP's administrator interaction in the form of question-answer.

MFP's fans and administrator also interact when a fan send a private message to MFP's administrator. The subject is often a request for information about studies or internships. The administrator makes sure to reply and to provide the requested follow-up.

A fan can also post a story directly on MFP. If the story does not directly involve MBARI's science or technology, the administrator will not engage with the fan as shown in figure 14 where a fan is engaging in a more entertaining level.
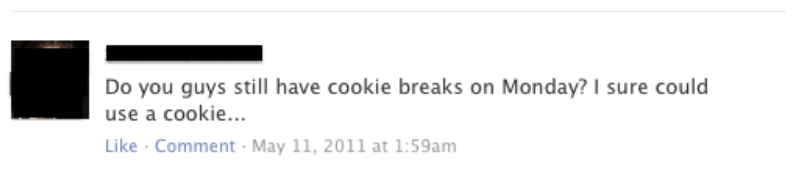

Figure 14. Story posted on MFP by a fan.

"Fan-Fan" interaction

The comment section of a story is an essential arena to foster the social context that would support learning through discussion, debate, knowledge sharing, etc. On MFP, this type of interaction is rare and, when occurring, does not trigger discussions,

debate or negotiation of meaning. This is illustrated in figure 15 where fans were invited to participate in a quiz to identify an animal. Two fans interacted with the one suggesting that the mysterious animal was be a nudibranch. While one fan seemed to agree with the suggestion and the other seemed to doubt, the three protagonists did not engage in discussion to explain and support their opinion.

Figure 15. Interaction between fans trying to identify a deep-sea animal.

The second type of "fan-fan" interaction occurs when fans like the comment of another fan (Fig. 16). This offers fans an easy and quick way to show appreciation and support to a specific comment.
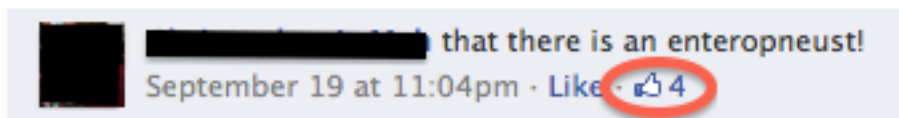

Figure 16. Fan's comment that received four likes from other fans.

"Fan-Fan's friends" interaction

Through the "share" action, a fan can duplicate an MFP's story, add his own comment and repost it as his own story while still acknowledging the source (Fig. 17).

Fig. 17. Left, a story on MFP. Right, the same story shared by a fan.

Some interviewees described how they share MFP's stories.

I press "like" and share the story and write the comment on my shared story so my friends will read it or just see it.

If I find the story a "jaw-dropper", I'll definitely hit the share button, put in some of my personal comments and observations and send it on its way to the post.

The shared story will then be visible for the fan's friends who are not necessarily MFP's fans. The fan's friends viewing this story can then like it, comment on it or even share it with their own friends.

Since privacy settings allow users to hide their stories from non-friends, most of the shared stories are not accessible for analysis. Nevertheless, some shared stories are accessible and seem to trigger a better social context for discussion than on MFP. In the figures 18 and 19 we can see that the fan discuss the content of the story shared with his friends in a way that was not observed on MFP between the fans.

Figure 18. Interactions between a fan sharing MFP's picture of a cephalopod and his own friends who are not MFP's fans (translation: "finns dessa på riktigt?"; Is it for real?, "ja absolut, på riktigt!"; yes, absolutely, for real!).

Figure 19. Interactions between a fan and his friends when he shares MFP's picture of a deep-sea fish.

During the interviews the "fan-fan's friends" interaction was mentioned. The reactions triggered by these shared stories seems to vary greatly. A first interviewee described his expectation about and the outcome of sharing MFP's stories.

I really don't have any expectation when it comes to my friends reacting to my shares about MBARI, or anything else I post/share, for that matter. Sometimes I do see a couple of LIKES but seldom a reply or comment in return.

When asked what type of reaction he got, he replied as follow.

just ooooh nice, what is that? yes that's about as far as it goes.

Another interviewee seemed to encounter a bit more success when sharing MFP's stories:

I have a few friends that react to it and like the info. Some of them comment on the post and share their thoughts, some wants to know more, and some of them have started to "like or follow" some of the pages I share posts from.

The "share" action is essential for an organization attempting to reach as broadly as possible. When an organization wants to spread information it will post a story that will be more or less successful depending on the number of people reached and the actions triggered by it. If the fans share this story, they duplicate it and post it in new environments with new users. The organization ends up with multiple copies of its story reaching different audiences. Therefore, the "share" action has the potential to greatly increase the reach of a single story (with multiple copies). Moreover, the story shared can result in fan's friends starting to follow MFP such as described by an interviewee who discovered MFP through a shared story from one of his Facebook friends.

"Fan-content" interaction

This interaction includes all actions that the fans take toward the content such as reading the text of a story, looking at the picture, clicking on a picture to see a close-up, clicking on a video to watch it or even clicking on the link provided in a story. Facebook records these "fan-content" interactions. The results from the data analysis will be presented later. It is difficult to see how deeply people engage with the content and what learning results from this engagement only based on the number of interactions. However, the interviews give more insight into how fans interact with the content.

I generally scan the headlines and if it's something I find interesting I will read further.

*Well, whenever they post I follow their link and see if that really interest me.
Most of the time I am following links.*

Another interviewee also highlighted the importance of links for further reading while asked if he got what he expected by following MFP.

Yes, as long there are links to in depth information around I am fine.

Even though the lack of participation between fans surely hinders the learning process, the direct contact between the fans and the content does help them to learn about the marine environment. This learning is sometimes mentioned directly in the comment section of a story (Fig. 20). The content also triggers amazement and interest from the fans (Fig. 21). Moreover, MFP's stories provide opportunities for fans to ask questions they might have had for a long time (Fig. 22).
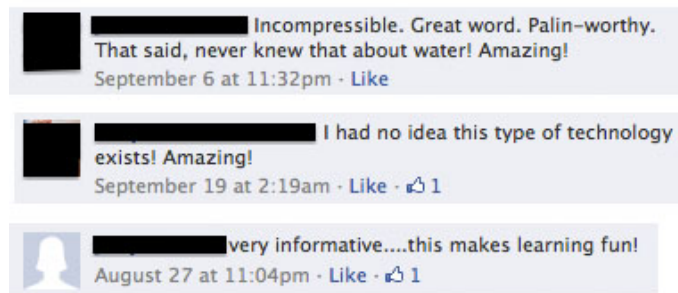

Figure 20. Fans' comments illustrating their learning with MFP's stories.

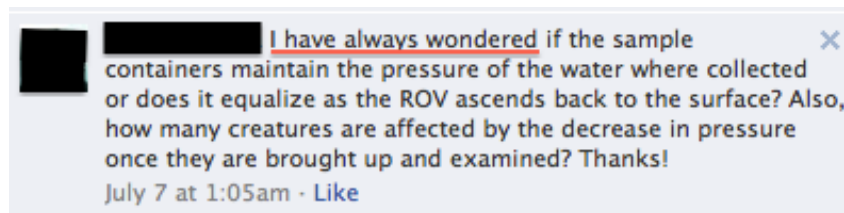Figure 21. Fans' comments expressing interest and amazement.

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Figure 22. Fan asking a question he had for a long time.

6.3. Barriers to social context optimal for learning practices

While looking at the four forms of interaction, one can see that Facebook offers a wide range of ways to interact with a specific story, with its creator or with the other fans. While MFP's fans seem to use the different ways to interact (by liking, sharing, looking at the picture, commenting etc.), it does not seem to create a fertile social context for learning through participation on MFP. In fact, I did not observe discussions between fans, exchange of ideas, arguments or negotiation of meaning on MFP. Facebook offers many features to foster this kind of participation, therefore one can wonder what hinders the development of this social context on MFP. To investigate this question, I scrutinized Facebook at three different levels: Facebook as a whole, Facebook pages in general and MFP in particular.

6.3.a. Facebook

Facebook has several features allowing users to create and maintain social contacts. Nevertheless, from a sociocultural perspective on learning it could not be taken for granted that users will engage in interaction just because Facebook is a media-rich environment offering several venues for interaction. From this perspective tools themselves are not believed to bring about change, however technologies are not neutral; new activities and new ways of learning building on information technology tools may emerge (Wertsch, 1998). In 1994, Wagner warned about this risk in formal education:

The growing "folk" acceptance of a causal relationship between system interactivity and instructional interaction has placed an unrealistic expectation on interaction technologies to ensure that instructional interaction do occur (Ibid., p. 8).

As expressed by Kreijns and colleagues (2003), in order to trigger social interaction "availability of communication media is necessary, but not sufficient." (Ibid., p. 341). Note that this argumentation is also true in a traditional setting as expressed by Littleton and Howe (2009) stating that placing children around a table

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does not mean that they will start to collaborate and work together. Recent studies on motivation to use Facebook provide some potential explanations concerning the lack of interaction observed on MFP. Researchers have highlighted that Facebook users are mainly looking for maintaining offline pre-existing relationships (Alhabash et al., 2012; Ellison, Steinfield & Lampe, 2007; Lampe, Ellison & Steinfield, 2006) rather than for meeting strangers or even for communicating with like-minded users (Alhabash et al., 2012; Subrahmanyam et al., 2008). The goal of keeping in touch with friends has been expressed in an interview:

I use Facebook as my main means of communication with friends (both distant and everyday ones – as a cheap and fast responsible way of chatting and sharing experiences), as well as for posting interesting or funny findings of the Internet.

The fact that Facebook users are not mainly looking to get in touch with strangers might partly explain why the level of social interaction is so low between fans that don't know each other on MFP.

An interviewee expressed this idea of nurturing her existing contacts by sharing MFP's stories with them while not engaging in discussion with like-minded fans on MFP.

I love to share my passion for the ocean and tell people what is going on. For that reason, I probably use the share button more often than other people. I can't remember that I ever comment on MBARI Facebook page.

6.3.b. Facebook pages

The research about Facebook pages is still in its infancy, therefore, it is not clear what is happening in the Facebook pages in general (Jahn & Kunz, 2012). Nevertheless, a study conducted by Lab42 (2012) highlighted the importance of a Facebook page for a brand. This study indicated that 50% of the consumers value a brand's Facebook page more than its website. Jahn and Kunz (2012) interviewed several fans of brands' pages and argue that fans mainly used the page passively although the authors do not specify what kind of behavior they consider as passive. An MFP interviewee also expressed the passivity while describing how he mainly engaged in reading and linking but not in commenting. One of the interviews revealed an interesting difference between the motivation to be on Facebook (as a social activity) and the motivation to join a page (as a personal activity). An interviewee said:

Well I use Facebook as my main means of communication with friends […]. I like to join […] pages related to my scientific interest, such as MBARI, to keep up with new discoveries or advances in my field, or simply interesting stuff that I can enjoy.

Another interviewee described how following MFP was a personal activity rather than a social one.

In short, it's a personal thing with no strings attached, promises made, or oaths taken.

6.3.c. MBARI Facebook page

It is interesting to note that out of the 37 people surveyed online by MBARI this summer and the 8 fans interviewed for this study, not a single person expressed being eager to communicate with new people sharing their interest in marine science or engineering. It seems to indicate that people are not on MFP to interact with like-minded people.

Rourke (2000) highlighted the importance of trust to engage in learning in social context among students:

If students are to offer their tentative ideas to their peers, if they are to critique the ideas of their peers, and if they are to interpret others' critiques as valuable rather than personal affronts, certain conditions must exist. Students need to trust each other (Ibid., p.2).

Wenger (1998) also argued that people with a strong attachment to a group are more likely to participate but such attachment is not visible on MFP. Moreover, MFP is an open group of more than 2300 fans and with many more people that can potentially read the comments posted by the fans. In this situation, creating an atmosphere of trust does not seem possible.

This lack of trust entailing lack of participation has been expressed in several interviews. When asked why he believed participation was low on MFP, an interviewee replied:

… maybe because of shyness associated with kind of 'saying something wrong' and being corrected.

Another interviewee also described her fear to comment due to her dyslexia and illustrated the importance of building trust in order to participate:

I'm building up my "esteem" to do so. Since I'm dyslexic I am often afraid of spelling things wrong, and I don't want anyone to think that I'm "stupid" so I need to feel relaxed. It's small baby-steps for me, I have done the same on other pages and after a while I just go with the flow and start posting. Often you meet the same people on the different pages and some of them know about my problem and it's then easier to write/comment.

A third interviewee also explained that he didn't engage in discussion with other fans. He stated that he was *afraid they might laugh at me*.

Along with the lack of inclination to participate due to a certain shyness or fear to be judged there is the absence of interest for other fans' comments as expressed in several interviews:

I think people focus more on the content of the post than on the comments other people do.

Again this lack of interest in other fans' comments arose when an interviewee was asked if he paid much attention to other fans' comments:

Not really. I'll give them a quick scan but I don't have the time, the energy, nor the inclination to respond/reply to each and every one of them.

An interviewee also highlighted the same weak interest in fans comment when asked if she read to other fans' comments:

I don't often comment. I do not often read other comments.

Yet another interviewee described how his comments were directly relevant to the story posted by MFP's administrator rather than replies to other fans' comments. He justified his behaviour by the fact that the content of the comments from other fans was often limited to words like "great", "hurra", "cool" which for him was not interesting.

Of course, there are people interested in other fans' comments such as this interviewee explaining why he paid attention to the comments of the other fans:

To see if anyone is thinking the same or similar to me and also other's perceptions.

Interestingly, this comment came from the same interviewee who stated being afraid that the fans would laugh at him showing that being interested in other fans' comments, does not mean that the fan will engage in discussion. Therefore, fans can

consider other fans' comments as interesting resources without being willing to interact with them. The challenges described so far seem to indicate that fans do not follow pages to engage in social practice with like-minded strangers. Even the users willing to engage with other fans encounter challenges due to the difficulty to build trust in an open arena.

It is important for scientific institutes to be aware of these pitfalls and integrate this reality in their Facebook strategy. It seems to be difficult to foster discussions between fans since a Facebook page has very few of the features of an arena where such a practice could develop. Moreover, it would require an important time investment to try to foster a feeling of confidence that would be sufficient for the few people willing to engage in discussion.

Despite the pitfalls aforementioned, MBARI's presence on Facebook seems important for the development of ocean literacy. An interviewee explained how MFP is unique:

MBARI's research is unique and new. Things that MBARI posts are not likely to be seen elsewhere.

MBARI is a unique marine institute with a cutting-edge expertise in deep-sea exploration and possesses an array of highly interesting images. These images used as situational interest hold the potential to develop citizens' individual interests and could support the learning process potentially to ocean literacy. In order to increase ocean literacy of a wide audience, these images need to be seen by as many citizens as possible (on Facebook and elsewhere) in order to serve as situational interest.

The combination of Facebook and MBARI's images can be efficient to reach a large audience. A picture taken by MBARI researchers and posted on Facebook by another organization gathered more than 15,000 likes, was shared more than 4,000 times and gathered more than 800 comments (Fig. 23). While it is impossible to know exactly how many people have viewed this photo, we know that 15,000 people saw it and liked it, and this photo was duplicated 4,000 times with each time the potential to reach a new public. In other words, this single photo from MBARI potentially served as situational interest for a large amount of people.
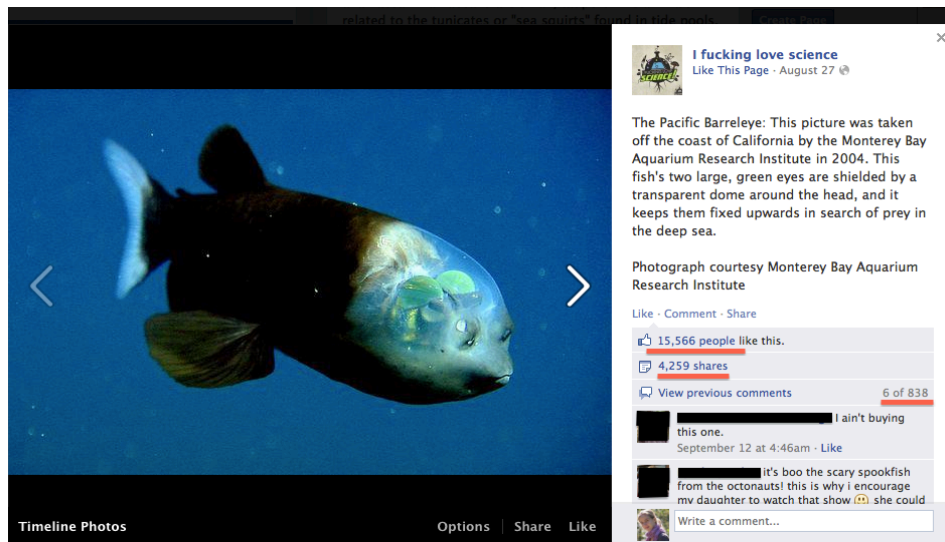
Figure 23. Photo of the barreleye fish (*Macropinna microstoma*) from MBARI posted on "I fucking love science" Facebook page.

While MBARI's images have the potential to reach a wide audience and to develop individual interests supporting ocean literacy, it is also very important for MBARI to have a sufficient level of OSM literacy in order to develop the best posting practices on Facebook and thus to fully exploit the potential of its images to educate the public.

6.4. Quantitative analysis on 2 posting strategies

During the summer 2012, MBARI evaluated its Facebook posting practices. MFP's staff designed a new posting strategy starting June 27th. A comparison of the stories posted during the period April 27th - June 26th (period 1; before implementation of the new posting strategy) and June 27th - August 27th (period 2; after the beginning of the new posting strategy) is provided to understand how the posting practices have been modified.

The first difference can be observed in the media used in MFP's stories. During period 1, 75% of MFP's stories included a link. While during period 2, 80% of the stories included a photo (Fig. 24).
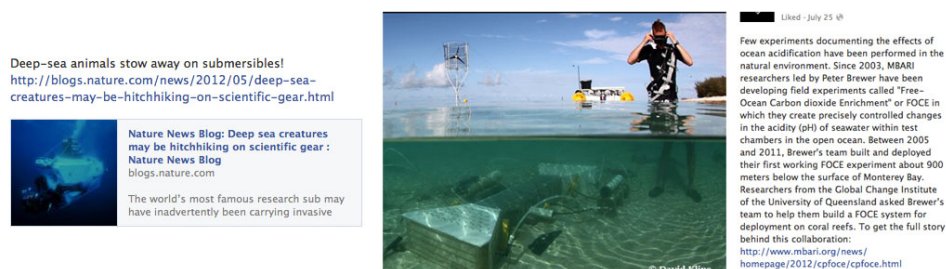
Period 1   Period 2

Figure 24. Comparison between stories from periods 1 and 2.

The number of words used in MFP's stories significantly increased during period 2 (Fig. 25).
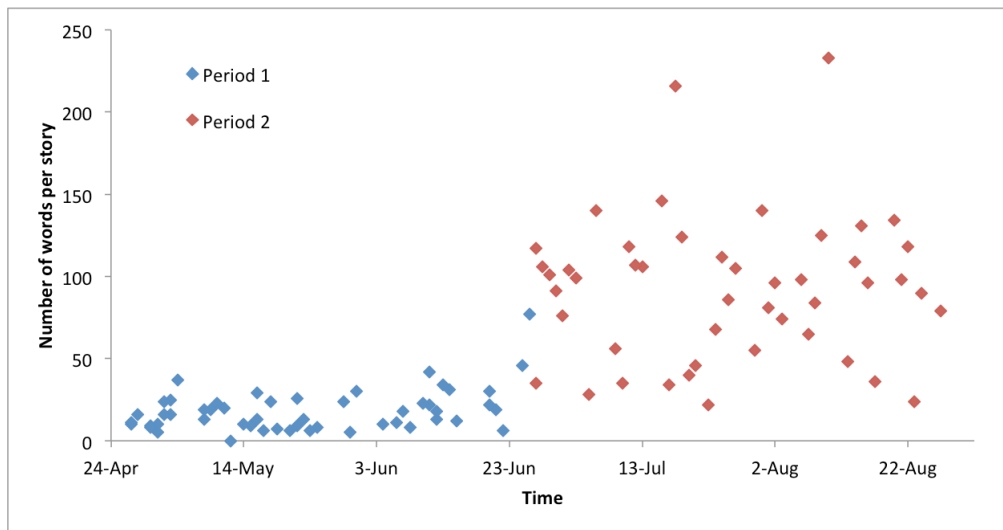

Figure 25. Number of words used per story through time.

During period 2, MFP's stories included several elements facilitating engagement of fans with different levels of individual interest (Fig. 26). The fans could look at the picture (1), read the description related to the picture (2), ask questions as MFP's administrator invited them to do (3) and follow links for further reading (4). The stories posted during period 1 typically included fewer levels of engagement, with a short description of a link provided.
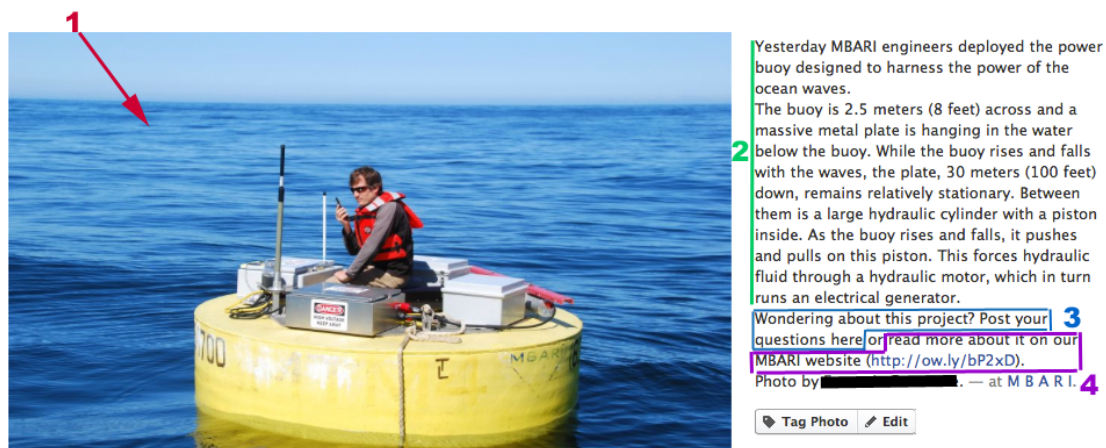

Figure 26. A story during period 2 enabling engagement at different levels. 1; photo, 2; description, 3; invitation to ask questions, 4; link for further reading.

6.5. Reach of MBARI Facebook page

I evaluated how and if these modifications of posting practices had improved MBARI's ability to reach more Facebook users.

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I investigated the impact of the new strategy on the number of fans. The number of fans increased over time (Fig. 27). Between May 27th and July 20th, the number of fans increased linearly (2.84 new fans daily; p<0.001). Between July 20th and July 24th, 76 new fans joined MFP (14 per day), as a result of a Facebook event linked to MBARI's Open House. Between July 24th and August 27th, the number of fans increased linearly by 3.09 new fans daily (p<0.001). Apart from the short and steep increase of fans due to the Open House, the new strategy did not increase the number of new fans per day.
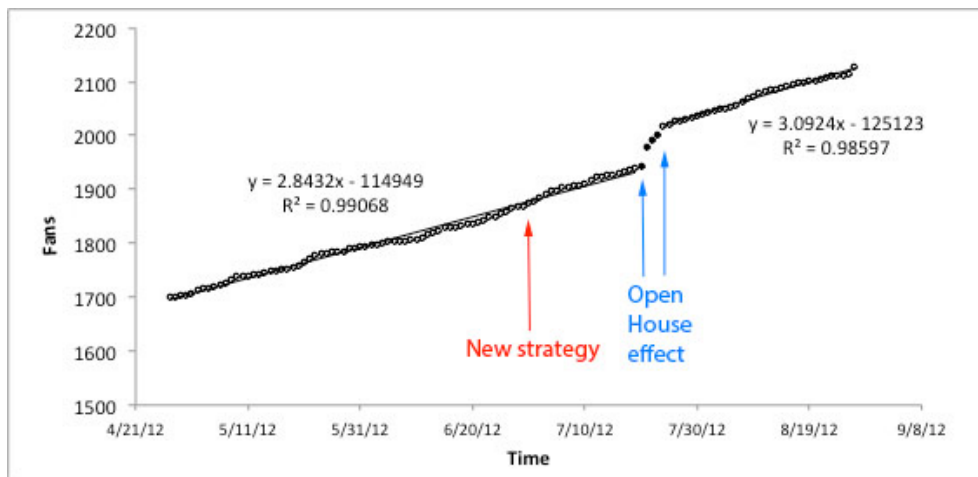

Figure 27. Increase in number of fans over time.

To evaluate the efficiency of a page, I used three different parameters; the daily organic reach of the page, the daily viral reach of the page, the daily number of users' actions on the page (like, share, comment, click on the links and the photos) happening on the page. Rather than investigating the evolution of each parameter independently, the relationship between the three parameters was investigated.

The daily organic and viral reach are related through a significant exponential relationship (p<0.001) (Fig. 28).
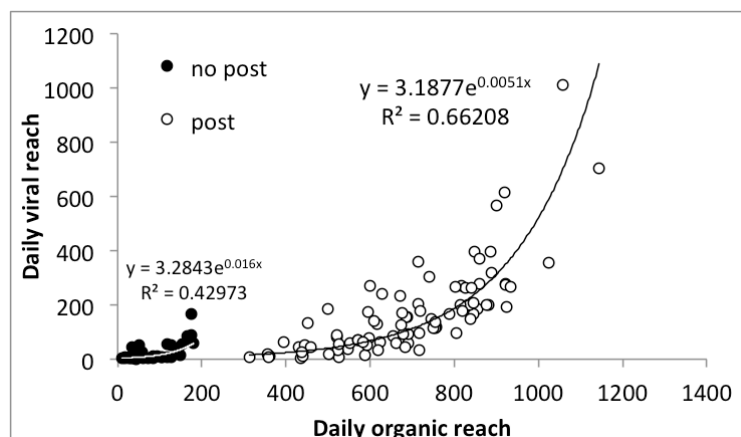

Fig. 28. Exponential relationship between the daily organic and viral reaches.

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The same exponential relationship is observed between the daily organic reach and the number of actions (Fig. 29).
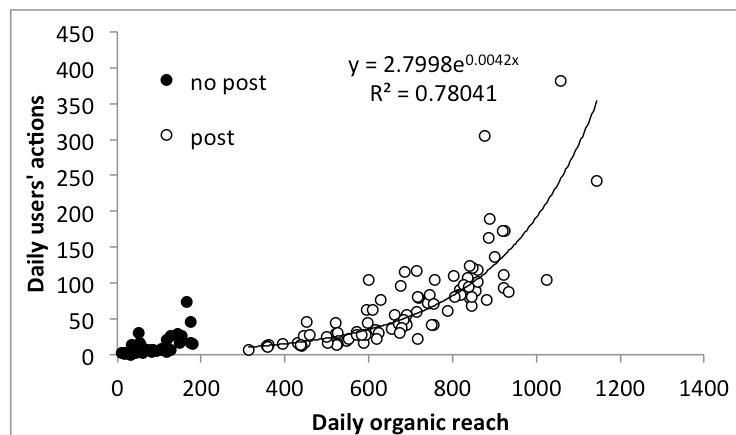

Fig. 29. Exponential relationship between the daily organic reach and the daily number of users' actions.

The daily viral reach and the daily number of users' actions increase exponentially with the daily organic reach, therefore, I investigated the impact of the new strategy on the daily organic reach only. Since the number of fans increased daily, the percentage of fans reached will be used to measure the organic reach instead of the number of fans reached.

Over time, the percentage of daily organic reach was highly variable. This variability can be explained by a combination of several factors. The percentage of daily organic reach was significantly higher (34.53 ± 0.82 %) when a story was posted compared to days without a story (4.02 ± 0.42 %; ANOVA, $p<0.001$; Fig. 30).
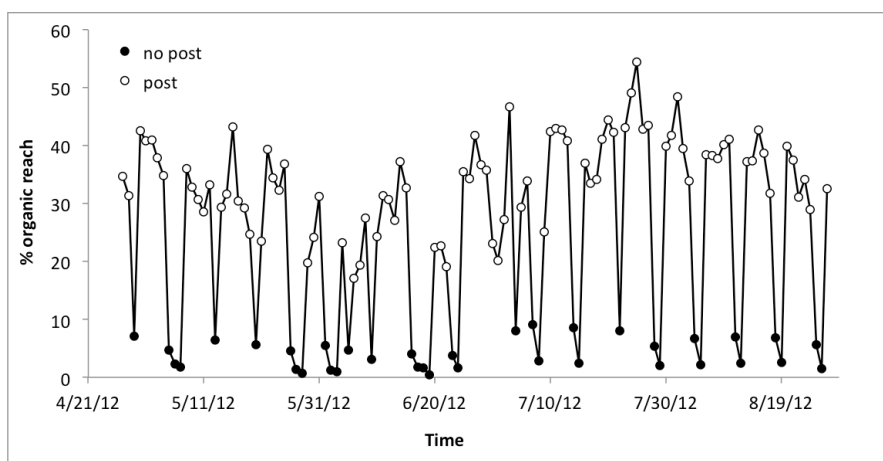

Figure 30. Percentage of daily organic reach through time.

The type of media posted in a story had a significant impact on the organic reach of this story (Fig. 31). "Text + picture" and "text + video" stories (story type 1) had a

significantly higher percentage of organic reach than "text only" and "text + link" stories (story type 2) (ANOVA, p<0.01).
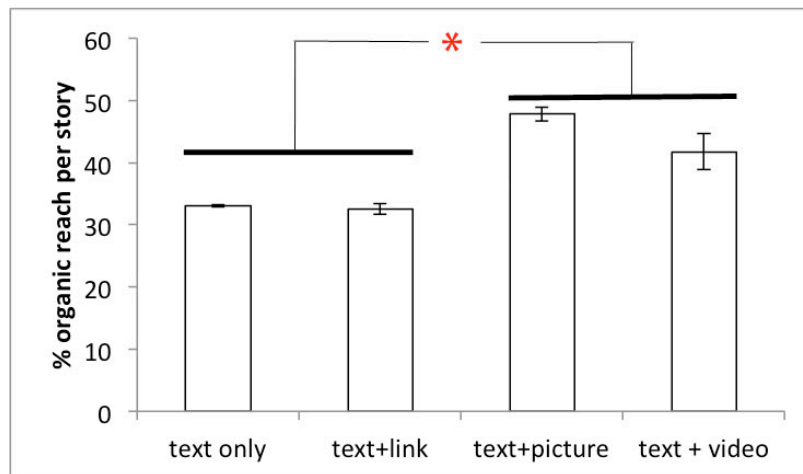

Figure 31. Percentage of organic reach per story for the different type of media.

The percentage of organic reach when a story was posted was also significantly higher (ANOVA, p<0.001) during period 2 (37.85±1.02%) compared to period 1 (30.96±1.06%). This difference is mainly due to the fact that pictures and videos were more frequently posted during period 2 while during period 1, links were the more frequent media used.

A significant relationship (p<0.001) was observed between the length of the stories (number of words) and the percentage of organic reach (Fig. 32). In most cases, long texts were associated with photos (period 2) while short texts were associated with links (period 1), therefore it is difficult to argue that the length of the story has a direct impact on the organic reach.
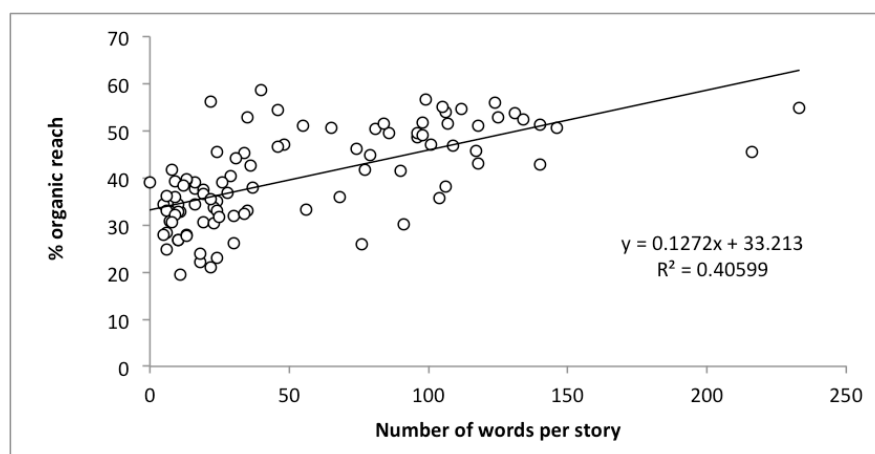

Figure 32. Relationship between the length of the stories and the percentage of organic reach.

There is no significant difference in percentage of organic reach between the different categories of stories posted (Fig. 33). Only the categories 1 to 5 were

analyzed because the number of replicates for the two others categories were too small.
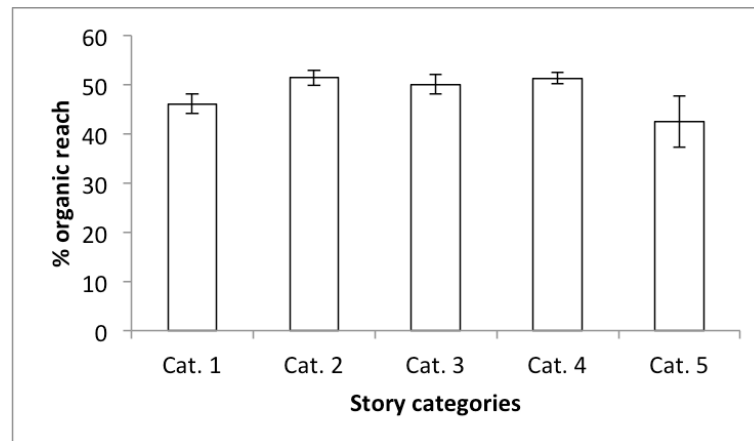

Figure 33. Percentage of organic reach for the different categories of stories. Cat. 1, history; cat. 2, species; cat.3, technology; cat. 4, behind the scene; cat. 5, video.

Based on the results described above, a predictive model of the daily organic reach was built using the following rules (Fig. 34):

- The percentage of fans reached on a given day corresponds to 1.98% of the total numbers of fans if there has not been any story posted for two days or more.

- If a story is posted with only text or a link (story type 1) 28.55% of the fans are reached. If a story is posted with a photo or a video (story type 2), 35.30% of the fans are reached.

- The organic reach on a given day (day x) increases if a story is posted the day before (day x-1). The increase in reach corresponds to 18.26% of the fans reached on day x-1.

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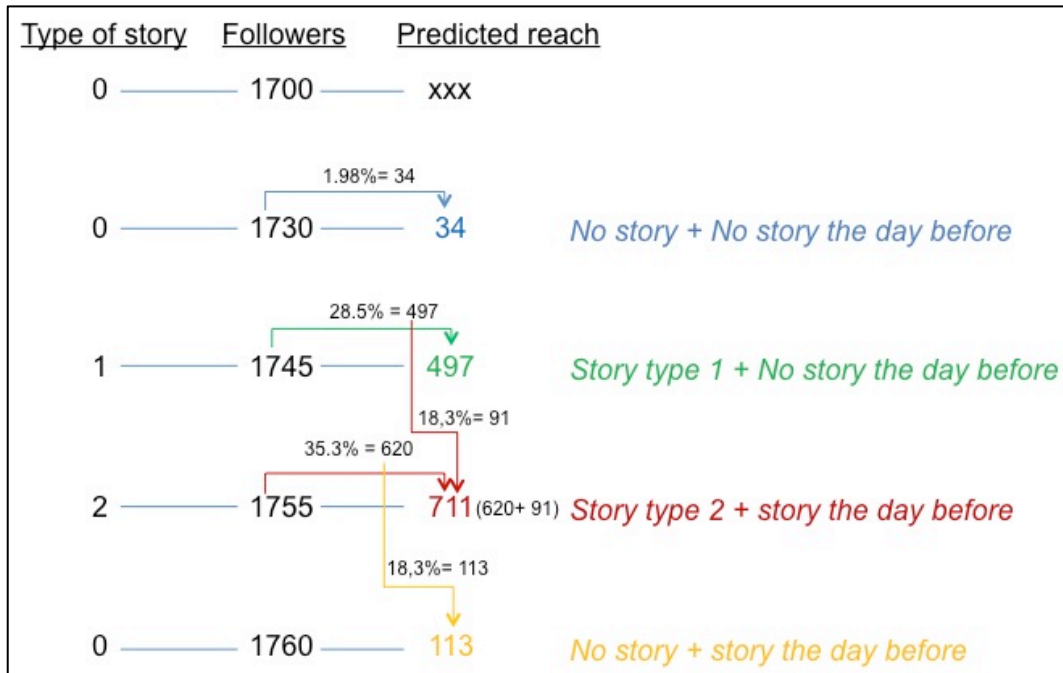
Figure 34. Illustration of the three rules used to build the predictive model.

The figure 35 compares the predicted and observed daily organic reach. This predictive model explains 89% of the observed variability (linear regressions between observed and predicted organic reach).

Figure 35. Predicted (red) and observed (blue) daily organic reach of MFP.

This predictive model was used to evaluate different posting strategies. The posting frequency is critical: the higher the number of days with a story in a week, the higher the average organic reach will be (Fig. 36).

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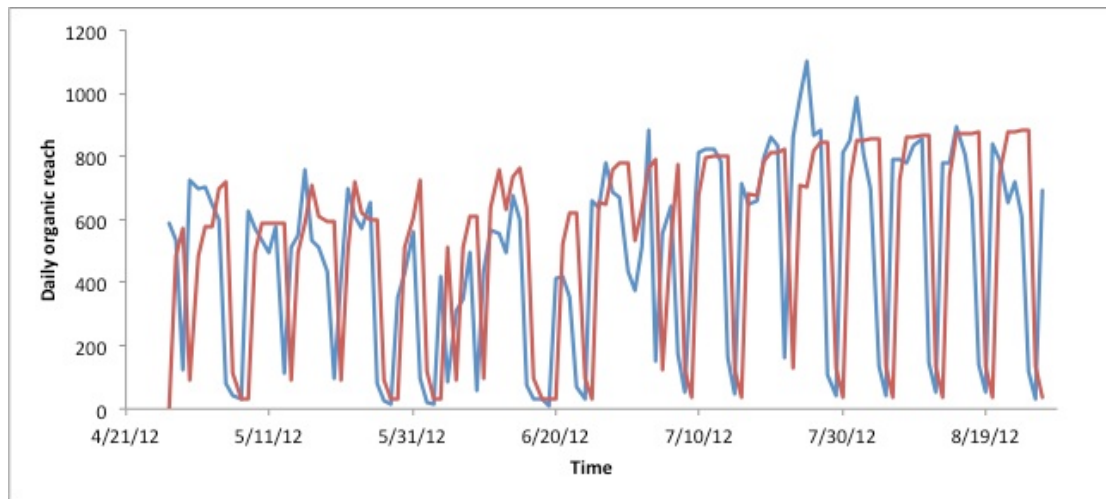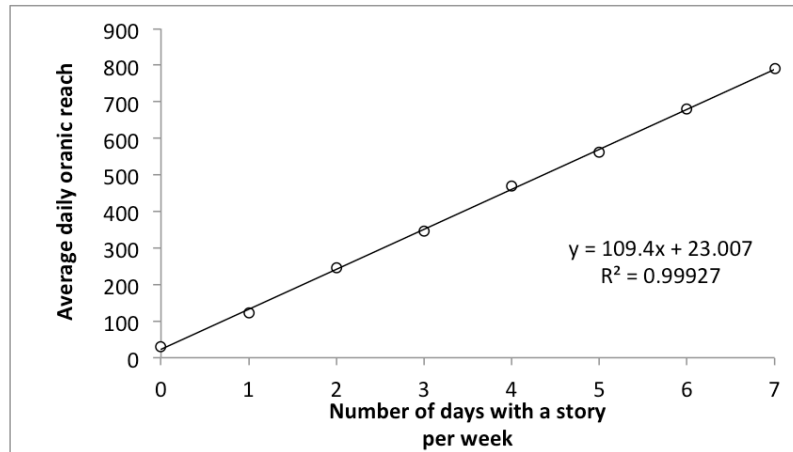Figure 36. Relationship between the average daily organic reach over the period tested (May 27th - August 27th) and the number of day with a story posted per week.

If stories are posted five days a week, the days of posting only have a minor impact on the average daily organic reach (Figure 37). The average organic reach corresponds to 563 fans when a story is posted Monday through Friday while the average organic reach is 559 fans when the 5 stories are posted randomly on 5 days during the week.
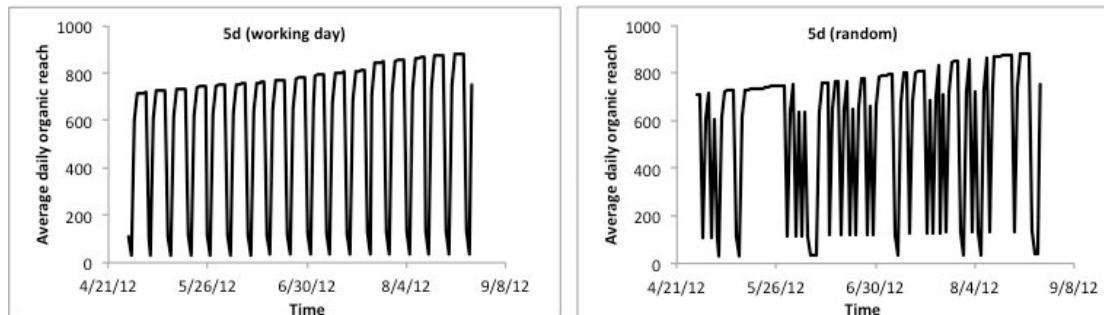
Figure 37. Predicted daily organic reach under two scenarios: one story posted per weekday (left) or five stories posted randomly during the week (right).

The time invested by MBARI to improve its OSM literacy and practices have improved the efficiency of MFP by increasing organic reach, viral reach and amount of fans' actions. The analysis of the data show that to optimize the daily organic reach, stories should be posted as often as possible on a daily basis but the day of posting in itself seems to have a minor impact on the efficiency of the story. Moreover, the stories should include a video or photo rather than only text or a text and a link.

By increasing its OSM literacy, MBARI has managed to reach more people with its content. This content, as situational interest, can potentially increase users' individual interest in marine science and engineering, supporting their motivation to

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learn more. In a sociocultural perspective on learning, participation is seen as an important element (Säljö, 2000; Vygotsky, 1978; Wenger, 1998) and is low on MFP. Nevertheless, the stories posted give MFP's fans an important opportunity to gain some knowledge about marine science.

6.6. Fans' actions on MBARI Facebook page

Several websites (e.g., Excelamktg, 2012; Falls, 2012) providing advices for page owners mention the importance of encouraging fans to take action. This strategy can potentially improve MFP's success. Asking MFP's fans to like and comment an MFP's story may have a positive impact on its Edgerank. It has been argued above that it is difficult to trigger meaningful discussions between fans on a Facebook page but this does not mean that the amount of comments cannot increase. MFP's administrator could ask specific questions to the fans such as "let us know if you appreciate this picture". The comments might not foster a more fertile social context for learning, but it will have a positive impact on the Edgerank increasing the probability that the future MFP's stories will be displayed on more fans' news feed. The importance of direct call-to-action was expressed during a couple of interviews.

MBARI should probably ask questions; ask people what their favourite is, ask them what they think of something, ask them to click "Like" and "Share" if they agree, etc.

You need to do participation stuffs. To get interaction, you need to make people participate.

Another interviewee shared the same opinion while wondering why fans do not interact more on MFB.

My guess is that the information posted on MBARI's page isn't often presented in a way that would facilitate discussions. It is almost always a presentation of something as fact; there are no questions being asked or no requests for feedback.

Finally the "share" action holds a high potential to reach a wider audience. When a fan shares an MFP's story, the story is duplicated and implemented in a new environment inhabited by friends. This duplicated story can potentially trigger more comments and discussions (which increases the story's Edgerank) due to the fact that it is shared between Facebook friends rather than between fans that do not know each other in real life. As previously discussed, it is difficult to evaluate if this kind of

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meaningful discussion happens on fans' shared stories since most of them are hidden due to the users privacy settings, but it surely increases the reach, and the number of actions linked to this story. If an MFP's story is shared three times, four copies (the original plus three replicates) of this story are viewed by four different audiences and placed in four different environments. All actions taken on MFP's stories will increase the chance to reach more people (organically, or virally) offering more opportunities for MFP's stories to serve as situational interest developing individual interest and motivation to learn about marine science. Moreover, each time someone sees an MFP's story, they will encounter MBARI's name and eventually will remember it and associate it with high quality and cutting-edge marine science and engineering.

6.7. Brief summary of the findings

Here are listed the research questions investigated in this study and a brief summary of the findings.

- Does Facebook, through interest and social interaction, have the potential to enhance the citizens' ocean literacy?

Facebook seems to have the potential to increase the public 's ocean literacy by enhancing its interest in marine science as shown with MFP in this study.

The potential of a story to promote ocean literacy through social interaction (e.g. discussions) seems very limited on Facebook pages in general and MFP in particular. But this potential seems more important when the fans share the stories with their own Facebook friends.

- What are the opportunities that scientists would need to embrace and the challenges to overcome in order to efficiently use Facebook to promote ocean literacy among the public?

Facebook offers the opportunity to reach a wide range of people with a more or less developed interest in marine science and to develop it. The content of the stories posted on Facebook, as situational interest, can potentially increase users' individual interest in marine science and engineering, supporting their motivation to learn more.

The main challenge is to try to foster social interaction on Facebook page, an arena with very few of the features requested to trigger participation.

- What are the practices that could help scientists to maximize their benefits from using Facebook?

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This study argues that practice such as regular posting of stories with videos or photos can help to reach more people. Moreover, this study suggests that posting call-to-actions could have a positive impact on the visibility of the story.

7. Further research

One should not forget that Facebook is only one part of MBARI's presence online. MBARI has a website, as well as Facebook, Twitter, Youtube and Tumblr accounts. An interviewee illustrated the importance of the connection between the different MBARI online presences:

I was doing my own research on rare abyssal fish on Youtube. Then I found MBARI's movies on Youtube, they brought me to their website and then from their website to Facebook.

It would be interesting to investigate MBARI's Internet practices as a whole rather than separated by outlets. The different online outlets are interconnected, therefore a good practice used on an outlet could potentially have positive impacts on the others. The opposite may be true as well, a bad practice on an outlet could have negative consequences on the others.

While the interviews were a very important source of data one needs to keep in mind that the interviewees, willing to spend an hour of their time answering questions about MFP, are a particular type of fan most likely more interested and engaged in marine science than other MFP's fans who did not reply to the invitation. Finally, it would be interesting if MFP's administrator could test a new posting strategy that would keep the important factors discovered during the first posting strategy but also would add new modifications such as posting a call-to-action to see if this could have a significant positive impact on MFP success.

8. Conclusion

Science and ocean literacies are important for the public at large to be able to participate in and become responsible citizens and decision-makers. The knowledge and expertise in this field often resides with scientists and science organizations that have encountered problems communicating with and cultivating scientific interest among the public. The recent OSM revolution offers scientists an opportunity to

communicate on a daily basis with the public. However, to benefit from the use of OSM, scientists need to become OSM literate to be aware of the standards and constraints of each online outlet.

Facebook represents a potential outlet where the public and the science community can meet, discuss and learn from each other in order to progressively decrease the gap between them by developing citizens' ocean literacy and scientists' OSM literacy.

This study revealed important challenges for the creation of a community based on a Facebook page where participation between members could potentially facilitate learning. This seems mainly due to the way people engage with Facebook and thus it would be quite difficult for scientists to try to foster this kind of participation in this online outlet.

The data collected indicate that frequent posting and the use of media such as photos are crucial parameters to maximize the amount of people reached by knowledge of the ocean. Moreover, a further way to increase the number of people reached would be to post call-to-actions inviting fans to like, comment and also to share the stories posted. To maximize an efficient use of Facebook, scientists should also be aware of the connection between the different OSM and be literate in each of them to foster an optimal synergy between them.

As discussed earlier, most of MFP's stories do not provide knowledge that is directly applicable to ocean conservation. However, MFP's stories can potentially improve fans' ocean literacy through discussions and through increasing individual interest. As demonstrated above, MFP is not a suitable resource to trigger discussions in general; therefore, it cannot develop fans' ocean literacy through discussions. The fans show amazement and enthusiasm toward MFP's stories indicating that MFP has the potential to reach a wide public on Facebook and to stimulate its interest in ocean science. As argued by several authors the interest support the motivation to learn (Lin, Hong & Huang, 2012) as well as improves the learning along with the recall and recognition (Hoffmann, 2002; Koeller, Baumert & Schnabel, 2001; Renninger et al., 2002; Renninger & Wozniak, 1985; Sadoski, 2001). While many authors describe the positive impact of interest on learning, the nature of this relationship might vary depending on the context. In that respect, it is difficult to know to what extent MFP (and the interest it triggers in marine science) will have a significant impact on the level of ocean literacy of Facebook users.

Finally, this study should be seen as a specific case in a larger problematic concerning the relation between scientists and the public. The OSM offer various easily accessible and cheap ways for scientists to get their words out. Nevertheless, the ease of OSM access does not mean that OSM are easy to use. Scientists eager to take advantages of these new communication channels should understand that each of them has its own practices that need to be understood and properly applied in order to help scientific outreach.

9. Appendix

Here are listed the questions used during the interviews.

- Tell me about your interest for marine topics in general?
- Tell me about your interest in science topics in general?
- How often do you engage in science learning (e.g., reading article, watching science program on TV, listen to scientific radio program, visit website related to science, etc.)
- Tell me about your use of Facebook (do you often comment, post, share, like) during the past week?
- Do you follow many organizations' pages?
- How did you hear about MBARI on Facebook?
- Why did you first decide to like the MBARI page?
- What did you hope to see on the MBARI page?
- Do you get what you expected by following MBARI on Facebook?
- How active are you on MBARI's Facebook page? (Do you often comment, like share MBARI's content)
- Why do you think people follow MBARI on FB?
- Do you pay much attention to the other fans comments?
- Fans do not seem to interact much between them on the MBARI's post, do you know why?
- Why do you think people are active on MBARI FB page (by sharing, liking, etc.)?
- Why do you think MBARI is active on FB (what kind of benefice for them)?

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