Nano-scientists as Consumers and Sources of Information about Nanoethics

MING-CHING LIANG, ANTHONY DUDO, LEE ANN KAHLOR, NIVEEN ABI GHANNAM, & ALLISON J. LAZARD

Department of Advertising and Public Relations
University of Texas at Austin
300 West Dean Keeton, A1200, Austin, TX78712
USA
liangmin@mail.utexas.edu
dudo@utexas.edu
kahlor@mail.utexas.edu
niveena@utexas.edu
lazard@utexas.edu

ABSTRACT: To address the communication gap between nano-scientists and ethicists, nano-scientists' ethical information seeking and sharing behavior are examined. Drawing on Ethics Position Theory (EPT) and Planned Risk Information Seeking Model (PRISM), this study seeks to profile ethical practices among nano-scientists and identify predictors for ethical information seeking and sharing.

KEYWORDS: nanoethics, information seeking, information sharing, ethics position, social responsibility

1. INTRODUCTION

Nanotechnology continues to attract significant interest and investment from government and industry (National Nanotechnology Initiate, 2008; Palmberg, Dernis, & Miguet, 2009). This emerging field, which consists of efforts to manipulate matter at the atomic and molecular level, offers potential for scientific and engineering breakthroughs previously thought impossible (Allhoff & Lin, 2010) and is commonly referred to as "the next industrial revolution" (White House, 2000). Corresponding with its development, a greater number of entities—including government, academe, media, scientists, ethicists, and the general public—have turned their attention toward the possible social and ethical implications of nanotechnology (i.e., nanoethics) due to the inherent novelty and uncertainty associated with working at the nanoscale (Allhoff, Lin, Moor, & Weckert, 2007; Robison, 2011).

The U.S. government has played an important role in the exploration and promotion of nanoethics. Calling for further examination of the societal and ethical aspects, the 21st Century Nanotechnology Research and Development Act was signed into law at the end of 2003 (D. Johnson, 2007). Additionally, to facilitate ethical practices among nano-scientists (i.e., scientists and engineers working at the nanoscale) and industrial practitioners, the U.S. government has invested considerable resources in the exploration of ethics related to nanotechnology (National Science Foundation, n.d.). So far, 93 grants have been awarded to projects associated with ethics in nanotechnology, totaling more than $34 million (National Science Foundation, n.d.). In addition, the National Nanotechnology Initiative (NNI) has identified ethical, legal, and societal issues (ELSIs) as an "important component of responsible

Liang, Ming-Ching, Anthony Dudo, Lee Ann Kahlor, Niveen Abi Ghannam, & Allison J. Lazard. (2013). *Nano-scientists as consumers and sources of information about nanoethics.* In Jean Goodwin, Michael F. Dahlstrom & Susanna Priest (Eds.), *Ethical issues in science communication: A theory-based approach* (pp. 135-149). Charleston, SC: CreateSpace.

development" and supports two research centers that specifically focus on researching nanotechnology ELSIs (National Nanotechnology Initiative, n.d.).

Scholarly efforts exploring the social and ethical issues of nanotechnology also have rapidly increased during the past decade. *Nanoethics*, an academic journal focusing on ELSIs of nanotechnology, has served as a specialized outlet since 2007. This increase in academic attention is also evident in publication trends. A search we conducted within the Web of Science database for peer-reviewed research about nanotechnology published between 1987 and 2012 yielded nearly 20,000 articles, approximately 2,100 of which broach some dimension of nanoethics (as identified via the Boolean keyword search operand, "ethics OR social"). Similar to other recent findings (Mnyusiwalla, Daar, & Singer, 2003), our quick-and-dirty search indicates an ample increase in nanotechnology-related research publications, a large proportion of which seem to be addressing social and ethical issues. This appears especially to be the case since the year 2000, when the average proportion of nanotechnology-related research publications broaching nanoethics jumped from between two to six percent of the overall research corpus to at least 10 percent of the overall research corpus, where it has remained through the year 2012.

Despite the apparent escalation of attention directed at nanoethics, this attention—and the many insights it has generated—may not be reaching a key audience: the individuals conducting nanoscale science, "nano-scientists." Several scholars have documented a disconnection between nano-scientists and nano-ethicists (Johnson, 2009). For example, Rasmussen, Ebbesen, and Andersen (2012) observed that even though attention to social, ethical, and legal aspects of nanoscience may enhance the development of a responsible discipline, few nano-scientists have participated in discussions about these topics. In addition to the lack of participation, perceived irrelevance has broadened the gap between scientists and ethicists (Viseu & Maguire, 2012). For example, a recent study indicates that for some scientists, ethics is regarded as an "extra-curricular" scientific activity, existing apart from their daily laboratory work (Viseu & Maguire, 2012). As a result, efforts that problematize nanoethics may exert little influence on the work being done by nano-scientists. Such a communication disconnect would represent a significant barrier to the long-term, responsible adoption and application of nanotechnologies; for the continued financial and scholarly investments in nanoethics to be truly valuable they must ultimately influence the practice and regulation of nanoscience itself.

With these considerations in mind, we seek to explore the issue of "nanoethics" through the eyes of the women and men at the leading edge of nanoscale innovation. We are interested in nano-scientists' behavior relative to nanoethics, specifically in terms of their perceptions of nanoethics and their monitoring, seeking, and sharing of information about social and ethical dimensions of nanoscience. Ultimately, we aim to offer an empirical assessment of nano-scientists' conceptualizations of nanoethics and their (dis)connections with information about nanoethics. Drawing from the research literature about information seeking, we also seek to identify potential predictors of nanoscientists' information seeking and sharing behavior about nanoethics. We hope that this research will help inform future efforts to direct the integration of nanotechnology into society in ways that minimize negative outcomes (Munnichs, 2004; Scott, 2003) and avoid the ethical fallouts associated with the rise of other recent emerging technologies, such as agricultural biotechnology (Gregorowius, Lindemann-Matthies, & Huppenbauer, 2012)..

2. ETHICS OF NANOTECHNOLOGY

2.1 Ethical Issues

Numerous scholars have identified existing and potential social and ethical issues related to nanotechnology (e.g., Allhoff et al., 2007; Bennett-Woods, 2008; O'Mathuna, 2009) and several frameworks have been proposed to approach and organize these issues. For example, Kermisch (2012) identifies five fundamental ethical issues regarding nanotechnologies: social desirability, difficulties to define nanotechnology, uncertainty, equality, and the use of nanotechnologies for both good and bad purposes. McGinn (2008, 2010a, 2013) proposes a different framework, describing ethical responsibilities of nano-scientists within three levels: micro-social, meso-social, and macro-social. The micro-social level includes challenges encountered in labs and production facilities that are related to safety issues. The meso-social level deals with interactions between labs and other institutions, such as funding agencies and the media, while the macro-social level encompasses ethical implications for society as a whole.

Nano-ethicists often point out that due to the unpredictable reactions and small particles involved in nanoscience (Robison, 2011) many ethical discussions focus on the potential outcomes—both intended and unintended—of nanotechnology development. These discussions, for example, center on how nanotechnologies can be used for both benign and maladaptive purposes, how society may react to nanotechnologies (Kermisch, 2012), safety protocols (Rasmussen et al., 2012), and privacy, control, and autonomy issues (Allhoff & Lin, 2006; Ebbesen, Andersen, & Besenbacher, 2006).

Another stream of nanoethics research focuses on the processes and procedures of the development of nanotechnology. Mnyusiwalla and colleagues (2003) observed a lag in ethical discussions as compared to the rapid pace of nanotechnology development. This observation has prompted some scholars to ponder possible ethical issues (Ebbesen et al., 2006) and suggest over-preparation rather than under-preparation (Lin, 2007). However, this somewhat extreme approach has been heavily criticized (Nordmann, 2007; Nordmann & Rip, 2009; Roache, 2008). Those who do not agree with such "speculative ethics" have emphasized the importance of addressing "here and now" issues based on past experiences with other emerging technologies (Ferrari, 2010; Nordmann & Rip, 2009). Concerns about equality and fairness associated with the development and distribution of nanotechnologies have also attracted attention to the process itself (Kermisch, 2012).

Another thread of discussion surrounding nanoethics questions the definition of this research area, while also debating if nanoethics exists as a unique field of study (Cutcliffe, Pense, & Zvalaren, 2012; Rasmussen et al., 2012). Some scholars maintain that nanotechnology introduces novel moral problems, such as human enhancement and undetectable privacy invasion, and therefore should be regarded as a separate discipline (Allhoff & Lin, 2006; Allhoff et al., 2007; Grunwald, 2005). Meanwhile, other scholars argue that the ethical issues emerging from nanotechnology are shared with other areas of technoscience or with other "New and Emerging Science and Technology (NEST)" (Brownsword, 2009; Godman, 2008; Meetoo, 2009; Swierstra & Rip, 2007). Similarly, McGinn (2010b) questioned the uniqueness of nanoethics as a field of research, but recognized two special attributes that are particular to the ethics of nanotechnology: the top-down approach and the emphasis on implications beyond labs and data (McGinn, 2010b). In the

same article, McGinn argued that the terminology "ethics of nanotechnology" should be used instead of nanoethics, because "nanoethics" implies unique ethical issues. Given the conceptual ambiguity that characterizes "nanoethics," we aim to ascertain how nano-scientists define this term. We therefore pose the following research question:

RQ1: How do nano-scientists conceptualize ethics of nanotechnology (i.e., "nanoethics")?

2.2 Ethical Practices and (Dis)Connections

With nanoethics gaining greater attention in recent years, the earlier paucity of ethical discussions pointed out by Mnyusiwalla et al. (2003) has become less of a problem (Rasmussen et al., 2012). However, even with increased attention several barriers persist relative to how the topic of nanoethics is communicated with nano-scientists and whether recommendations from nanoethics scholarship are being implemented (Rasmussen et al., 2012; Viseu & Maguire, 2012).

Nano-scientists' alleged lack of engagement in ethics discussions suggests a communication gap. Although numerous nanoethics issues have been discussed in academic settings (e.g., journals, conferences, etc.) the primary, if not exclusive, participants in these conversations are ethicists and social scientists (Rasmussen et al., 2012). This has led some scholars to suggest that scarce participation among nano-scientists makes these discussions futile, advocating that nanoethics discussions be broadened to include interdisciplinary collaborations (Rasmussen et al., 2012). Other scholars have identified differences in viewpoints about nanoethics between scientists and lay people (Davies & Macnaghten, 2010; Nordmann & Macnaghten, 2010) and different perspectives between scientists and industrial practitioners (Shelley-Egan, 2010).

In addition, not all nano-scientists incorporate in their work the ethical issues beyond the micro-social level (i.e., within their lab). Beginning in 2003, the 21st Century Nanotechnology Research and Development Act mandated that researchers and industrial producers take into consideration ethical, legal, environmental, and societal implications of nanotechnology (U.S. Government Printing Office, 2003). However, after interviews with scientists, engineers, and policymakers, Viseu and Maguire (2012) concluded that some researchers view nanoethics as superfluous to their daily work and thus did not integrate ESLIs in their scientific practices.

The limited participation by the scientists coupled with their lack of attention to ethical concerns may be creating a "double-divide" among nano-scientists whereby they do not take part in ethical discussions and do not attend to the possible macro-level ethical issues of their work. To better understand the current status of nano-scientists' ethical practices related to nanotechnology, we pose the following research question:

RQ2: To what extent do nano-scientists integrate ethics into their work?

3. ETHICAL PERSPECTIVES

3.1 Current State

Based on the social and ethical implications of nanotechnology, many scholars have started to probe nano-scientists' viewpoints of societal and ethical issues that surround their work. For

example, studies have been conducted to assess scientists' perception of the risks and benefits of nanotechnology, as well as implications for regulation (Corley, Scheufele, & Hu, 2009; Kim, Corley, & Scheufele, 2012; Scheufele et al., 2007). A series of studies led by Scheufele revealed that compared to the general public, nano-scientists are more optimistic about the potential of nanotechnology with less concern for the risks to society at large (except for problems associated with pollution and health) (Scheufele et al., 2007).

A study by McGinn (2008) surveyed 1,037 researchers from university-based nanotechnology facilities about ethical issues of nanotechnology focusing on nano-scientists' perception of social responsibility. Findings showed that most respondents were aware of the existence of significant ethical issues associated with nanotechnology as well as the need to address those issues: 43% indicated that ethical dimensions of nanotechnology are as important as the scientific aspects, while 8% thought that the ethical aspects of nanotechnology are more important than scientific ones.

The existing literature lends insights into scientists' general perspectives about ethical issues of nanotechnology. However, the gap between perception and practices suggests the presence of intervening factors that have not yet been identified. Personal relevance may be one factor. Although McGinn (2008) found that a majority of survey respondents are aware of ethical issues related to their work, to our knowledge, few researchers have probed how nano-scientists perceive their own work in terms of ethical concerns. In an effort to better explain ethical practices, we pose the following research question:

RQ3: Do nano-scientists perceive their own work as ethically risky?

3.2 Ethical Position

Another way to approach the ethical perspectives of nano-scientists is through the literature of ethical ideology. Ethical ideology has been applied to the study of professional ethics in the context of business (Forsyth, 1992), insurance (Tansey, Brown, Hyman, & Dawson Jr., 1994), accounting (Douglas, Davidson, & Schwartz, 2001), marketing (Ferrell & Gresham, 1985), and public relations (Kim & Choi, 2003). In a seminal work published in 1980, Forsyth proposed a taxonomy of ethical ideologies and suggested that categories of ethical positions predict differences in ethical judgment (Forsyth, 1980). Based on this work, the Ethics Position Theory (EPT) was developed (Forsyth, O'Boyle Jr., & McDaniel, 2008).

The Ethics Position Theory (EPT) posits that two dimensions of moral philosophy determine an individual's ethical ideology: relativism and idealism (Forsyth, 1980). Relativism is defined as the extent to which individuals "reject the possibility of formulating or relying on universal moral rules when drawing conclusions about moral questions" (Forsyth, 1980, p. 175), whereas idealism is associated with the perceived achievability of benign outcomes (Doorn, 2012). People high in relativism (or particularism, as suggested by Doorn) are less likely to believe in the existence of universal moral principles; rather, they take into consideration different features across a variety of situations. Individuals with a low level of idealism tend to see the possibility of mixed positive and negative consequences. Those two dimensions result in the categorization of four ethics positions: exceptionism, absolutism, subjectivism, and situationism.

Exceptionism features low relativism and low idealism. People in this category make ethical judgments based on moral principles but are also open to exceptions. Absolutists, on the other hand, are characterized by low relativism and high idealism and act according to moral

rules to achieve positive consequences. Both subjectivists and situationists exhibit a tendency toward relativism and reject the existence of universal moral principles. While subjectivists' actions are consistent with their personal values, situationists are concerned about optimized consequences and act accordingly (Forsyth, 1980).

According to EPT, personal ethics positions affect how people evaluate, feel, and behave in ethically challenging scenarios (Forsyth et al., 2008). This claim has received some empirical support across different contexts, such as moral decision making (Ferrell & Gresham, 1985; Forsyth, 1992; Kim & Choi, 2003), reactions to transgression (Forsyth & Nye, 1990; Winter, Stylianou, & Giacalone, 2004), and punishment suggestions (Giacalone, Fricker, & Beard, 1995). Yet, not many studies have applied ethical judgments to scientific research. In the context of social psychology research, a study found that ethics positions are correlated with factors that subjects use to appraise whether social psychology studies are ethical: exceptionists base their judgment on consequences; absolutists evaluate primarily the costs and risks of the procedures; subjectivists assess the harmfulness and legitimacy of research procedures; and situationists consider both costs and benefits of the study (Forsyth & Pope, 1984). However, in another study in which participants were asked to evaluate a project related to genetic modification, the results showed no significant correlation between the individual researcher's attitude toward the project and relativism (Fisher, Small, Roth, Mallon, & Jerebine, 2005).

Drawing from the EPT, the present study seeks to identify possible relationships between nano-scientists' personal ethics positions and their nanoethics information behavior. In order to examine those possible relationships, we pose the following research question:

RQ4: What categories of ethical ideologies are most apparent in nano-scientists?

4. ETHICAL INFORMATION BEHAVIOR AND PREDICTORS

Ethical information seeking behaviors undertaken by nano-scientists may constitute an initial step for the integration of nanoethics perspectives into their research agendas and practices. Although little is known about the seeking and sharing of ethical information about nanotechnology, the linkage between information seeking and action has been documented and empirically examined in other fields, such as health information seeking. Information seeking serves as a prelude to many other kinds of health-promoting behaviors, such as cancer screening, self-care management, and treatment compliance (see Galarce, Ramanadhan, & Viswanath, 2011, for a summary). The AISAS™ model, which theorizes a hierarchy of communication effects—attention, interest, seeking, action, and sharing—regards information seeking as a precursor of information sharing (Dentsu, 2006). An element that may be meaningful in the field of nanotechnology is that scientists consider themselves to be poorly informed about the ethical issues of nanoscience (McGinn, 2008). Hence, in this study we turn our attention to ethical information behaviors, assuming that nano-scientists who more frequently engage with nanoethics information—via seeking and sharing—will be more likely to connect it to their scientific work. Before exploring the determinants of ethical information seeking, it is important to ask the following research questions:

RQ5a: To what extent do nano-scientists (1) seek and (2) share information about nanoethics?

RQ5b: How do nano-scientists (1) seek and (2) share information about nanoethics? Do they use specific sources of information? Do they use certain media?

RQ5c: What types of nanoethics information do nano-scientists most frequently (1) seek and (2) share?

RQ5d: Who do nano-scientists share nanoethics information with?

The literature on information seeking identifies several predictors that motivate information seeking behaviors, ranging from social and environmental factors, such as information accessibility and social capital, to individual differences, such as personality and knowledge (Viswanath, Ramanadhan, & Kontos, 2007). Attribution of responsibility has also been documented as a potential predictor of information seeking (Griffin et al., 2008).

4.1 Attribution of Responsibility

Viseu (2012) conducted interviews with researchers and government agents about how they integrate social and ethical issues in their work. While some sought to integrate ethics and societal concerns in their scientific activities, others saw those issues as being outside of their scientific work and attributed responsibility for ethical concerns to external entities, such as social scientists and the public. Research on the sense of ethical responsibility may help explain what seems to be the passive and inactive approach of nano-scientists.

Beginning in the mid-20th century, social psychologists started to investigate the association between sense of responsibility and pro-social behavior (Darley & Latane, 1974; Latane & Darley, 1968) and found that a sense of personal responsibility for a pro-social behavior enhanced the intention and likelihood to act pro-socially (Hines, Hungerford, & Tomera, 1986). By contrast, when other parties are perceived as able to take action, an individual's sense of personal responsibility decreased and he/she became less likely to act pro-socially (Darley & Latane, 1974). This phenomenon was labeled as "diffusion of responsibility" or "bystander effect." In the model of responsible environmental behavior, the individual sense of responsibility is listed as a predictor of environmentally responsible behaviors (Bamberg & Moser, 2007; Hines et al., 1986).

In the current study, ethical information seeking and sharing are considered as pro-social behaviors. We seek to understand nano-scientists' personal sense of ethical responsibility and the role that may play in their ethical information behaviors.

RQ6: To what extent do nano-scientists feel a responsibility to actively (1) seek and (2) share ethical information?

RQ7: Does a sense of personal responsibility on the part of nano-scientists predict their intention to (1) seek and (2) share ethical information?

As mentioned above, there are few studies that specifically address information seeking and sharing behaviors in ethics. To systematically explore the predictors of information behaviors regarding ethics of nanotechnology, we use the planned risk information seeking model (PRISM) (Kahlor, 2010) as a theoretical framework. The use of PRISM to explain nanoethics information behavior is justified for two reasons. First, ethics are associated with risks in nature: ethics define right and wrong and relate to the possible influences on different parties (McGinn, 2010b). Second, as mentioned earlier, risk constitutes an integral part of the ethical issues of nanotechnology. Therefore, we argue that a risk information seeking model is appropriate for this study.

4.2 Planned Risk Information Seeking Model (PRISM)

The PRISM model is built upon several frameworks of risk information seeking that include the risk information seeking and processing model (RISP) (Griffin, Dunwoody, & Neuwirth, 1999), the Extended Parallel Processing Model (Witte, 1992), the Theory of Motivated Information Management (TMIM) (Afifi & Weiner, 2004), and the Comprehensive Model of Information Seeking (CMIS) (Johnson, 1997). Specifically, the PRISM assumes that risk information seeking is a deliberate search for information and incorporates the theory of planned behavior factors to explain information seeking about risks (Kahlor, 2010). The model has been tested in the context of health and environmental risks.

The PRISM highlights the role of knowledge insufficiency, risk perception, affective reaction, attitude toward information seeking, seeking-related subjective norms, and perceived information seeking control in predicting information seeking intention. While PRISM explained a considerable proportion of the variance in information seeking intention in previous studies, knowledge insufficiency and perceived seeking control tended to be weaker predictors (Kahlor, 2010). For the reason of parsimony, those two factors are excluded in our conceptual model of nano-ethical information seeking behavior.

Although little research has been done on information sharing (except in the field of organizational behavior), scholars consider information sharing an aspect of information processing that shares common predictors with information seeking, such as uncertainties and subjective norms (Griffin, Dunwoody, & Neuwirth, 1999; Mesmer-Magnus & DeChurch, 2009). Therefore, we argue that nano-ethical information sharing can be determined by factors that also motivate information seeking about nanoethics. With these considerations in mind, the following research question is posed and a conceptual model is constructed (see Figure 1).

RQ8: What factors predict nano-scientists' ethical (1) information seeking and (2) information sharing?

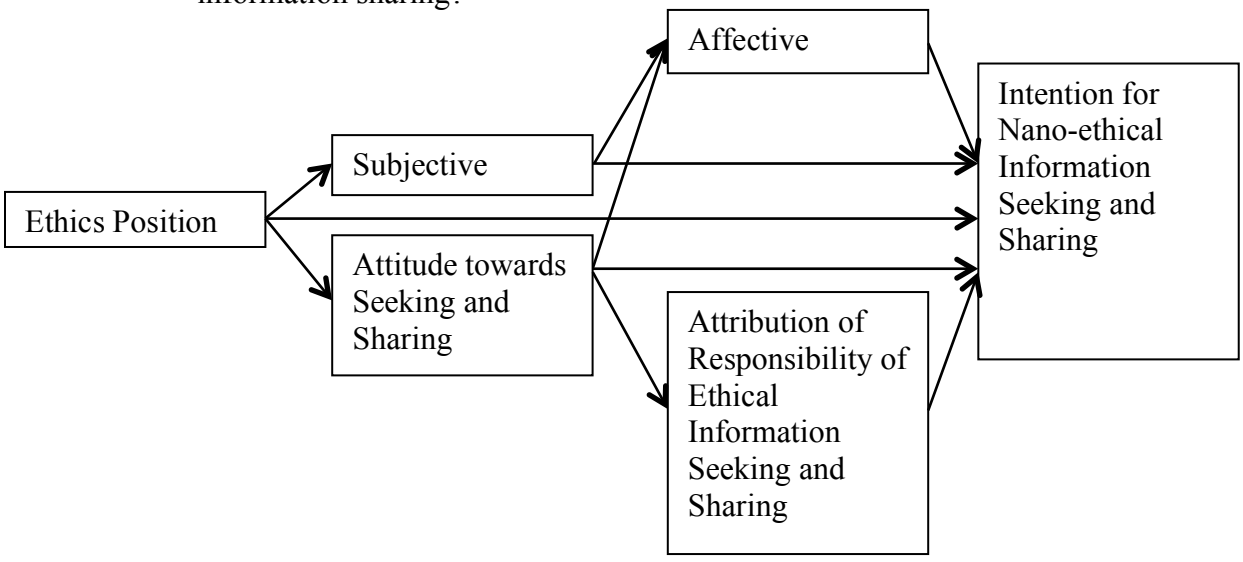

Fig. 1. Conceptual Framework of Ethical Information Seeking and Sharing

5. METHOD

5.1 Participants and Procedure

An online survey will be administrated to active nano-scientists. Our sample is based on a list of user contact information provided by the National Nanotechnology Infrastructure Network (NNIN). According to the latest available report, the NNIN was used by 5,518 scientists from March 2009 to January 2010. Of that total, 84% of the users were affiliated with academic institutes and most were graduate students (NNIN, 2010). About 15% were identified as industrial users. We will be utilizing a portion of the NINN user list (approximately 2,100 nano-scientists), so our sample should be considered convenient and purposive in nature. The contact list provided by NNIN is expected to contain some invalid contacts due to student graduation and career changes, so contact verification will be conducted prior to data collection. The online survey procedure will adhere to the Tailored Design Method (Dillman, 2007).

5.2 Proposed Measurement

Our online survey will include closed- and open-ended questions. Our research questions center on several key concepts: conceptualizations of nanoethics, ethical practices, risk perception, ethics position, attribution of responsibility, subjective norms and affect associated with information behaviors, ethical information seeking, and ethical information sharing.

Participants will be asked about their definition of nanoethics (RQ1) through an open-ended question, along with items adopted from McGinn (2008). For ethical practices (RQ2), three items derived from an interview study (Viseu & Maguire, 2012) will be included. The Ethics Position Questionnaire (EPQ) will be used to capture nano-scientists' ethical ideologies (RQ4) (Forsyth, 1980). Questions related to risk perception (RQ3), subjective norms, affect (RQ8), and information behavior measurements will be modified from previous PRISM studies (Kahlor, 2010). To profile nano-scientists' ethical information behaviors (RQ5), three open ended questions will be asked. Five Likert-style items will measure attribution of responsibility (RQ6). Sample questions can be found in Table 1.

Table 1. Proposed Measurements.

Construct	Format	Sample Items	Sources
conceptualizations of nanoethics	Open-ended	List the top ethical issues of nanotechnology.	
	Likert items	• The only ethical responsibility of a researcher at a nanotechnology lab is to follow laboratory rules. • Researchers should always consider ethical responsibilities of their work for larger public societies.	McGinn (2008)
ethical practices	Likert items	• I think about ethical and societal implications of nanotechnology because it is mandated by the law.	Viseu (2012)

		• Ethical and societal implications of nanotechnology add extra workload for nano-scientists. • Ethical and societal implications of nanotechnology are an integral part of my work on nanotechnology.	
risk perception	Open-ended	Do you consider your work on nanotechnology ethically risky?	
	Likert items	How likely is it that the ethical concerns you listed above actually happen? How severe do you think the results would be?	Kahlor (2010)
ethics position	Likert items	• People should make certain that their actions never intentionally harm another even to a small degree. • Risks to another should never be tolerated, irrespective of how small the risks might be. • The existence of potential harm to others is always wrong, irrespective of the benefits to be gained. • One should never psychologically or physically harm another person. • One should not perform an action which might in any way threaten the dignity and welfare of another individual. • If an action could harm an innocent other, then it should not be done. • Deciding whether or not to perform an act by balancing the positive consequences of the act against the negative consequences of the act is immoral. • The dignity and welfare of the people should be the most important concern in any society. • It is never necessary to sacrifice the welfare of others. • Moral behaviors are actions that closely match ideals of the most "perfect" action. • There are no ethical principles that are so important that they should be a part of any code of ethics. • What is ethical varies from one situation and society to another. • Moral standards should be seen as being individualistic; what one person considers to be moral may be judged to be immoral by another person.	Forsyth (1980)

		• Different types of morality cannot be compared as to "rightness." • Questions of what is ethical for everyone can never be resolved since what is moral or immoral is up to the individual. • Moral standards are simply personal rules that indicate how a person should behave, and are not to be applied in making judgments of others. • Ethical considerations in interpersonal relations are so complex that individuals should be allowed to formulate their own individual codes. • Rigidly codifying an ethical position that prevents certain types of actions could stand in the way of better human relations and adjustment. • No rule concerning lying can be formulated; whether a lie is permissible or not permissible totally depends upon the situation. • Whether a lie is judged to be moral or immoral depends upon the circumstances surrounding the action.	
attitude toward seeking /sharing	Semantic differential	• To me, seeking/sharing information about nanoethics is: …worthless or valuable …bad or good …harmful or beneficial …unhelpful or helpful …unproductive or productive …foolish or wise …not useful or useful	Kahlor (2010)
attribution of responsibility	Likert items	• I feel responsible to seek/share information about nanoethics • It is the safety technicians' responsibility to seek/share information about nanoethics • The government should be held accountable for seeking/sharing information about nanoethics • Social scientists are responsible for seeking/sharing information about nanoethics • Everyone studying nanotechnology is responsible for seeking/sharing information about nanoethics	
subjective norms	Likert	• It is expected of me that I seek/share	Kahlor

	items	information about nanoethics. • Most people who are important to me think that I should seek/share information about nanoethics. • Others expect me to seek information about nanoethics. • People in my life whose opinions I value seek/share information about nanoethics.	(2010)
affective response associated with information behaviors	Likert items	I feel worried about the risks associated with nanoethics.	Kahlor (2010)
ethical information seeking	Open-ended	Do you seek information about nanoethics? How? Where?	
	Likert items	I have actively looked for information regarding nanoethics.	Kahlor (2010)
ethical information sharing	Open-ended	Do you share information about nanoethics? How? Where?	
	Likert items	I have shared information regarding nanoethics with other people.	

5.3 Analyisis

Some of the questions will be developed or modified specifically for this study. To ensure the reliability and validity of measures, a preliminary testing of the survey will be conducted with 50 students at the University of Texas at Austin who are users of the NNIN list.

After data-cleaning, descriptive statistics will be conducted to profile the current state of nano-scientists' perception and ethical practices followed by a path analysis or structural equation modeling to examine relationships of interest.

6. CONCLUSION

An understanding of the social and ethical issues posed by nanotechnology is critical to enhance the responsible development of nanoscience and avoid setbacks due to unethical practices (Ebbesen, 2008; Mnyusiwalla et al., 2003). Recognizing that disconnects exist between ethical practices and ethical discussions, our study focuses on information behaviors related to the ethics of nanotechnology. By profiling nano-scientists' current state of ethical perspectives and practices and exploring possible determinants of ethical information behaviors, this study seeks to better understand ethical information behaviors that may inform future efforts to bridge gaps that have been observed in the ethics of nanotechnology.

ACKNOWLEDGEMENTS: This study is funded by the National Nanotechnology Infrastructure Network (NNIN).

REFERENCES

Afifi, W. A., & Weiner, J. L. (2004). Toward a theory of motivated information management. *Communication Theory, 14*(2), 167–190. doi: 10.1111/j.1468-2885.2004.tb00310.x

Allhoff, F., & Lin, P. (2006). What's so special about nanotechnology and nanoethics? *International Journal of Applied Philosophy, 20*(2), 179–190.

Allhoff, F., Lin, P., Moor, J., & Weckert, J. (2007). *Nanoethics: The ethical and social implications of nanotechnology*. Hoboken, NJ: Wiley.

Bamberg, S., & Moser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. Journal of Environmental Psychology, 27(1), 14–25.

Bennett-Woods, D. (2008). *Nanotechnology: Ethics and society*. Boca Raton, FL: CRC Press.

Brownsword, R. (2009). Nanoethics: Old wine, new bottles? *Journal of Consumer Policy, 32*(4), 355–379.

Corley, E. A., Scheufele, D. A., & Hu, Q. (2009). Of risks and regulations: How leading US nanoscientists form policy stances about nanotechnology. *Journal of Nanoparticle Research, 11*(7), 1573–1585.

Cutcliffe, S. H., Pense, C. M., & Zvalaren, M. (2012). Framing the discussion: Nanotechnology and the social construction of technology–What STS scholars are saying. *NanoEthics, 6*(2), 81–99.

Darley, J. M., & Latane, B. (1974). Bystander intervention in emergencies: Diffusion of responsibility. *Crowding and Behavior, 8*, 61.

Davies, S., & Macnaghten, P. (2010). Narratives of mastery and resistance: Lay ethics of nanotechnology. *NanoEthics, 4*(2), 141–151. doi: 10.1007/s11569-010-0096-5

Dentsu. (2006). Digitazation changing the consumer purchasing process: From AIDMA to AISAS. *Annual report for the year ended March 31, 2006*. Retrieved from http://www.dentsu.com/ir/data/pdf/AR2006_E6.pdf

Doorn, N. (2012). Exploring responsibility rationales in research and development (R&D). *Science, Technology & Human Values, 37*(3), 180–209.

Douglas, P. C., Davidson, R. A., & Schwartz, B. N. (2001). The effect of organizational culture and ethical orientation on accountants' ethical judgments. *Journal of Business Ethics, 34*(2), 101–121.

Ebbesen, M. (2008). The role of the humanities and social sciences in nanotechnology research and development. *NanoEthics, 2*(3), 333. doi: 10.1007/s11569-008-0045-8

Ebbesen, M., Andersen, S., & Besenbacher, F. (2006). Ethics in nanotechnology: Starting from scratch? *Bulletin of Science, Technology & Society, 26*(6), 451–462.

Ferrari, A. (2010). Developments in the debate on nanoethics: Traditional approaches and the need for new kinds of analysis. *NanoEthics, 4*(1), 27–52. doi: 10.1007/s11569-009-0081-z

Ferrell, O. C., & Gresham, L. G. (1985, Summer). A contingency framework for understanding ethical decision making in marketing. *The Journal of Marketing, 49*, 87–96.

Fisher, M., Small, B., Roth, H., Mallon, M., & Jerebine, B. (2005). What do individuals in different science groups within a life sciences organization think about genetic modification? *Public Understanding of Science, 14*(3), 317–326.

Forsyth, D. R. (1980). A taxonomy of ethical ideologies. *Journal of Personality and Social Psychology, 39*(1), 175–184.

Forsyth, D. R. (1992). Judging the morality of business practices: The influence of personal moral philosophies. *Journal of business ethics, 11*(5–6), 461–470.

Forsyth, D. R., & Nye, J. L. (1990). Personal moral philosophies and moral choice. *Journal of Research in Personality, 24*(4), 398–414.

Forsyth, D. R., O'Boyle, E.H., Jr., & McDaniel, M. A. (2008). East meets west: A meta-analytic investigation of cultural variations in idealism and relativism. *Journal of Business Ethics, 83*(4), 813–833.

Forsyth, D. R., & Pope, W. R. (1984). Ethical ideology and judgments of social psychological research: Multidimensional analysis. *Journal of Personality and Social Psychology, 46*(6), 1365–1375.

Galarce, E. M., Ramanadhan, S., & Viswanath, K. (2011). Health information seeking. In T. L. Thompson, R. Parrott, & J. F. Nussbaum (Eds.), *The Routledge handbook of health communication* (pp. 167–180). Hoboken, NJ: Routledge.

Giacalone, R. A., Fricker, S., & Beard, J. W. (1995). The impact of ethical ideology on modifiers of ethical decisions and suggested punishment for ethical infractions. *Journal of Business Ethics, 14*(7), 497–510.

Godman, M. (2008). But is it unique to nanotechnology? *Science and Engineering Ethics, 14*(3), 391–403.

Gregorowius, D., Lindemann-Matthies, P., & Huppenbauer, M. (2012). Ethical discourse on the use of genetically modified crops: A review of academic publications in the fields of ecology and environmental ethics. *Journal of Agricultural & Environmental Ethics, 25*(3), 265–293.

Griffin, R. J., Dunwoody, S., & Neuwirth, K. (1999). Proposed model of the relationship of risk information seeking and processing to the development of preventive behaviors. *Environmental Research, 80*(2), S230–S245.

Griffin, R. J., Yang, Z., ter Huurne, E., Boerner, F., Ortiz, S., & Dunwoody, S. (2008). After the flood: Anger, attribution, and the seeking of information. *Science Communication, 29*(3), 285–315.

Grunwald, A. (2005). Nanotechnology—A new field of ethical inquiry? *Science and Engineering Ethics, 11*(2), 187–201.

Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1986). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *Journal of Environmental Education, 18*, 1–8. doi: 10.1080/00958964.1987.9943482

Johnson, D. (2007). Ethics and technology 'in the making': An essay on the challenge of nanoethics. *NanoEthics, 1*(1), 21–30. doi: 10.1007/s11569-007-0006-7

Johnson, J. D. (1997). *Cancer-related information seeking*. Cresskill, New Jersey: Hampton Press.

Johnson, S. (2009, Summer). The era of nanomedicine and nanoethics: Has it come, is it still coming, or will it pass us by? *American Journal of Bioethics 9*(10), 1–2.

Kahlor, L. (2010). PRISM: A planned risk information seeking model. *Health Communication, 25*(4), 345–356.

Kermisch, C. (2012). Do new ethical issues arise at each stage of nanotechnological development? *NanoEthics, 6*(1), 29–37. doi: 10.1007/s11569-011-0137-8

Kim, Y., & Choi, Y. (2003). Ethical standards appear to change with age and ideology: A survey of practitioners. *Public Relations Review, 29*(1), 79–89.

Kim, Y., Corley, E. A., & Scheufele, D. A. (2012). Classifying US nano-scientists: Of cautious innovators, regulators, and technology optimists. *Science and Public Policy, 39*(1), 30–38.

Latane, B., & Darley, J. M. (1968). Group inhibition of bystander intervention in emergencies. *Journal of Personality and Social Psychology, 10*(3), 215–221.

Lin, P. (2007). In defense of nanoethics: A reply to Adam Keiper. Retrieved from http://www.nanotech-now.com/columns/?article=113

McGinn, R. (2008). Ethics and nanotechnology: Views of nanotechnology researchers. *NanoEthics, 2*(2), 101–131. doi: 10.1007/s11569-008-0040-0

McGinn, R. (2010a). Ethical Responsibilities of nanotechnology researchers: A short guide. *NanoEthics, 4*(1), 1–12. doi: 10.1007/s11569-010-0082-y

McGinn, R. (2010b). What's different, ethically, about nanotechnology? Foundational questions and answers. *NanoEthics, 4*(2), 115–128. doi: 10.1007/s11569-010-0089-4

McGinn, R. (2013). Discernment and denial: Nanotechnology researchers' recognition of ethical responsibilities related to their work. *NanoEthics*, 1–13. doi: 10.1007/s11569-013-0174-6

Meetoo, D. (2009). Nanotechnology: Is there a need for ethical principles? *British Journal of Nursing, 18*(20), 1264–1268.

Mesmer-Magnus, J. R., & DeChurch, L. A. (2009). Information sharing and team performance: A meta-analysis. *Journal of Applied Psychology, 94*(2), 535.

Mnyusiwalla, A., Daar, A. S., & Singer, P. A. (2003). 'Mind the gap': Science and ethics in nanotechnology. *Nanotechnology, 14*(3), R9.

Munnichs, G. (2004). Whom to trust? Public concerns, late modern risks, and expert trustworthiness. *Journal of Agricultural & Environmental Ethics, 17*(2), 113–130.

National Nanotechnology Infrastructure Network. (2010). *Abridged NNIN annual report for March 2009–Jan 2010 (FY09)* (ECS-0335765). Retrieved from http://www.nnin.org/sites/default/files/files/NNIN_annual_report_Feb_2010_abridged.pdf

National Nanotechnology Initiate. (2008). Research and development leading to a revolution in technology and industry. *Supplement to the president's 2009 budget*. Washington, DC: Office of Science and Technology Policy.

National Nanotechnology Initiative (NNI). (n.d.). Ethical, legal, and societal issues. Retrieved from http://www.nano.gov/you/ethical-legal-issues

National Science Foundation. (n.d.). NSF National Nanotechnology Initiative (NNI). Retrieved from http://www.nsf.gov/crssprgm/nano/

Nordmann, A. (2007). If and then: A critique of speculative nanoethics. *NanoEthics, 1*(1), 31–46. doi: 10.1007/s11569-007-0007-6

Nordmann, A., & Macnaghten, P. (2010). Engaging narratives and the limits of lay ethics: Introduction. *NanoEthics, 4*(2), 133–140. doi: 10.1007/s11569-010-0095-6

Nordmann, A., & Rip, A. (2009). Mind the gap revisited. *Nature Nanotechnology, 4*(5), 273.

O'Mathuna, D. P. (2009). *Nanoethics: Big ethical issues with small technology*. London: Continuum.

Palmberg, C., Dernis, H., & Miguet, C. (2009). Nanotechnology: An overview based on indicators and statistics. *OECD science, technology, and industry working papers* (No. 2009/07). OECD Publishing.

Rasmussen, A. J., Ebbesen, M., & Andersen, S. (2012). Nanoethics—A collaboration across disciplines. *NanoEthics, 6*(3), 185–193.

Roache, R. (2008). Ethics, speculation, and values. *NanoEthics, 2*(3), 317–327. doi: 10.1007/s11569-008-0050-y

Robison, W. (2011). Nano-technology, ethics, and risks. *NanoEthics, 5*(1), 1–13. doi: 10.1007/s11569-010-0108-5

Scheufele, D. A., Corley, E. A., Dunwoody, S., Shih, T.-J., Hillback, E., & Guston, D. H. (2007). Scientists worry about some risks more than the public. *Nature Nanotechnology, 2*(12), 732–734.

Scott, D. (2003). Science and the consequences of mistrust: Lessons from recent GM controversies. *Journal of Agricultural & Environmental Ethics, 16*(6), 569–582.

Shelley-Egan, C. (2010). The ambivalence of promising technology. *NanoEthics, 4*(2), 183–189. doi: 10.1007/s11569-010-0099-2

Swierstra, T., & Rip, A. (2007). Nano-ethics as NEST-ethics: Patterns of moral argumentation about new and emerging science and technology. *NanoEthics, 1*(1), 3–20.

Tansey, R., Brown, G., Hyman, M. R., & Dawson, L.E., Jr. (1994, Winter). Personal moral philosophies and the moral judgments of salespeople. *The Journal of Personal Selling and Sales Management, 14*, 59–75.

U.S. Government Printing Office. (2003). The 21st century nanotechnology research and development act. Retrieved from http://www.gpo.gov/fdsys/pkg/PLAW-108publ153/html/PLAW-108publ153.htm

Viseu, A., & Maguire, H. (2012). Integrating and enacting "social and ethical issues" in nanotechnology practices. *NanoEthics, 6*(3), 195–209.

Viswanath, K., Ramanadhan, S., & Kontos, E. Z. (2007). Mass media. In S. Galea (Ed.), *Macrosocial determinants of population health* (pp. 275–294). New York, NY: Springer.

White House. (2000). National Nanotechnology Initiative: Leading to the next Industrial Revolution. Retrieved from http://clinton4.nara.gov/textonly/WH/New/html/20000121_4.html

Winter, S. J., Stylianou, A. C., & Giacalone, R. A. (2004). Individual differences in the acceptability of unethical information technology practices: The case of Machiavellianism and ethical ideology. *Journal of Business Ethics, 54*(3), 273–301.

Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs, 59*, 401–421. doi: 10.1080/03637759209376276