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Facebook Use and Public Participation in Science: A Comparison Between the General Public and Users of a Science Facebook Fan Page

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Facebook Use and Public Participation in Science: A Comparison Between the General Public and Users of a Science Facebook Fan Page

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Abstract

Investigating the role of SNSs in engaging the public in scientific affairs is necessary in the modern society where risk and scientific innovations bear a high level of uncertainty. This study employs the O-S-O-R model in its attempt to examine the impact of SNSs on civic activism and the potential mediating role of self-efficacy and scientific knowledge. It is noteworthy that this study utilizes data collected from two different populations –the general public and the users of the Facebook fan page “Pansci.com,” the biggest scientific online group in Taiwan.

Based on a total sample size of 1,960, we found that Facebook use increases knowledge only for “Pansci.com” users. Moreover, Facebook use is positively related to self-efficacy and public participation in both samples. However, its effect on self-efficacy is stronger for “Pansci.com” users. Quite differently, the effect of self-efficacy on participation is stronger for the general public. Lastly, self-efficacy, but not knowledge, serves as a significant mediator between Facebook use and public participation in both samples. Implications of these findings will be discussed.

Keywords: Social Network Sites, Facebook, Efficacy, Science Communication, Public Participation

Introduction

Social networking sites (SNSs), an important form of ICT, serve as important platforms for users to instantly interact with one another and engage in public affairs nowadays (Whiting & Williams, 2013). They are interactive, user-focused, and can distribute a massive amount of information (Nisbet and Scheufele, 2009; Scherman, Arriagada, & Valenzuela 2014; Chou et al., 2009). Besides, SNSs allow users to create and join groups with common interests and similar ideas, and to eventually organize activities (Valenzuela, Park & Kee, 2009). Therefore, the effect of SNSs on public participation in a variety of public affairs attracts many scholars' attention. This study will emphasize the role of Facebook in the context of science communication.

As science becomes increasingly complex and intertwined with people's daily lives, public participation in science turns out to be an important issue in modern societies (Powell & Colin, 2008). In contrast to the more traditional impact assessment model, in which the impact of science on society is evaluated after innovations are developed, scholars nowadays have emphasized the need to involve the public in earlier stages of scientific development (Nisbet & Scheufele, 2009). This idea is called "upstream engagement" (Wilsdon & Willis, 2004; Tait, 2009).

Engaging the public is necessary and helpful in two aspects. First, public participation contributes to a more transparent and accountable process of public policy-making. Research has indicated that when risk issues, for example global warming, nanotechnology, are discussed only within expert circles (i.e., government officials or scientists), citizens are likely to become more distrustful and skeptical (Powell & Colin, 2008; Eden, 1996; Powell & Colin, 2009). Science is important for

influencing policy decisions on how to deal with those risks. In order to avoid the ‘expertization’ of science, it is significant to raise its public profile and strengthen its ability to shape society (Eden, 1996).

Furthermore, in a democracy, citizens should have a say in decisions about scientific developments that will affect their lives and society in significant ways. Some researchers have pointed out that greater well-being can be obtained through higher levels of democratic engagement among individuals and societies (Hampton, 2011). Moreover, lay citizens have valuable knowledge and points of view to bring to discussions, and thus their input can contribute to more comprehensive, stronger societal decisions (Powell & Colin, 2008).

Social networking sites (SNSs) nowadays serve as important platforms for users to instantly interact with one another and engage in public participation (Valenzuela, Park & Kee, 2009; Whiting & Williams, 2013; Kwon, D’Angelo & McLeod, 2013; Raacke & Bonds-Raacke, 2008; Alhabash, Park, Kononova, Chiang & Wise, 2012). First, Nisbet and Scheufele (2009) indicated that the interactive and user-focused digital content of social media could work to fill the information gaps in the area of science. Even users non-interested in specific issues can engage with public participation due to casual or incidental exposure via social media (Scherman, Arriagada, & Valenzuela 2014).

Second, SNSs users are able to distribute a massive amount of information to a large number of contacts on SNSs, which increases the probability of reaching critical mass and facilitates mobilization (Scherman, Arriagada, & Valenzuela 2014; Chou et al., 2009). Third, SNSs allow users to create and join groups with common interests and similar ideas, and to eventually organize activities (Valenzuela, Park & Kee, 2009). Some features of SNS groups, such as calendar services, allow users to manage

events or activity invitations, and thus can support organizing activities more concretely (Wohn et al., 2011).

In this study, the O-S-O-R model (Orientations-Stimulus- Orientations-Response model) is applied. The first O indicates the role of preexisting orientations, for example, socioeconomic status, age, education level. The second O refers to personal-psychological factors in Stimulus that conditions media use. In the study, Facebook is treated as stimulus. Finally, the ultimate effect of media use is Response which is people's public behavior in science in this research (Jung, Kim, & de Zúniga, 2011; Scheufele, Nisbet, Brossard, & Nisbet, 2004).

Few studies focused on what mediated communication and public participation and they indicated that future research should explore especially the second O (Jung, Kim, & de Zúniga, 2011). They further pointed out knowledge and efficacy was concentrated as role of mediators in the process of communication to participation and they are also the main two focus in this paper (Jung, Kim, & de Zúniga, 2011; McLeod, Scheufele, & Moy, 1999). Knowledge is highly related to the public involvement in decision making (Wilsdon & Willis, 2004). SNSs can gain knowledge for users in the two ways. First, SNSs can allow users to search and collect information, and obtain useful professional expertise (Pi, Chou, & Liao, 2013). Second, although for most users, SNSs provide opportunities for users to gain more knowledge about specific issues which they may be not have been interested in originally (Barker, Dozier, Weiss, & Borden, 2013). The communication process among citizens also influences people's civic attitudes and behaviors by allowing them to exchange information, elaborate on problems facing the community and learn about opportunities to participate in civic activities (Jung, Kim & de Zúniga, 2011).

As far as the motivator for participating in such events, self-efficacy is a particularly important concept (Vraga et al., 2015). Self-efficacy is defined as “people’s beliefs in their capabilities to produce given attainments” (Bandura, 1994, p.307). It determines how people feel, think, motivate themselves and behave. Those with higher levels of self-efficacy are more likely to act (Pinkleton, Austin & Fortman, 1998). There are three reasons why SNS-use can cultivate users’ self-efficacy.

First, SNSs provide people with successful experiences of engaging with social issues and communicating information to others in their social network (Vraga et al., 2015; Velasquez & LaRosem, 2015). For example, users may publicly support social issues via SNSs and obtain governments’ response to such actions (Vraga et al., 2015). Experience is the most powerful source of efficacy beliefs since it allows individuals to learn firsthand the reach of their own capabilities. Therefore, if these experiences are perceived as successful, users can obtain their own perceived capabilities of what they can achieve (Velasquez & LaRosem, 2015).

Second, information-rich SNSs satisfy citizens’ levels of information seeking. SNS users’ acquisition of greater knowledge is positively related to their development of higher perceptions of efficacy (Pinkleton, Austin & Fortman, 1998). Third, SNS users can comment on their friends’ posts and message their friends. Such instant interactivity inherent in SNSs also increases the levels of users’ self-efficacy (Vitag et al., 2011; Tedesco, 2007).

Most of the studies about SNSs focus on one specific sample group (Scherman, Arriagada, & Valenzuela 2014; Wohn et al., 2011). For example, a sample may be limited to one conservative community or one college student population (Zhang, Johnson, Seltzer, & Bichard, 2010; Valenzuela, Park & Kee, 2009). Only selecting one sample population has limited previous studies’ ability to generalize research

findings to area broader context. Furthermore, the majority of research focused on social media users' political behavior (Jung, Kim & de Zúniga, 2011; Kushin & Yamamoto, 2010; Rainie, Smith, Schlozman, Brady & Verba, 2012), while only a few studies examined public participation in science.

Additionally, most previous studies focused on the relationship between self-efficacy and traditional media (Hofstetter, Zuniga & Dozier, 2001; Holbert, Lambe, Dudo & Carlton, 2007). For instance, television could provide viewers with an increased sense of efficacy. By giving them feelings of competence, viewers felt they better understood specific issues (Hoffman & Thomson, 2009). However, the relationship between internet use and self-efficacy was also discussed in previous research (Coleman, Morrison & Svennevig, 2008; Shen, Wang, Guo & Guo, 2009). The Internet provided individuals with easy access to information and thus further increased their efficacy (Kenski & Stroud, 2006).

Research about SNSs and self-efficacy and their relationship to scientific participation is still rare. To examine whether SNS use certainly influences users' self-efficacy and public participation, two methods can be used. One method is to investigate the relationship between the two variables within a single dataset, which is the approach taken by most current studies. The alternative method is to compare the levels of self-efficacy and behaviors between users and non-users of a particular science-related Facebook page, which assembles users with the same scientific interest but different backgrounds. The alternative method is applied in this research.

The Facebook fan page "Pansci," the biggest scientific online group in Taiwan, is taken as an example. This study contributes to expand the understanding of O-S-O-R model of communication effects and first uncovers the relationship between Facebook, users' scientific knowledge and level of self-efficacy and public

participation, and will then further combine the two datasets – Facebook fan page users and general users – to compare the differences between specific scientific group member and general users on Facebook. The results of this study can paint a clearer picture about the role of SNSs in facilitating public engagement in science.

Literature Review

Definition of Scientific Use of Facebook

Social Networking sites are online services that allow users to create an individual profile, present themselves, articulate their social network, maintain connections with other users – usually people known offline – and navigate through these networks of contacts. Profiles allow users to learn detailed information about their contacts, including personal background, interests, and whereabouts. Users can communicate with people they already know offline or new acquaintances through a variety of tools within the same site, including chatting, sending private message, leaving public comments on users’ profiles, linking to outside content and sharing photos and videos (Gil de Zúñiga, Jung, & Valenzuela, 2012; Ellison, Steinfield, & Lampe, 2007).

In this study, Facebook is taken as an example. As of December 2016, monthly active Facebook users around the world reached 1.86 billion (Facebook, 2017). As one of the most popular social networks, Facebook’s sweeping influence cannot be ignored. As one of biggest SNSs around the world, Facebook includes mass information. Most of Facebook users create an account by connecting with acquaintances. The functions of commenting, joining/creating a group and liking a fan page allow users to connect with others who share similar ideas and interests with them. Facebook exemplifies all of the elements of SNSs, in particular promoting

public participation, so it is a suitable case for examining how SNSs influence users' public participation.

Ellison, Steinfield & Lampe (2007) created an assessment of Facebook intensity (FBI), measuring intensity on a scale to obtain a better measure of Facebook usage than frequency or duration indices. The number of Facebook friends and the amount of time spent on Facebook were also included. However, the scale did not include multiple dimensions of use, which provides a more nuanced insight than only measurement of time spent on site (Smock, Ellison, Lampe, & Wohn, 2011). Previous studies assess many dimensions of Facebook use by examining different features of Facebook, such as status updates, sharing information, posting photos/videos, commenting, joining a group, liking a fan page and sending private messages (Vitak et al., 2011; Smock, Ellison, Lampe, & Wohn, 2011; Pi, Chou, & Liao, 2013). This study took into account the features of Facebook that enable or facilitate communication among users: sharing information and commenting.

Definition of Public Participation

In the recent years, involving the public in decision making about science and technology policy has become a trend (Rowe, & Frewer, 2000; Chopyak & Levesque, 2002; Wilsdon & Willis, 2004; Nistbet & Scheufele, 2009). Scientists gradually increasingly involve the public in their work due to “a recognition of basic human rights regarding democracy and procedural justice” (Rowe, & Frewer, 2000, p.5) and in response to perceived citizens' mistrust of government (Rowe, & Frewer, 2000; Wilsdon & Willis, 2004).

The concept of upstream engagement was mentioned when public participation was discussed (Joly & Kaufmann, 2008; Pidgeon & Rogers-Hayden, 2007; Kurath & Gisler, 2009; Wilsdon & Willis, 2004). The notion of upstream engagement supports

mutual learning and two-way communication. When people discuss how to deal with unique issues, in the early stages of scientific and technological development two-way communication, such as dialogue, has to take place (Joly & Kaufmann, 2008; Pidgeon & Rogers-Hayden, 2007). Not downstream, but upstream engagement suggests a genuine and democratic science-society interaction through involving public knowledge in emerging science and technology related decision-making (Kurath & Gisler, 2009).

Controversial issues such nanotechnology, nuclear power, genetically modified food or chemical hazards provide wider historical and interpretive contexts, as such science and technology is highly relevant to people's lives. To get research and development funding and support, policy and science communities try to eliminate people's fears and win the public's acceptance. Upstream engagement is the best option for avoiding future conflicts over life-science research and its applications, starting from the early decision-making on basic research funding (Pidgeon & Rogers-Hayden, 2007; Tait, 2009).

The development of public participation and how scientists involve the public in their work is separated into three phrases: 1. Public understanding of science (PUS), 2. From deficit to dialogue, and finally 3. Moving engagement upstream (Wilsdon & Willis, 2004). Based on the public understanding of science, people generally lacked knowledge of scientific facts, so scientists first embarked on a mission to inform and educate people (Jiang & Chang, 2016; Wilsdon & Willis, 2004). However, this kind of one-way communication caused some problems. When risk issues, for example global warming, nanotechnology, nuclear power, and genetically modified food are discussed exclusively within expert circles (i.e., between government officials or scientists), citizens are likely to become more distrustful and skeptical (Powell & Colin, 2008;

Eden, 1996; Powell & Colin, 2009). Science is important for influencing policy decisions on how to deal with those risks. In order to avoid the ‘expertization’ of science and the scientific community’s negligence of citizens’ diversity of knowledge, it is significant to raise public profile of science and strengthen the public’s ability to shape society (Eden, 1996; Jiang & Chang, 2016).

When policy and science communities started to involve the public into decision-making processes, dialogue was initiated and public engagement moved upstream (Wilsdon & Willis, 2004). Lay citizens are believed to have valuable knowledge and points of view to bring to discussions, and thus their input can contribute to more comprehensive, stronger societal decisions (Powell & Colin, 2008). Besides, public participation contributes to a more transparent and accountable process of public policy-making. (Eden, 1996; Jiang & Chang, 2016; Shih, 2016).

Oftentimes the public may be at the receiving end, or lowest level of top-down communication or a one-way flow of information, such as attending a speech. At the highest level, which is characterized by dialogue and two-way information exchange, people actively seek information through mechanisms as consultation exercises, focus groups, and questionnaires, and finally may be selected to take part in exercises that provide them with a degree of decision-making authority (Rowe, & Frewer, 2000).

Public participation was defined as “a group of procedures designed to consult, involved, and inform the public to allow those affected by a decision to have an input into that decision” (Rowe & Frewer, 2000, p.6). Another definition was “the practice of consulting and involving members of the public in the agenda-setting, decision-making, and policy-forming activities of the organization of institutions responsible for such functions (Powell & Colin, 2008). Citizens can interact with or discuss with others and related government department and institutions. The can be involved in

decision-making process by participating activities such as science cafes, focus groups, scenarios workshops, deliberative polls, citizen juries, and consensus conferences (Powell & Colin, 2008). Several participation methods were categorized: referenda, public hearings/inquiries, public opinion surveys, negotiated rule making, consensus conference, citizen's jury/panel, citizen/public advisory committee and focus groups (Rowe & Frewer, 2000).

The past studies focus on the importance of public participation and the necessary citizen engagement in science (Rowe & Frewer, 2000; Powell & Colin, 2008; Eden, 1996) and evaluation of effective public participation (Rowe & Frewer, 2000). Few studies focus on how people exactly gain the power to involve in public affairs (Shih, 2016) and how to identify the environmental factors that will mediate the effectiveness of the different participation methods (Jiang & Chang, 2016).

Direct relationship

The relationship between scientific use of Facebook and public participation in science.

Numerous previous studies about how media influence people's behavior have indicated both negative and positive relationships between traditional media use and public participation. For example, television was found to deflect people from involvement in civic matters (McLeod, Scheufele & Moy, 1999; Wang, 2007). However, some studies pointed out that some people exhibited increased civic behavior due to gaining more information and knowledge through newspapers, and mass media provided people with more mobilizing information (McLeod, Scheufele & Moy, 1999).

After we entered the era of the Internet, mass information was provided on an unprecedented scale. In the era of Web 1.0, the internet allowed audience to select the extent of their exposure to information (Wang, 2007). Unlike traditional media, the internet is full of interactivity, which increases people's interest and encourages expression of opinion (Wang, 2007). The more frequently users expressed their opinions through the Internet, the more participation they exhibited (Wang, 2007). The internet increased the accessibility, simplicity and rapidity of the communication process, which allows users to gain mass amounts of information (Wang, 2007; Shah, Kwak & Holbert, 2001).

In recent years, the various functions of social media have increased the possibilities for public participation (Gil de Zúñiga, Jung & Valenzuela, 2012). Interactive and user-focused digital content is included as a feature of most SNSs. Research has indicated that the mass amount of information is available on SNSs (Robelia, Greenhow & Burton, 2011). Users are exposed to more information by others' posting and sharing (Bode, 2016). By this, social media fills information gaps in the area of science (Nisbet & Scheufele, 2009).

Moreover, social media allows users to obtain information from a network of known others and therefore may be of users' greater interest (Bode, 2016). SNSs facilitate access to a large number of contacts, increasing the probability of reaching critical mass (Scherman, Arriagada, & Valenzuela, 2014). The social nature of this new media facilitates quicker information distribution. Furthermore, users are influenced by acquaintances they care about and are thus encouraged to display more public participation.

Third, SNSs allow users to create and join groups with common interests and similar ideas, and to eventually organize activities (Valenzuela, Park & Kee, 2009;

Scherman, Arriagada, & Valenzuela 2014). Besides existing contacts, users can also find new contacts on SNSs or create a group or fan page in which they may share and discuss specific topics or ideas that they are all interested in. After sharing similar ideas with one another, users eventually organize activities together. SNSs increase individuals' connectivity and enable users' direct participation (Valenzuela, Park & Kee, 2009; Scherman, Arriagada, & Valenzuela 2014; Chou, Hunt, Beckjord, Moser, & Hesse, 2009).

Indirect Relationship

O-S-O-R model.

In this study, the O-S-O-R model (Orientations-Stimulus- Orientations-Response model) is applied. The first O indicates the role of preexisting orientations and the second O refers to personal-psychological factors in Stimulus that conditions media use. Finally, the ultimate effect of media use is Response (Jung, Kim, & de Zúniga, 2011; Scheufele, Nisbet, Brossard, & Nisbet, 2004).

The first orientations: sociodemographic variables and controlled variables— age, gender, education level, length of use, fan page membership, and scientific exposure to traditional media.

In this framework, in addition to the set of structural, cultural, cognitive and motivational characteristics (McLeod, Kosicki, & McLeod, 2002), socioeconomic status, age and gender are included in the first orientations which is the first O in O-S-O-R model and are important predictors of people's participation (Jung, Kim, & de Zúniga, 2011). For example, research has presented a positive relationship between people's age and their participation, and has suggested that the relationship between

gender and participation varies across different countries. In general, those with higher socioeconomic status tend to display higher media use, knowledge, efficacy and eventually participation (Jung, Kim, & de Zúniga, 2011). Besides, exposure stimulates interest and discussion, and can produce supplemental effects to participation (McLeod, Kosicki, & McLeod, 2002). In this study, age, gender, education level, the length of use, the number of fan pages people have joined, and their exposure are all included in the first orientations. These variables can affect the other dependent variables in this model, so they are residualized for all statistical tests of relationships. Therefore, this study focuses on the process of how communication variables, such as Facebook use, influence people's scientific participation outcomes without influence of socio-demographic variables.

Stimulus: the relationship between scientific use of Facebook and scientific knowledge and self-efficacy.

Scientific knowledge.

If scientists and the government wanted to involve the public in decision-making, the typical first step was to embark on a mission to inform. From the early 1970s, the US National Science Foundation uncovered the levels of people's understanding of science through a survey of knowledge of scientific facts (Wilsdon & Willis, 2004).

Many studies indicated that those who were more cognitively sophisticated are more likely to engage in activities (McLeod, Scheufele and Moy, 1999). The positive relationships between communication tools, or media, and knowledge have been discussed at length. Traditional media, such as television and newspapers, was viewed

a tool to close the knowledge gap between people and increase public knowledge (Eveland & Scheufele, 2000; Do & Kincaid, 2006; Vitak et al., 2011).

Besides the great amounts of information it provides, the internet allows users not only to seek information at any time, but also to dig deeper into issues through the use of hyperlinks and search engines. However, the current knowledge gaps have not disappeared just because the audience no longer only receives content on televisions and newspaper. The content that users are not interested in could possibly be skipped by them (Eveland & Scheufele, 2000). Besides, the internet is a medium where individuals largely control their exposure to content. Those who are not interested in scientific issues are likely to not seek out related topic online (Kenski & Stroud, 2006). SNSs may be a better field for users to gain knowledge for the following reasons.

A lot of studies indicate that there is an association between SNSs and people's knowledge (Pi, Chou, & Liao, 2013; Barker, Dozier, Weiss, & Borden, 2013). First, SNSs can allow users to search and collect information, and obtain useful professional expertise (Pi, Chou, & Liao, 2013). It is easier for users to seek information and provide resources to others (Barker, Dozier, Weiss, & Borden, 2013). Second, although for most users, SNSs are used for entertainment and passing the time, users are probably exposed to the information that is shared by their friends. They can view, share and follow up on those materials posted by others and this is how SNSs provide opportunities for users to gain more knowledge about specific issues which they may be not have been interested in originally (Barker, Dozier, Weiss, & Borden, 2013).

Numerous studies indicate substantial knowledge gain from media use. Although most measures of factual knowledge are often too limited to capture the full picture of what audience members take away from media use, open-ended questions measuring

the audience's cognitive complexity might result from both personal characteristics and patterns of media use (McLeod, Kosicki, & McLeod, 2002). According to the statements, Hypothesis 1a is proposed:

H1a: Scientific use of Facebook will be positively related to the scientific knowledge.

Self-efficacy.

Self-efficacy is an obvious motivator of people's behavior. Bandura (1995) defined perceived self-efficacy as "beliefs in one's capability to organize and execute the courses of action required to manage prospective situations" (p.2). Efficacy beliefs have a great impact on how people think, feel, motivate themselves and act. Bandura separated sources of efficacy beliefs into four types: mastery experience, vicarious experience, social persuasion, and physiological and emotional states. Except subjective mastery experience and physiological and emotional states, mass media could provide the functions of vicarious experience and social persuasion. Through vicarious experiences, people see the success of those who are similar to themselves, and believe they have the ability to reach the achievement as well. Social persuasion means that people who are verbally persuaded that they possess the capabilities to master given activities are more likely to mobilize greater efforts and sustain them than if they harbor self-doubts and dwell on personal flaws when problems arise (Bandura, 1995).

Media effects on efficacy have been described in many previous studies. Traditional media, for example television and radio, cultivated people's levels of self-efficacy. Concerning media campaigns on television, those who had high levels of exposure had higher levels of self-efficacy (Agha, 2003). However, although

watching TV and reading newspapers familiarizes some people with certain knowledge and makes them believe they make do some changes in society, such information no longer reaches the youngest target. Instead, young users turn to the Internet for information searching (Moeller, de Vreese, Esser, & Kunz, 2014). By using the Internet, people gain information and interact without the limitation of time and space (Moeller, de Vreese, Esser, & Kunz, 2014). The Internet also enables normal people to interact with public officials, and many websites are built as platforms to communicate specific issues and information (Kenski & Stroud, 2006). Moreover, diverse perspective and personal opinions can be found easily on the Internet, and people express themselves according to their knowledge (Shen, Wang, Guo & Guo, 2009; Jung, Kim & de Zúniga, 2011). The Internet provides an avenue for users not only to exchange opinions and values but also to participate in some activities while expending significantly less time, money, and physical efforts (Jung, Kim & de Zúniga, 2011). The more frequently users expressed their opinions through the Internet, the more they had a sense of efficacy (Wang, 2007). The accessibility of information and feeling of full mastery of information made people believe that they could make certain changes (Jung, Kim & de Zúniga (2011).

However, since more knowledgeable individuals could possibly track down more information, the Internet may perpetuate knowledge gaps (Kenski & Stroud, 2006). Social media, with all the advantages of the Internet, provides chances to open the conversation between people with different interests. According to Moeller, de Vreese, Esser, & Kunz (2014), through SNSs, readers can share, comment and engage in debate about an article with minimal effort. In such comments, debates and discussions, SNSs users can provide others with hyperlinks to more information about the subject.

Without the limitation of space and time, users spend a significant portion of the day using SNSs. Sharing, and talking online about something users have encountered and are interested in has become the standard way to deal with information. On SNSs, people can encounter various types of information and knowledge. As friends on SNSs share information about some specific issues they care about, people are exposed to information even if they are originally may not be interested in it. With a great amount of knowledge, people's level of efficacy increases.

In the case of Facebook, the functions such as posting, commenting, and event invites can involve users in information distribution, issue discussion and even event participation. In the light of the previous argument, Hypothesis 1b is proposed:

H1b: Scientific use of Facebook will be positively related to levels of self-efficacy.

The second orientations: scientific knowledge and self-efficacy as mediator.

Scientific knowledge.

Knowledge is a predictive of active participation in public affairs (Jung, Kim & de Zúniga, 2011) and some empirical studies have shown the scientific knowledge was positively associated with public participation (Ho, Brossard, & Scheufele, 2008). Previous studies indicated that information held on a variety of behaviors and norms related with a democratic citizenry and the sources of factual knowledge included textbook facts and surveillance facts (Jennings, 1996). Informational media, such as news programs, can promote public participation by triggering citizens' mental reasoning and elaboration of news events, which subsequently promote individuals' participation in public affairs. The communication process among citizens also

influences people's civic attitudes and behaviors by allowing them to exchange information, elaborate on problems facing the community and learn about opportunities to participate in civic activities. Besides, knowledge could possibly spur public participation through the feeling of efficacy (Jung, Kim & de Zúniga, 2011).

Self-efficacy.

Previous studies indicated that self-efficacy can be prediction of public participation (Jung, Kim & de Zúniga, 2011; Shah, et al., 2007). First, self-efficacy, a feeling of confidence and self-qualification, made people have communicating behavior (Jung, Kim & de Zúniga, 2011). Although high level of citizens' sense of efficacy combined with low trust reduced their interest and involvement in public affairs, they were influenced one-way communication which was different from two-way communication media form (Shah et al, 2007). Second, the reason why those with higher levels of self-efficacy were likely to act was people with higher levels of self-efficacy believed that others were affected more than oneself by a given message. The belief was called the third-person effect. People might have behavior because the influence they predict affecting others of a given message (Pinkleton, Austin, & Fortman, 1998).

According to the aforementioned statement, Hypothesis 2a and 2b are proposed:

H2a: Scientific knowledge will be positively related to public participation in science.

H2b: Self-efficacy will be positively related to public participation in science.

One pattern in different samples.

A significant amount of research has indicated that Facebook is positively related to public participation. For example, people with a Facebook account engage

in more public activities than those without a Facebook account (Valenzuela, Arriagada, & Scherman, 2012). Users with the same interests and hobbies can discuss topics of interest, share personal expertise and ideas, and provide experience with solving problems to others on SNSs. SNSs, for example Facebook, provide the function of Group and Fan pages, which offer a specific space for users with common interests to generate discussions and share information. Users can easily, efficiently interact and share information with others once they join a group or like a Fan page (Pi, Chou, & Liao, 2013).

Furthermore, Facebook fan page Pansci.com increases people's public participation (Shih, 2016). Although previous studies have already indicated the positive relationship between Facebook and participation, they investigated only one survey. To understand more clearly the certain relationship between scientific use of Facebook, people's scientific participation and their level of efficacy, this study compares the users and non-users of a specific science-related Facebook page. Pansci.com users are defined as specific scientific group members in this study. Research Questions are provided:

RQ1a: Will the relationship between scientific use of Facebook and scientific knowledge vary by different samples?

RQ1b: Will the relationship between scientific use of Facebook and levels of self-efficacy vary by different samples?

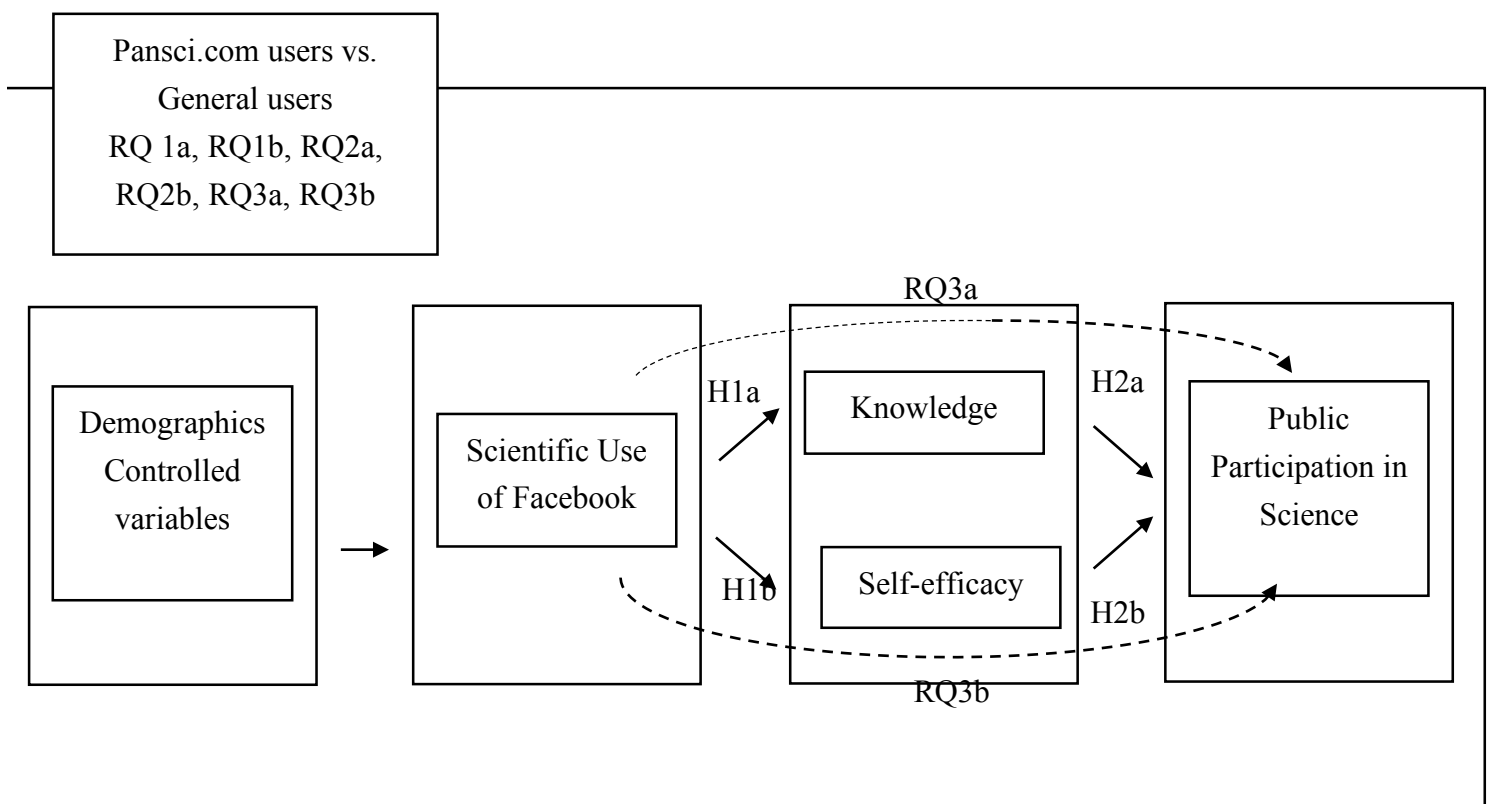
RQ2a: Will the relationship between scientific knowledge and public participation in science vary by different samples?

RQ2b: Will the relationship between self-efficacy and public participation in science vary by different samples? RQ3a: Will scientific knowledge significantly mediate the

relationship between scientific use of Facebook and public participation in science?

Will the relationship vary by different samples?

RQ3b: Will self-efficacy significantly mediate the relationship between scientific use of Facebook and public participation in science? Will the relationship vary by different samples?



Method

Data

The analyses of this study were based on two datasets. First, one is for specific Facebook users who use scientific Facebook fan page Pansci.com, and second, the other is for general Facebook users.

The first survey was for specific Facebook users who use scientific Facebook fan page Pansci.com. Based on data from an online survey platform Survey Monkey (<http://www.surveymonkey.com>), through many distributing ways including Taiwanese well-known website PPT(telnet://ptt.cc), a sample size of N =1,160 was collected. It was conducted from August to December, 2014.

The other analyses in this study for general Facebook users were based on data collected from an online survey platform Eastern Online (EOL) Corporation with a sample size of N = 800. It was conducted for 10 days from 22th to 31th May 2015. The sample of this study shared similar demographic characteristics with the overall Taiwanese population. The cooperation rate was 40 percent. The sample was based on a carefully constructed probability sample that minimized sampling and non-response biases.

Dependent variables

Public participation in science.

In this study, to specifically assess the civic behaviors related to science, five survey questions about consumer behavior and civic behavior were applied. These five questions were taken from the report Americans' Actions to Limit Global Warming (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Rosenthal, 2014) published by Yale University and George Mason University. The report indicated that consumer behavior has become a way through which people express their values and concerns. Policies and actions of a company may be influenced by consumers'

choices. Besides, the report also pointed out that people express their values and concerns through their civic behavior, for example, writing a letter or email to related officials or donating money. The variables will be elaborated upon in chapter three. Shih (2016) separated behaviors into two categories which were information participation and public participation. In this paper, users' public participation was needed to know so variables about public participation were used. The variables about public participation in science of Pansci.com and general samples were measured an additive index of five items with a 5-point scale (1= *never*; 5= *always*), asking respondents their level of frequency with the following statements: (1) "How often do you participate in scientific, technology related or environmental public hearings or seminars"; (2) "How often do you participate in programs related to environmental protection or ecological rehabilitation?"; (3) "How often do you donate to environmental groups, scientific media, animal protection groups or associated non-governmental institutions?"; (4) How often do you encourage or punish a company for the sake of environmental protection?; (5) "How often do you express your opinions about environmental protection issues by writing a letter, email or calling relevant government offices or representatives?" (Pansci.com: $M = 2.05$, $SD = .80$, *Cronbach's alpha* = .78; general: $M = 1.93$, $SD = .72$, *Cronbach's alpha* = .84).

Mediating variables

Scientific knowledge.

Scientific knowledge as an additive index of multiple choices quiz-like questions. The questions for Pansci.com users were (1) Which of the following is a key factor that enables an airplane to lift? (A: Air pressure beneath the wing is greater than that above the wing.); (2) A farmer thinks that the vegetables on her farm are not getting enough water. Her son suggests that they use water from the nearby ocean to

water the vegetables. Is this a good idea? (C: No, because ocean water is too salty for plants grown on land.); (3) How do most fish get the oxygen they need to survive? (B: Using their gills, they take in oxygen that is dissolved in water.); (4) For which reason any people experience shortness of breath more quickly at the top of a mountain than along a seashore? (C: A lower percent of oxygen in the blood.); (5) Which is a better way to make sure whether a new medicine is valid? If 1000 volunteers want to join a scientist's disease study, he should... (A: He should give the medicine to half of volunteers and not give to the other half of volunteers.); (6) As part of a laboratory experiment, five students measured the weight of the same leaf four times. They recorded 20 slightly different weights. All of the work was done carefully and correctly. Their goal was to be as accurate as possible and reduce error in the experiment to a minimum. Which of the following is the BEST method to report the weight of the leaf? (C: Average all of the weights that were recorded.).

For general users, scientific knowledge was an additive index of five true/false quiz-like questions. were (1) All radioactivity is man-made; (2) Electrons are smaller than atoms; (3) Lasers work by focusing sound waves; (4) The center of the Earth is very hot; and (5) The continents have been moving their location for millions of years and will continue to move in the future. The correct answer from the respondents were counted one point. Therefore, the index ranged from 1 to 5, where a higher value indicated a higher level of scientific knowledge (Pansci.com: $M = 5.5$, $SD = .76$, $KR-20 = .31$; general: $M = 3.53$, $SD = 1.27$, $KR-20 = .58$).

Self-efficacy.

The questions conducted people's efficacy included: (1) "I consider myself to be well qualified to participate in the communication of scientific knowledge or

science-related issues”; (2) “I feel that I have a pretty good understanding of scientific knowledge or important scientific issues”; (3) “I think that I am better informed about science than most people”; (4) “Sometimes science seems so complicated that a person like me cannot really understand what is going on”; and (5) “A person like me is unlikely to make much contribution to the dissemination of scientific knowledge.” The respondents answered these questions on the surveys for both Pansci.com users and general samples, these items were measured on 5-point scales item from 1= *strongly disagree* to 5= *strongly agree*. Items (4) and (5) were reverse coded to make the valence of all question consistent (Pansci.com: $M = 3.3$, $SD = .73$, *Cronbach's alpha* = .78; general: $M = 2.92$, $SD = 0.61$, *Cronbach's alpha* = .76).

Independent variable

Scientific use of Facebook.

McLeod & McDonald (1985) suggested that attention and exposure should be included when a survey assessed media effect so scientific use of Facebook was an additive index of five items for both the Pansci.com and general samples: (1) “In the past month, how often did you see information about science or technology on Facebook?” (2) “How much attention did you pay to the information on Facebook?” (3) “How often did you read the information you encounter on Facebook?”. Besides, this study took into account the features of Facebook that enable or facilitate communication among users: sharing information and commenting. Therefore, (4) “How often did you share information you encounter on Facebook?” (5) “How often did you comment on information you encounter on Facebook?” were also included. The survey on Pansci.com users was specifically for users’ scientific use of Facebook

fan page Pansci.com so the items were (1) “In the past month, how often did you see information from Facebook fan page Pansci.com on Facebook?” (2) “How much attention did you pay to the information from Facebook fan page Pansci.com on Facebook?” (3) “How often did you read the information from Facebook fan page Pansci.com you encounter on Facebook?” (4) “How often did you share information from Facebook fan page Pansci.com you encounter on Facebook?” (5) “How often did you comment on information from Facebook fan page Pansci.com you encounter on Facebook?”. For both Pansci.com and general samples, these items were measured on 5-point scales item from 1= *never* to 5= *always* (Pansci.com: $M = 3.18$, $SD = .56$, *Cronbach's alpha* = .71; general: $M = 2.52$, $SD = .75$, *Cronbach's alpha* = .8).

Control variables

Socio-demographics.

As the analysis utilized data from two separate data collections, “0” was coded to indicate Facebook fan page Pansci.com users and “1” was coded to indicate general Facebook users. Demographics including age, gender, and education level also served as controlled variables in the analysis. Age was measured as continuous variables (Pansci.com: $M = 28$, $SD = 12.42$; general: $M = 35$, $SD = 8.26$). Gender was a dichotomous variable with female coded as “0” and male coded as “1” (Pansci.com: 50 percent females; general: 50 percent females). Education was an ordinal variable and both surveys included five categories, ranging from “elementary” (coded as “1”) to “graduate and above (coded as “5”). Across the Pansci.com and general samples, the median value for education was “4”, indicating “college”.

Membership of science fan pages.

To know the condition of distributing scientific message on Facebook, one open question was included: “how many Facebook fan page related to science and technology do you join?” For both Pansci.com and general samples, number was the unit (Pansci.com: $M = 6.68$, $SD = 8.3$; general: $M = 1.46$, $SD = 2.81$).

The length of time.

The length of time included one open-ended question which was “in the past week, how many hours did you use Facebook including subscribing, reading through and discussing with other and so on on Facebook per day averagely?”. For both Pansci.com and general samples, hour was the unit. For example, a respondent who used Facebook for three hours and thirty minute in the past week would fill 3.5 into the blank. (Pansci.com: $M = 5.4$, $SD = 3.56$; general: $M = 2.73$, $SD = 2.48$).

Scientific exposure to traditional media.

To know Facebook users’ level of concern about scientific information on traditional news and media, an additive index of two items was for both samples: (1) “How often do you see the news about science and technology on newspaper, magazine, television and radio, except on the Internet?”; (2) “How often do you notice the news about science and technology on newspaper, magazine, television and radio, except on the Internet?”. For both Pansci.com and general samples, these items were measured on 5-point scales item from 1= *never* to 5= *always* (Pansci.com: $M = 3.53$, $SD = .74$, $r = .61$; general: $M = 2.96$, $SD = .8$, $r = .76$).

Table1

Descriptions and correlations of variables: demographics, scientific knowledge and self-efficacy (Pansci.com users)

	Correlations									
	Age	Education level	Gender	Time	Fan Page	Exposure	Scientific use of Facebook	Scientific knowledge	Self-Efficacy	Public participation
Age	1									
Education Level	.246**	1								
Gender	.009	.051	1							
Time	-.022	.004	.007	1						
Fan Page	.020	.033	-.023	.078**	1					
Exposure	.150**	.026	-.128**	-.059*	.076**	1				
Scientific use of Facebook	.159**	.051	-.141**	.028	.113**	.252**	1			
Scientific knowledge	.026	.044	-.158**	-.105**	.030	.124**	.168**	1		
Self-efficacy	-.021	.114**	-.174**	-.073*	.108**	.352**	.374**	.284**	1	
Public participation	.059*	.176**	.006	.053	.106**	.198**	.208**	.008	.239**	1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Table2

Descriptions and correlations of variables: demographics, scientific knowledge and self-efficacy (General users)

Correlations										
	Age	Education level	Gender	Time	Fan Page	Exposure	Scientific use of Facebook	Scientific knowledge	Self-efficacy	Public Participation
Age	1									
Education Level	-.059	1								
Gender	.025	.128**	1							
Time	-.168**	-.036	-.070*	1						
Fan Page	-.110**	.116**	.170**	.160**	1					
Exposure	.108*	.141**	.244**	.067	.224**	1				
Scientific use of Facebook	-.115**	.014	.090*	.162**	.226**	.128**	1			
Scientific knowledge	-.103**	.236**	.236**	.009	.103**	.266**	.038	1		
Self-efficacy	-.036	.159**	.341**	.042	.244**	.436**	.201**	.237**	1	
Public participation	-.007	.119**	.134**	.191**	.353**	.306**	.238**	.014	.352	1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Result

In this study, an ordinary least squares (OLS) regression was used to test models predicting each of the three following dependent variables: 1) scientific knowledge; 2) self-efficacy and 3) public participation in science, separately. The OLS regression tested the relationships modeling, the independent variables were entered in blocks according to their assumed causal order, so as to examine their relative explanatory power. In this analysis, the following independent variables were entered in blocks:

- 1) Demographics and other controlled variables (age, gender, education level, membership of science fan pages, the length of time)
- 2) Scientific exposure to traditional media and Scientific use of Facebook
- 3) Scientific knowledge and self-efficacy

In the combined sample, interactions were calculated in order to test: 1) whether the relationship between scientific use of Facebook and scientific knowledge will vary by different samples; 2) whether relationship between scientific use of Facebook and levels of self-efficacy will vary by different samples; 3) whether the relationship between scientific knowledge and public participation in science will vary by different samples; 4) whether the relationship between self-efficacy and public participation in science will vary by different samples; 5) whether the relationship between scientific use of Facebook and public participation in science mediated by scientific knowledge will vary by different samples; and 6) whether the relationship between scientific use of Facebook and public participation in science mediated by self-efficacy will vary by different samples. As outlined earlier, statistical interactions represent the notion that the relationship between two variables (e.g., the link between

scientific use of Facebook and public participation in science) differs according to Facebook users' scientific knowledge and level of self-efficacy.

Each of the interaction terms was constructed by multiplying the standardized values of the main effect variables. This was done to prevent any possible multicollinearity problems that might arise between the interaction term and its components. The interactions between 1) data and scientific use of Facebook, 2) data and scientific knowledge, and 3) data and self-efficacy, were discussed in the final block of this study to predict the dependent variable.

Table 3 showed the first set of ordinary regression models of factors predicting scientific knowledge. For the Pansci.com sample, females ($\beta=-.16$, $p<.001$) and those with scientific exposure to traditional media ($\beta=.07$, $p<.05$) had more scientific knowledge. However, the length of time ($\beta=-.11$, $p<.001$) was negatively associated with scientific knowledge of Pansci.com users. The relationship between scientific use of Facebook ($\beta=.13$, $p<.001$) and scientific knowledge was significantly positive. Those with higher level of scientific use of Facebook had more scientific knowledge. This result corresponded to **Hypothesis 1a**: Scientific use of Facebook will be positively related to the scientific knowledge. Socio-demographics and other controlled variables accounted for 3.5 percent and scientific exposure to traditional media accounted for 2.5 percent. The overall regression model accounted for 6.4 percent of the total variance in predicting scientific knowledge for Pansci.com sample.

For general sample, males ($\beta=.21$, $p<.001$) and those with higher education level ($\beta=.20$, $p<.001$) had more scientific knowledge. Moreover, the relationship between scientific exposure ($\beta=.22$, $p<.001$) and scientific knowledge was positive. The relationship between scientific use of Facebook and scientific knowledge was

insignificant. **Hypothesis 1a** was not supported in general sample. Socio-demographics and other controlled variable accounted for 10.9 percent and scientific exposure to traditional media accounted for 4.1 percent. The regression model accounted for 15 percent of the total variance in predicting scientific knowledge for general sample.

For combined sample, younger ($\beta = -.04$, $p < .05$) and those with higher education level ($\beta = .10$, $p < .001$) were positively related to scientific knowledge. Those with higher scientific exposure ($\beta = .14$, $p < .001$) also had more scientific knowledge. However, the length of time ($\beta = -.04$, $p < .05$) was negatively associated with scientific knowledge. The variable data ($\beta = -.65$, $p < .001$) was negatively related to scientific knowledge. It showed that possibly more Pansci.com users had more scientific knowledge. The relationship between scientific use of Facebook ($\beta = .05$, $p < .01$) was positively associated with scientific knowledge; therefore, **Hypothesis 1a** was supported. **Research question 1a** asked whether the relationship between scientific use of Facebook and scientific knowledge will vary by different samples. The answer was no. Socio-demographics and other controlled variables accounted for 50.5 percent and scientific exposure to traditional media and scientific use of Facebook accounted for 2.1 percent. In combined sample, the regression model accounted for 52 percent of the total variance in predicting scientific knowledge.

Table 3

Ordinary Least Regression Model with Scientific Knowledge as Outcome Variable

	Pansci.com Sample (N=1160)	General Sample (N=800)	Combined sample (N=1960)
<u>Block 1</u>			
Age	.01	-.09**	-.04*
Gender (1=male)	-.16***	.21***	.04
Education level	.05	.20***	.10***
Membership of science fan pages	.03	-.03	.03
The length of time Data	-.11***	.01	-.04*
(0=pansci.com; 1=general)	--	--	-.65***
Incr. R ²	4%***	10.9%***	50.5%***
<u>Block 2</u>			
Scientific exposure to traditional media	.07*	.22***	.14***
Scientific use of Facebook	.13***	-.02	.05**
Incr. R ²	2.5%***	4.1%***	2.1%***
<u>Block 3</u>			
Data x Scientific use of Facebook	--	--	-.03
Incr. R ²	--	--	.1%
Final R ²	6.4%	15%	52.6%

Notes. Coefficients are standardized ordinary least squares regression coefficients.

***p<.001, **p<.01, *p<.05

From Table 4, for Pansci.com users, females ($\beta=-.18$, $p<.001$), education level ($\beta=.13$, $p<.001$), membership of science fan pages ($\beta=.11$, $p<.001$) and scientific

exposure ($\beta=.27, p<.001$) was positively related to level of self-efficacy. Scientific use of Facebook However, the length of time ($\beta=-.07, p<.001$) were negatively related to the level of Pansci.com users' levels of self-efficacy. They could be explained those spent less time on Facebook had higher level of self-efficacy. **Hypothesis 1b** proposed the relationship between scientific use of Facebook and levels of self-efficacy was positive. The result supported it. The scientific use of Facebook ($\beta=.30, p<.001$) was significantly associated with levels of self-efficacy. Socio-demographics, other controlled variables accounted for 6.5 percent and scientific exposure to traditional media and scientific use of Facebook accounted for 19.1 percent of the variance in level of self-efficacy. The regression model predicting users' level of self-efficacy accounted for total of 25.6 percent in Pansci.com sample.

For general users, males ($\beta=.00, p<.001$), those with higher education level ($\beta=.13, p<.01$) and more membership of science fan pages ($\beta=.13, p<.001$) had higher level of self-efficacy. Besides, those the relationship between scientific exposure ($\beta=.34, p<.001$) and levels of self-efficacy were positive. Those with more scientific use of Facebook ($\beta=.11, p<.001$) had higher levels of self-efficacy. The resulted meant that **Hypothesis 1b** was supported. Socio-demographics, other controlled variables accounted for 16.3 percent. Scientific exposure to traditional media and scientific use of Facebook accounted for 11.9 percent of the variance in self-efficacy. The regression model predicting self-efficacy accounted for total 28.3 percent in general sample.

For combined sample, female ($\beta=-.11, p<.001$), education level ($\beta=.11, p<.001$) and more membership ($\beta=.06, p<.01$) of science fan pages were positively associated with level of self-efficacy. Those with scientific exposure to traditional media ($\beta=.34, p<.01$) was also had higher levels of self-efficacy. However, the length of time

($\beta=-.07$, $p<.01$) was negatively related to levels of self-efficacy. Those spent less time on Facebook would have higher levels of self-efficacy. Data ($\beta=-.20$, $p<.001$) was also negatively related to levels of self-efficacy. It indicated that more Pansci.com users had higher level of self-efficacy. The relationship between scientific use of Facebook ($\beta=.25$, $p<.001$) and levels of self-efficacy was positively. Therefore, **Hypothesis 1b** was supported. In combined sample, the overall regression model predicting levels of self-efficacy accounted for 29.2 percent. Socio-demographics and other controlled variables accounted for 10.2 percent. Scientific exposure to traditional media and scientific use of Facebook accounted for additional 18.2 percent of the variance in levels of self-efficacy.

Table 4

Ordinary Least Regression Model with Self-efficacy as Outcome Variable

	Pansci.com Sample (N=1160)	General Sample (N=800)	Combined sample (N=1960)
<u>Block 1</u>			
Age	-.06	-.05	-.11***
Gender (1=male)	-.18***	.00***	.01
Education level	.13***	.13**	.11***
Membership of science fan pages	.11***	.13***	.06**
The length of time Data	-.08**	.04	-.07**
	--	--	-.20***
(0=pansci.com; 1=general)			
Incr. R ²	6.5%***	16.3%***	10.2%***
<u>Block 2</u>			
Scientific exposure to traditional media	.27***	.34***	.34***
Scientific use of Facebook	.30***	.11**	.25***
Incr. R ²	19.1%***	11.9%***	18.2%***
<u>Block 3</u>			
Data x scientific use of Facebook			-.09***
Incr. R ²	--	--	0.9%***
Final R ²	25.6%	28.3%	29.2%

Notes. Coefficients are standardized ordinary least squares regression coefficients.

***p<.001, **p<.01, *p<.05

To assess whether predicting levels of self-efficacy was substantially different between two samples, **Research Question 1b** asked whether the relationship between scientific use of Facebook and levels of self-efficacy will vary by different samples. The answer was yes. Table 4 showed that the interaction between data and scientific use of Facebook ($\beta=-.09$, $p<.001$) was statistically significant. As **Figure 1** showed

that those with higher scientific use of Facebook in Pansci.com sample had more levels of self-efficacy than those in general sample.

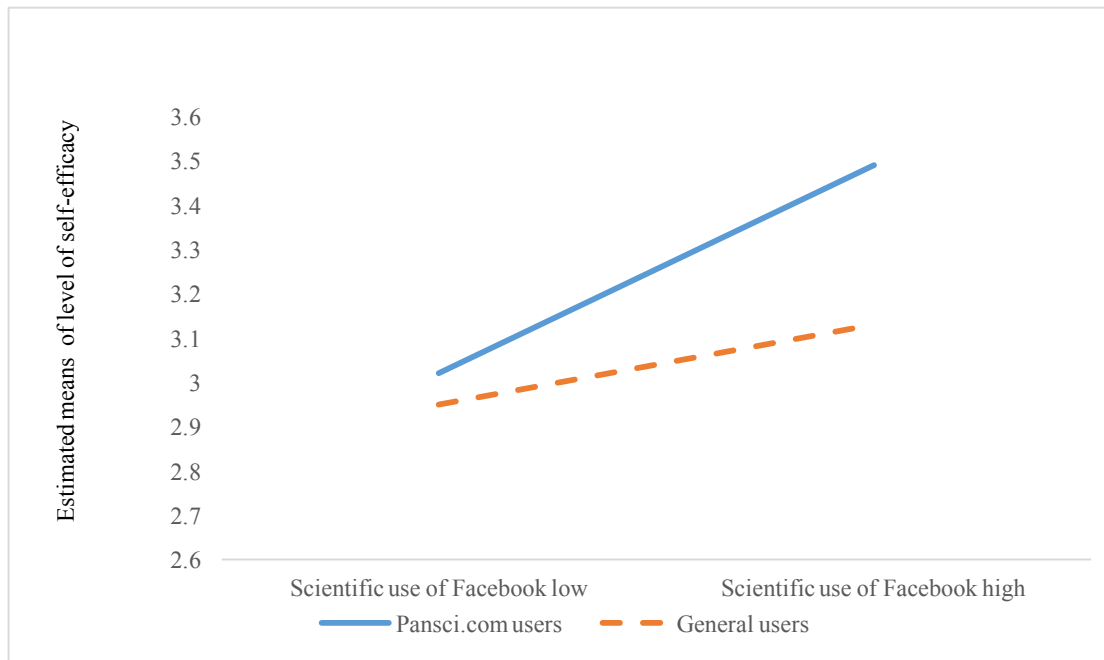


Figure 1. Interaction effects on levels of self-efficacy by scientific use of Facebook of different samples.

Table 5 indicated that for Pansci.com users, education level ($\beta=.17$, $p<.001$), membership of science fan pages ($\beta=.09$, $p<.05$), and scientific exposure ($\beta=.17$, $p<.001$) were positively related to public participation in science. Besides, the relationship between scientific use of Facebook ($\beta=.16$, $p<.001$) and public participation in science was also positive. **Hypothesis 2a** proposed the positive relationship between scientific knowledge and public participation in science. It was not supported because scientific knowledge ($\beta=-.07$, $p<.05$) was negatively associated with public participation in science and meant that those with less scientific knowledge would have more public participation in science. However, **Hypothesis 2b** which proposed the positive relationship between levels of self-efficacy and public participation in science was supported. Self-efficacy ($\beta=.16$, $p<.001$) was positively

associated with public participation in science. Those with higher level of self-efficacy had more public participation in science. The regression model predicting public participation in science accounted for total of 12.3 percent of variance in the dependent variable in Pansci.com sample. Socio-demographics and other controlled variables accounted for 4.3 percent. Scientific exposure to traditional media and scientific use of Facebook accounted for 6 percent of the variance in public participation in science. Scientific knowledge and self-efficacy accounted for an additional 1.9 percent of the variance.

For general users, except age, all other controlled variables were positively associated with public participation in science (gender: $\beta=.08$, $p<.05$; education level: $\beta=.08$, $p<.05$; membership of science fan pages: $\beta=.31$, $p<.001$; the length of time: $\beta=.16$, $p<.001$; scientific exposure to traditional media: $\beta=.21$, $p<.001$). The relationship between scientific use of Facebook ($\beta=.14$, $p<.001$) and public participation in science was positive. However, scientific knowledge ($\beta=-.12$, $p<.001$) and public participation in science was negatively association with each other. It showed that **Hypothesis 2a** was not supported. The relationship between self-efficacy ($\beta=.22$, $p<.001$) and public participation in science was positive so **Hypothesis 2b** was supported. The regression model predicting public participation in science accounted for total of 26.2 percent of the variance in dependent variable in general sample. Socio-demographic and other controlled variables accounted for 16 percent. Scientific exposure to traditional media and scientific use of Facebook accounted for 5.8 percent and scientific knowledge and self-efficacy accounted for additional 4.4 percent.

In combined sample, males ($\beta=.06$, $p<.05$), those with higher education level ($\beta=.15$, $p<.001$), those with more membership of science fan page ($\beta=.31$, $p<.001$),

the length of time ($\beta=.09$, $p<.001$) and scientific exposure to traditional media ($\beta=.21$, $p<.001$) had more public participation in science. Besides, scientific use of Facebook ($\beta=.17$, $p<.001$) was positively related to public participation in science. Besides, self-efficacy ($\beta=.19$, $p<.001$) was also positively linked to public participation in science. **Hypothesis 2b** was supported. However, scientific knowledge ($\beta=-.13$, $p<.001$) was negatively associated with public participation in science so **Hypothesis 2a** was not supported. In combined sample, the overall regression model predicting public participation in science accounted for total of 16 percent. Socio-demographic and other controlled variables accounted for 5.6 percent. Scientific exposure to traditional media and scientific use of Facebook accounted for 7.3 percent. Scientific knowledge and self-efficacy accounted for 2.9 percent.

Table 5
Ordinary Least Regression Model with Public Participation in Science as Outcome Variable

	Pansci.com Sample (N=1160)	General Sample (N=800)	Combined sample (N=1960)
<u>Block 1</u>			
Age	.02	.06	.02
Gender (1=male)	.00	.08*	.06*
Education level	.17***	.08*	.15***
Membership of science fan pages	.09*	.31***	.13***
The length of time Data	.05	.16***	.09***
	--	--	.06
(0=pansci.com; 1=general)			
Incr. R ²	4.3%***	16%***	5.6%***
<u>Block 2</u>			
Scientific exposure	.17***	.21***	.21***

to traditional media			
Scientific use of Facebook	.16***	.14***	.17***
Incr. R ²	6%***	5.8%***	7.3%***
<u>Block 3</u>			
Scientific knowledge	-.07*	-.12***	-.13***
Self-efficacy	.16***	.22***	.19***
Incr. R ²	1.9%***	4.4%***	2.9%***
<u>Block 4</u>			
Data x Scientific use of Facebook	-	-	.03
Data x scientific knowledge	-	-	.01
Data x self-efficacy	-	-	.05*
Incr. R ²	-	-	.02%
Final R ²	12.3%	26.2%	16%

Notes. Coefficients are standardized ordinary least squares regression coefficients. Coefficients for the interactions terms were before-entry betas. Interaction terms were created after the two interacting items were standardized.

***p<.001, **p<.01, *p<.05

To assess whether predicting public participation in science was indeed substantially different between two groups, a final interactions block was entered in combined regression model. Table 5 showed that the interaction between self-efficacy and data ($\beta=.05$, $p<.05$) was statistically significant. However, the interaction between scientific use of Facebook and two samples and the interaction between scientific knowledge and two samples were not significantly related to the outcome variables. According to the result, **Research Question 2a** which asked whether the effect of scientific knowledge on public participation in science vary by different sample was not supported. However, **Research Question 2b** which asked whether the effect of self-efficacy on public participation vary by different sample was supported. As

Figure 2 showed, in using Facebook for scientific proposes, those with higher self-efficacy in general sample experienced more public participation in science than those in Pansci.com sample.

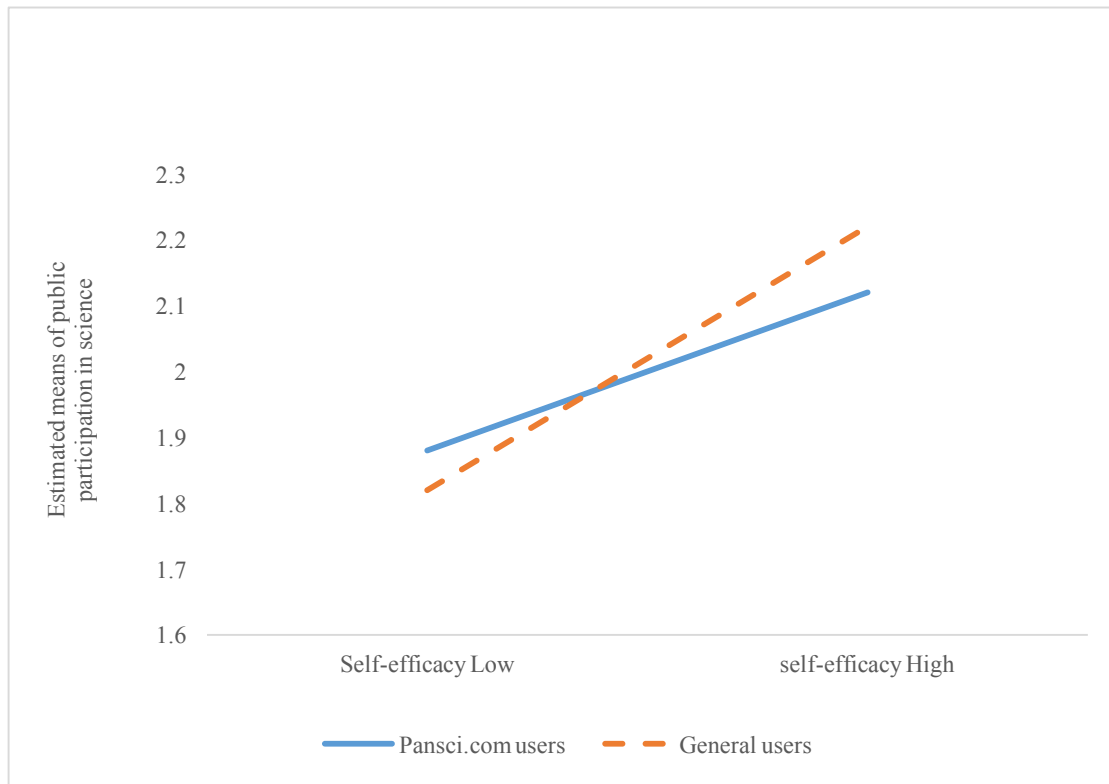


Figure 2. Interaction effects of scientific use of Facebook on public participation in science by level of self-efficacy of different samples.

To test the mediation effect, the study applied “PROCESS” a macro for SPSS developed by Hayes (2013). **Research Questions 3a** asked whether scientific knowledge significantly will mediate the relationship between scientific use of Facebook and public participation in science and whether the relationship will vary by different samples. The answers were no. The result showed that in Pansci.com and general samples, the indirect effect was not significant when scientific knowledge was mediator. The relationship did not vary by different samples.

Research Question 3b asked whether self-efficacy will significantly mediate the relationship between scientific use of Facebook and public participation in science

and whether the relationship will vary by different samples. According to the Table 5, the answers were yes and no. Scientific use of Facebook could increase self-efficacy and further increase the level of public participation in science (Pansci.com: $\beta=.0638$; general: $\beta=.325$). However, no significant effect in combined sample and it meant that the relationship did not vary by different samples.

Table 5. *Mediation Effect Result*. Scientific knowledge and self-efficacy as mediator.

	Pansci.com sample		General sample		Combined sample	
	Indirect Effect	Confidence Intervals	Indirect Effect	Confidence Intervals	Indirect Effect	Confidence Intervals
Path 1P	-.0062 (.0058)	-.0231~ .0005	.0047 (.0062)	-.0058~ .0191	.0062 (.0083)	-.0086~ .0239
Path 2	.0638 (.0144)	.0375~ .0940*	.0325 (.0111)	.0134~ .0566*	-.0227 (.0185)	-.0598~ .0131

Notes: Path 1: Facebook use → knowledge → Public participation; Path 2: Facebook use → self-efficacy → Public participation; Values in parentheses are standard errors of the regression coefficients.

* $p < .05$

Discussion

As social media becomes more and more popular in the world nowadays, its influence on people's behavior is highly relevant and requires further research. In this study, based on O-S-O-R model, how users' scientific use of Facebook influenced their scientific knowledge and self-efficacy was examined. Their impacts on users' public participation in science were the other main point. Besides, Pansci.com users and general users were taken as example to compare the differences between specific scientific group members and general users on Facebook.

S - O₂ (Scientific use of Facebook – scientific knowledge/ self-efficacy)

In the Pansci.com sample, the relationship between scientific use of Facebook and scientific knowledge was positive. However, in the general sample, the relationship between scientific use of Facebook and scientific knowledge was insignificant. Compared to general users, information seeking motivation of Pansci.com was stronger (information seeking motivation: Pansci.com: $M = 4.01$; general: $M = 3.59$). In the general sample, users' socializing and self-status seeking motivations were stronger. (socializing motivation: Pansci.com: $M = 3.19$, general: $M = 3.60$; self-status seeking motivation: $M = 2.54$, general: $M = 3.51$). The motivation of their Facebook use may influence their knowledge gaining.

The result indicated that the relationship between scientific use of Facebook and their self-efficacy was significantly positive. The result supported previous research, which found SNSs with all the advantages of the Internet, offered opportunities to open the conversation between people with different interests, without the limitation of space and time (Kenski & Stroud, 2006; Moller, de Vresse, Esser & Kunz, 2014). Through features of SNSs, user could share and comment and further gain information with minimal effort, which increased their perceived efficacy.

The result showed that the impact of scientific use of Facebook is stronger for the general public than Pansci.com users. Two explanation are provided for this result. First, 29.9 percent of users in the Pansci.com sample were from institute of technology. They possibly provided knowledge on Facebook and are treated as scientists or experts on Facebook. Second, Pansci.com users have joined Facebook fan page Pansci.com for nine months ($M = 9.5$; $SD = 8.55$). Because they joined the

fan page Pansci.com for a long time, they did not feel that Facebook could make their self-efficacy increase.

O₂ – R (scientific knowledge/self-efficacy – public participation in science)

In both samples, the relationship between scientific knowledge and public participation in science was negative. The more knowledge people had, the less likely they were to engage in civic behaviors related to science. This finding is in contradiction to existing literature, which generally found a positive relationship. Several possible explanations are proposed. The first explanation is related to the reliability of our knowledge measure. Specifically, we used true/ false quiz-like questions to tap people's level of scientific knowledge. This type of measurement usually does not produce very high reliability coefficients and the KR-20 of the knowledge measures in both samples was not satisfactory. However, the relationship pattern was consistent in both samples. Therefore, the finding does not seem to be a result of the measurement quality.

The second explanation is about the motivations of using Facebook. For "Pansci.com" users, entertainment was the main motivation driving their Facebook use behavior. In contrast, the general public used Facebook for the purpose of socializing and self-identity. To the extent that informational use of the media usually serves as a better predictor of participation, the fact that both groups of people used Facebook for non-informational purposes may change the impact of knowledge on civic activism.

Third, knowledge is positively related to trust because "less knowledgeable citizens are more likely to view public officials' blunders as signs of bad character" (Galston, 2007, p. 637). If people trust the government a lot, there may not be a need

to get involved in civic actions. Therefore, more knowledgeable people turned out to be engagement civic activities to a lesser extent.

It will be an interesting topic for future research. But regardless of the reasons behind, it is noteworthy that those who were involved in the policy-making process in Taiwan were not the scientific experts or social elites.

The positive relationship between self-efficacy and public participation in science proved self-efficacy made users have communicating behavior (Jung, Kim & de Zúniga, 2011). Besides, Pansci.com users with higher self-efficacy had more public participation in science. Pinkleton, Austin, & Fortman (1998) indicated that those with higher levels of self-efficacy were likely to act because they believed that the others were affected more than oneself by a given message. People might have behavior because of the influence they predict affecting others of a given message.

S – O₂ – R (Scientific use of Facebook – scientific knowledge/self-efficacy – public participation in science)

As our findings suggest, scientific knowledge was not a significant mediator of Facebook use and public participation in both samples. This finding warrants discussion in two aspects. First, although Facebook use was significantly related scientific knowledge, which, in turn, negatively predicted public participation for “Pansci.com” users, the overall indirect effect was not statistically significant. It means that the contribution of Facebook use to people’s civic engagement was still positive. Second, for the general public sample, it is noteworthy that Facebook use did not increase people’s participation through a heightened level of scientific knowledge. In other words, the reasons why Facebook use were positively related to people’s participatory behavior may be explained by factors other knowledge. This finding

suggests that it may be useless if government or interest groups aim to increase public engagement merely by providing information.

In contrast, self-efficacy serves as a mediator between Facebook use and public participation in both samples. It means that, in addition to the direct impact, Facebook use can also drive public participation through increasing people's level of self-efficacy. Therefore, those who would like to engage the public in civic affairs need to work out ways that integrates efficacious information in the Facebook content.

Direct effect

S – R (Scientific use of Facebook - public participation in science).

It is important to point out that, outside of O-S-O-R model, scientific use of Facebook had direct effect on public participation in science. Besides indirect effect, scientific use of Facebook was positively associated with public participation in science. The nature of social media facilitates a large number of contacts, increasing the probability of reaching critical mass. Users are influenced by acquaintances they are about and are thus encouraged to display more public participation (Scherman, Arriagada, & Valenzuela, 2014). Moreover, SNSs allow users to create and join groups with common interests and similar ideas, and eventually organize activities (Valenzuela, Park & Kee, 2009). SNSs increase individuals' connectivity and enable users' direct public participation (Scherman, Arriagada, & Valenzuela, 2014; Valenzuela, Park & Kee, 2009; Chou, Hunt, Beckjord, Moser, & Hesse, 2009).

Limitation

Before addressing the contribution of this study, some limitations and potential directions will be pointed out for future research. First, the first orientation can include motivation. According to previous studies, specifically different types of motivation were more correlated to civic action than recreational uses (Valenzuela, Park & Kee, 2009; Kwon, D'Angelo & McLeod, 2013). Second, SNSs enable users to discuss and elaborate their thoughts easily. O-S-R-O-R model can apply to study how media have the impact on the process of reasoning and how the process influence users' behavior. Third, the measurement of Facebook use in this study were only posting and commenting. However, users can also join a group or like a fan page by join specific social networks. The different features of Facebook have different effect on people's scientific knowledge and self-efficacy. Moreover, Facebook was an example in this study and cannot treat as entity of SNSs.

Fourth, the knowledge variables in this study account for how much people know about scientific facts. Other types of knowledge may be examined in future study. Fifth, the variables of public participation in science were overall. Public participation of different controversial issues can be discussed meticulously to understand how SNSs influenced users' knowledge and self-efficacy when facing different issues.

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