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SCIENTIFIC LITERACY IN SCIENCE LESSON

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Abstract: The aim of this study was to determine: 1) definition of scientific literacy, 2) aspects of scientific literacy. 3) kinds of scientific literacy, 4) the role of curriculum in 2013 to develop scientific literacy. The method of this paper is research note paper, with a literature review of research journals about scientific literacy in science learning. The Curriculum 2013 has emphasized scientific literacy on the learning process by suggesting the utilize of the scientific approach. The scientific approach provides an opportunity for students to perform contextual learning, therefore the learning experiences that students got becomes more meaningful. The scientific approach provides an opportunity for students to connect between the previous concept, the concept being studied and its relationship with other materials that are expected able to improve the scientific literacy of students. The scientific approach to learning science developed from the scientific method commonly known as the science process skills.

Keywords: *scientific literacy, curriculum, scientific approach, learning science*

1 INTRODUCTON

'Literacy science' term has been used in the literature for more than four decades (Gallagher & Harsch, 1997), though not always with the same meaning (Bybee, 1997 in Holbrook and Rannikmae, 2009).

Many definitions have been proposed for scientific literacy since Paul DeHart Hurd used the term in 1958 (American Association for the Advancement of Science [AAAS], 1989; Bybee, 1997; Gräber et al., 2001; Holbrook & Rannikmae, 1997; Hurd, 1958; Laugksch, 2000; National Science Education Standards (National Standard Science Education), 1996). There is confusion as to its exact meaning; Norris and Philips (2003) (in Holbrook and Rannikmae 2009) argues that scientific literacy terms have been used to incorporate various components of the following: a) Knowledge of the substantive content knowledge and the ability to distinguish from non-science; b) Understand the science and its applications; c) Knowledge of what counts as science; d) Freedom in learning science; e) The ability of scientific thinking; f) The ability to use scientific knowledge in solving problems; g) The knowledge required for intelligent participation in science-based issues; h) Understanding the nature of science, including its relationship to culture; i) Appreciation of and comfort with the science, including the wonder and curiosity; j) Knowledge of the risks and benefits of science; and k) The ability to think critically about science and dealing with scientific expertise.

In this paper are advised to retain the use of scientific literacy is still appropriate, but necessary for scientific literacy relates to the appreciation of the nature of science, the personal attributes of learning, including attitudes and also for the development of social values (Holbrook & Rannikmae, 2009). For this, the relevance of learning plays a role and teaching materials, strive toward increasing student scientific literacy, need to consider the social frame, the introduction of science conceptually on a need to know basis, and to embrace the situation socioscientific that provide relevance for responsible citizenship (Holbrook, 2008).

It is very difficult to provide clarity of meaning both scientific literacy, and science and technology literacy (the term used in the recognition of the relationship between science and technology in everyday life). This is especially true when translating terms into languages other than English. A forum on

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literacy in science and technology for all (UNESCO, 1993) suggest the term of France as "la culture scientifique et technologique," a translation that clearly reflects the intention of cultures and points the way to recognize that someone is literate science and technology is the one that can function in society as a whole, not just as scientists in the workplace (Holbrook and Rannikmae, 2009).

Millar (1997) in Holbrook and Rannikmae (2009) showed that the civilian scientific literacy is considered as the level of understanding of science and technology needed citizens is important, which can be the data showed that the number of elementary school science as a predictor of the strongest scientific literacy in adults. Whatever definition is actually there, it seems, is general agreement that the term 'scientific literacy' is used rather metaphorically. Thus beyond any notion of reading and writing, and some will claim that it refers only to the ability to read scientific journals. The use of metaphors tend to transform into a slogan scientific literacy, which means all things to all people, but it serves to demonstrate the purpose of science education. Thus, the purpose of science education can be expressed as the scientific, technological, literacy (icase, 2003; Norris & Phillips, 2003 in Holbrook and Rannikmae, 2009).

Enhancing the scientific literacy (also commonly referred to as science literacy) of students has been a goal of science educators for more than a century. John Dewey's turn-of-the-20th-century calls for the use of experiential learning and inquiry practice were directed toward enhancing the general scientific literacy of students. He argued that teaching theory should be more closely associated with desired outcomes (1904), and that the best way to get students to become more scientifically aware and informed is through the processes of experiential learning having students learn science by mimicking the work of scientists. Six years later, Dewey (1910) noted, "Science teaching has suffered because science has been so frequently presented just as so much ready-made knowledge, so much subject-matter of fact and law, rather than as the effective method of inquiry into any subject-matter" (Wening, www.phy.ilstu.edu/wening/thsp/chapters/scientificliteracy).

A society scientific literacy is one of the main goals of science education (Norris & Phillips, 2003). Various efforts to reform science education has been widely applied in various countries, but the recent emphasis on scientific inquiry and the nature of science (NOS) is a reform that distinguishes between current efforts by previous efforts. For example, in developed countries like the united reforms undertaken emphasizes on the development of an accurate understanding of science and science literacy. In the American standard document "Benchmarks for Scientific Literacy" (AAAS, 1993), "the National Science Education Standards" (NSTA, 2000), and "The Next Generation Science Standards" (NGSS Lead States, 2013) in addition to mentioning the understanding of concepts fundamental concepts of science are also photographing nature of science (NOS) and scientific inquiry (scientific inquiry) as a key component in scientific literacy. Although a sense of concern for the public science literacy is different from one nation to other nations, but the level of scientific literacy which is owned by the people was the main reason for changing or reforming science education. Indonesia is among the countries that have concerns about scientific literacy nation. Implementation of Curriculum 2013 is one of the efforts to reform the education and science education in particular. Curriculum 2013 provides reinforcement or revitalization in some aspects of the previous curriculum. Therefore, the curriculum in 2013 gives hope for the realization of scientific literacy community. However, on the other hand Curriculum 2013 also has challenges to be faced in implementing them in the field (Rahayu, 2014). Formulation of the problem in this paper are: 1) Does the definition of scientific literacy?, 2) What aspects of scientific literacy? 3) What kinds of scientific literacy!, 4) How Curriculum 2013 in developing scientific literacy? The aim in this paper are: 1) To determine the definition of scientific literacy, 2) To know the aspects of scientific literacy, 3) To know the kinds of

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scientific literacy, 4) To determine the role of curriculum in 2013 in developing science literacy

2 DISCUSSION

2.1 Definition of Scientific literacy

Scientific literacy is an individual scientific knowledge and the use of knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues, an understanding of the characteristic features of science as a form of human knowledge and inquiry, awareness of how science and technology, intellectual, and cultural environments, and willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen (PISA 2006).

PISA determine scientific literacy in three dimensions (OECD, 2007): 1) First, the scientific concepts (Scientific knowledge or concepts), which is necessary to understand certain phenomena of nature and the changes made to it through human activity Main content ratings selected from the three fields of application: science in life and health; earth and environmental sciences, and science and technology, 2) Second, the scientific process (Scientific processes), which is centered on the ability to acquire, interpret and act upon evidence. Five such processes present in OECD / PISA relate to: the recognition of scientific questions, identifying evidence, drawing of conclusions, communications conclusion, demonstration of understanding of scientific concepts, 3) Third, scientific situations (Situations or Contexts), chosen mainly from people's lives daily -day instead of the practice of science in the classroom or laboratory, or the work of professional scientists. Such as mathematics, science figures in people's lives in konteksmulai of personal circumstances or private to the public, global issues more broadly.

Rennie (2005) in Pelger and Nilsson (2015) description of scientific literacy as knowing science as a way of thinking, finding, organizing and using information to make decisions has received strong support in the Swedish national school curricula of science. Pelger and Nilsson (2015) also quote from Roberts (2007) drew attention to two differing positions for scientific literacy vision I and vision II, where vision I was described as being scientist-centered with a strong focus on science content knowledge. Vision II, he described as being more student-centered and context driven, moving beyond seeing science as only facts and knowledge, and instead connecting it to situations that students are likely to encounter as citizens. In terms of popular science and science communication, scientific literacy could be expanded from university science to ongoing participation in science activities in society by citizens of all ages. As such, scientific literacy could describe the attempt to move towards a more socially useful conception of science education, a conception that might also attract students' interest in a powerful way.

While agreement on the meaning of scientific literacy, there seems to be two main camps, or point of view: a) those who advocated a central role for science knowledge; and b) those who see science literacy refers to the usefulness of society. The first group seems to be very common among science teachers today. The "science literacy" explains that the main component of scientific literacy is an understanding of science content, namely the basic concepts of science. The second group of "scientific literacy" looks at science literacy as a requirement to be able to adapt to the challenges of a rapidly changing world. The focus of this look scientific literacy is to develop life skills (Rychen & Salganik, 2003) namely the view that recognizes the need for reasoning skills in a social context and emphasized that scientific literacy is intended for everyone, not just to those who choose a career in science or specialists in the field of science (Rahayu, 2014).

Between the two camps, Gräber et al. (2001) saw a view that spans the continuum between the two extremes of the subject competence and meta competence. While the Bybee (1997) propose a comprehensive hierarchical model is still very much driven by the discipline of science, a more central

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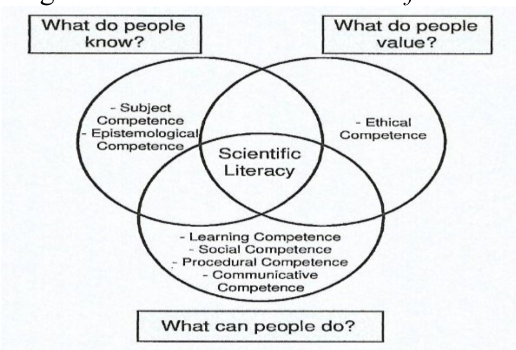
position can be taken in which the competence of the subject matter. Further intermediate outlook for science literacy see a general purpose oriented to the needs of the community, to learn how to deal with social problems and make rational decisions. Shamos (1995) defines scientific literacy, which includes content and process knowledge broad and deep competence. He sees science literacy is much more in terms of promoting a competent consumer science with the ability to gain knowledge from experts.

Figure 1 Gräber model for *scientific literacy*.



Gräber models for scientific literacy (2001), is depicted in Figure 1, which is proposed as a competency-based. This model reconsiders the balance between the various competencies and reflect on science education can make a specific contribution of adult education. This view upholds needs scientific literacy to be much more than the knowledge and integrating component values education as an important component of science education (and although only ethical component mentioned, can be seen to interact with the human rights, tolerance, education for peace, equality gender, and place of indigenous technology) (Holbrook & Rannikmae, 2009).

2.2 Aspects of Scientific literacy

As part of the Science Technology Society (STS), "the National Science Education Standards" NSTA (1991) suggest that the science literacy and technology necessary intellectual skills and other attributes, namely: a) Property (Higher Order Thinking Skills): 1) use the concept science and technology, as well as the informed reflection on the ethical values, in solving everyday problems and make responsible decisions in everyday life, including work and recreation; 2) puts, collect, analyze, and evaluate sources of scientific and technological information and use these resources to solve problems, make decisions, and take action; 3) The difference between the scientific and technological evidence and personal opinion and the information that is reliable and dependable; 4) offer explanations of natural phenomena tested its validity; 5) applies skepticism, method-careful, logical reasoning, and creativity in investigating the observable universe; 6) defended the decision and the action using rational arguments based on evidence; 7) analysis of the interaction between science, technology and society. b) attitude: 1) showing curiosity about human nature and making the world; 2) the value of scientific research and technological problem-solving; 3) remains open to new evidence and the tentativeness of scientific / technological knowledge; and 4) engage in science / technology for excitement and a possible explanation. c) the community: 1) recognizes that science and technology human effort; 2) weighing the benefit / burden of the development of science and technology; 3) recognizes the strengths and limitations of science and technology to advance human welfare; and 4) engaging in personal and community action responsible after weighing the possible consequences of alternative options. d) interdisciplinary: 1) linking science and technology to other human endeavors, eg history, mathematics, arts, and humanities; and 2) consider aspects of political, economic, moral and ethics of science and technology related to personal issues and global.

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Tabel 1. Aspects of Scientific literacy (Dani, 2009)

Aspect	Components
The knowledge of science	Facts, concepts, principles, laws, hypotheses, theories, and models of science
The investigative nature of science	Using methods and processes of science such as observation, measuring, classifying, inferring, recording and analyzing data, communicating using a variety of means such as, writing, speaking, using graphs, tables, and charts, making calculations, and experimenting
Science as a way of knowing	Emphasis on thinking, reasoning, and reflection in the construction of scientific knowledge and the work of scientists Empirical nature of science Ensuring objectivity in science Use of assumptions in science Inductive and deductive reasoning Cause and effect relationships Relationships between evidence and proof Role of self-examination in science Describes how scientists experiment
Interaction of science, technology, and society	Impact of science on society Inter-relationships between science, society, and technology Careers Science-related social issues Personal use of science to make everyday decisions, solve everyday problems, and improve one's life Science related moral and ethical issues

Shwartz, Zwi and Hofstein (2006) explain the chemical literacy as follows**:** Chemical literacy, an overview: 1). Scientific and chemical content knowledge**.** A chemically literate person understands the following ideas: 1a) G*eneral scientific ideas* • Chemistry is an experimental discipline. Chemists conduct scientific inquiries, make generalizations, and suggest theories to explain the natural world. • Chemistry provides knowledge used to explain phenomena in other areas, such as earth

sciences and life sciences; 1b). *Characteristics of chemistry (Key ideas):* • Chemistry tries to explain macroscopic phenomena in terms of the molecular structure of matter. • Chemistry investigates the dynamics of processes and reactions. • Chemistry investigates the energy changes during a chemical reaction. • Chemistry aims at understanding and explaining life in terms of chemical structures and processes of living systems. • Chemists use a specific language. A literate person does not have to use this language, but should appreciate its contribution to the development of the discipline, 2). Chemistry in context: A chemically literate person is able to: • Acknowledge the importance of chemical knowledge in explaining everyday phenomena. • Use his/her understanding of chemistry in his/her daily life, as a consumer of new products and technologies, in decision-making, and in participating in a social debate regarding chemistry-related issues. • Understand the relations between innovations in chemistry and sociological processes, 3).

Higher-order learning skills: A chemically literate person is able to raise a question, look for information and relate to it, when needed. He/she can analyze the loss/benefit in any debate. (A list of skills and the appropriate chemical context is given in the full document of defining ‘chemical literacy’.), 4). Affective aspects: A chemically literate person has an impartial and realistic view of chemistry and its applications. Moreover, he/she expresses interest in chemical issues, especially in non-formal frameworks (such as a TV programs).

2.3 Kinds of Scientific Literacy

At the school level, Bybee (1997) (in Holbrook and Rannikmae, 2009) have suggested scientific literacy in four functional levels: a) Nominal (can recognize scientific terms, but does not have a clear understanding of the meaning); b) Functional (can use scientific and technological vocabulary, but this usually only out of context as is the case for example in school exams); c) Conceptual and procedural (showing understanding and relationships between concepts and can use the process of meaning); and d) Multidimensional (not only understanding, but has developed a science and technology perspective that includes the nature of science, the role of science and technology in the private and public life).

Miller’s three aspects of scientific literacy: the nature of science, key science terms, and science’s relevance to society (Salamon, 2007). Miller (2007 in Ogunkola and O’Neale, 2013) refers to two dimensions of scientific literacy. The first is a basic knowledge of key scientific concepts such as stem cell, molecule, nanometer, neuron, laser, DNA, nuclear power, continental drift, the cause of the seasons, biological evolution, and the greenhouse effect. The second dimension is an understanding of the process of science i.e. an understanding that science bases its conclusions on evidence and reason rather than emotion, ideology, ancient texts, authority figures, superstition, or religion.

2.4 The role of curriculum in 2013 in Developing Scientific Literacy

Nowadays, scientific inquiry becomes the main focus in science education. Various reform document, for example Benchmarks for Science Literacy (AAAS, 1993); A Framework for K-12 Science Education: Practices, crosscutting Concepts, and Core Ideas (NRC, 2011); "The Next Generation Science Standards" (NGSS Lead States, 2013) emphasized that students need to develop the ability to do scientific inquiry. Scientific inquiry is a critical component to develop scientific literacy. By doing inquiry students gain basic experience to reflect the nature of science (NOS) and the limitations of science or a scientific claim (Flick & Lederman, 2006) in Rahayu (2014). Holbrook and Rannikmae (2007) explore the meaning of the nature of science education to enhance scientific literacy. It argues that the teaching approach for science education should be regarded as “education through science”, rather than “science through education”. A model of the nature of science education is proposed, having its foundations based on activity theory rather than logical positivism. This encompasses an understanding of the nature of science, with links to achievement of goals in the personal domain, stressing intellectual and communication skill development, as well as the promotion of character and positive attitudes, plus achievement of goals in the social education domain, stressing cooperative learning and socio-scientific decision-making. Marks and Eilk (2009) the summarized teaching approach intends to more thoroughly promote reflection on scientific questions in the framework of their socioeconomical and ecological consequences. This is done by inserting authentic and controversial debates on socioscientific issues into chemistry teaching, which provoke and allow for open discussions and individual decision making processes. After discussing the framework, we present one example which deals with musk fragrances used in cosmetic products, and we give an overview of different respective issues. From experience gained in applying the different examples, the potential of this teaching approach is then reflected upon as a source for promoting the process oriented skills of evaluation and communication as essential parts of a well developed scientific literacy. Based on the National Research Council’s (NRC), some studies have suggested

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that inquiry-based learning is necessary for improving scientific literacy. The NRC's recommendations also claim that "hands-on" activities are insufficient and suggest "minds-on," inquiry-base investigations (as cited in Rudd et al., 2001, p. 1680). In order for inquiry to be most effective, laboratory activities should be coordinated closely with lectures to give sufficient time for reflection and discussion (Bryant, 2006, p. 61). To put this approach into perspective, students create their own cognitive frameworks and place new knowledge in them. The course material, then, is a topical rather than a broad coverage approach. In some sense, since the material is self-chosen, students might pick topics that are relevant to their lives. In the process, students build their scientific vocabulary and learn the nature of science research writing, including building hypotheses and research questions (McNeal and Murrain, 1994 in Salamon, 2007).

Scientific inquiry has a variety of definitions. But basically scientific inquiry is a systematic approach used by scientists (scientist) in an attempt to answer the questions that interested him (Lederman, 2004: 309 in Rahayu, 2014). Such an approach is a combination of science process skills (such as observing, inferencing, classifying, predicting, measuring, asking, interpreting and analyzing the data) with the content of science, scientific reasoning, and critical thinking to develop science / science (Lederman, 2009; Lederman, Lederman, & Antink, 2013 in Rahayu 2014). In addition, for educational purposes, Lederman (2004) suggests that we can distinguish between inquiry scientific (as the process to develop science) with the nature of science (NOS) (as conventions and assumptions underlying the process) so that the knowledge generated has Characteristic certain. Understanding the process and nature of science (NOS) and be able to do scientific inquiry is a prerequisite of effective science teaching. It is not enough for us simply to teach the facts only and have students do lab activities using a recipe book (cookbook). Therefore, teachers of science including chemistry teacher must understand how a scientist (scientist) think and act and then develop methods to communicate this understanding to their students. A teacher who is directly involved in the learning of science / chemistry should be able to do by using the science process skills and processes must also be capable of bringing the attitudes and perspectives of scientists into the classroom. To make it happen, we need a basic understanding of the nature of science (NOS) (Watson & Parsons, 1998). With a better understanding of the nature of science, understanding of materials science / chemistry and ability to perform the process of science, science teacher can teach science as an activity-oriented concept, hands-on / minds-on, problem solving and activity of critical thinking, which in turn can encourage scientific literacy students.

One of the main goals of science education that is written in a variety of curriculum documents or standards of science education in the world is the realization of scientific literacy (Norris & Phillips, 2003) and the various reforms and efforts focused on the development of an accurate understanding of science and science literacy, also referred to in various documents has become the nature of science (NOS) and scientific inquiry as an important component to develop scientific literacy. The following is an analysis of how the Curriculum 2013 explicit theoretical foundation / philosophical science literacy, inquiry science and the nature of science (NOS), which is the hope and challenges us to create a society / students at the end of education has scientific literacy are better (more developed) (Rahayu, 2014).

When compared with the previous curriculum 2006, the Curriculum 2013 has been expressly categorizing competencies-competencies to be achieved by students during school learning into core competencies and core competencies then elaborated further into basic competency.

All Core Competency Curriculum 2013 into the category of scientific literacy models Graber et al. This is our hope for the purpose of achieving scientific literacy. In general, Curriculum 2013 has expectations that lead to realizing the scientific literacy of them is that the students have (a) the ability to

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communicate, (b) the ability to think critically and creatively, (c) the ability to consider the issue in moral side, (d) the ability to live in a global society, (e) has a broad interest in the life and readiness to work, according to the intelligence of talents / interests, and care for the environment. Curricula must be able to respond to these challenges so that the need to develop these abilities in the learning process and teachers are required to be more creative in developing classroom learning (Rahayu, 2014).

Approach / strategy / models / methods of learning are indispensable in supporting the realization of the whole competence contained in Curriculum 2013. In the sense that the curriculum includes what should be taught to students, while learning is how what is taught can be mastered by students. Learning implementation is preceded by the preparation of lesson plan (RPP) developed by teachers, either individually or in groups which refer to the syllabus. Scientific inquiry is essential in developing science literacy and if scientific inquiry together with the nature of science (NOS) is applied in the study, there will be an effective learning.

In principle, inquiry science is a systematic approach used by scientists (scientist) in an attempt to answer the questions that interested him (Lederman, 2004), which is a combination of science process skills (such as observing, inferencing, clarifying, predicting, measuring, asking, interpreting and analyzing the data) with the subject matter of science / chemistry, scientific reasoning, and critical thinking to develop science / science (Lederman, Lederman, and Antink, 2013). Curriculum 2013 places emphasis on the learning process by suggesting the use of the scientific approach (scientific approach) or could be interpreted as an approach to scientific inquiry. In Permendikbud No. 81A in 2013 explained that the process of learning the scientific approach consists of five learning experience that is: a). observed; b). ask; c). gather information; d). associate; and e) communicate (Rahayu, 2014).

If the terms of the definition given by PISA of scientific literacy that scientific literacy is the capacity to use science knowledge to identify questions and to draw evidence-based Conclusions in order to understand and help the make decisions about the natural world and the changes made to it through human activity "(Harlen, 2002 cit.Rahayu, 2014), the core of learning activities leading to scientific literacy is to conduct scientific inquiry where the heart of the activities of inquiry is the" ask a question "or" to identify questions "are questions that can answered by scientific inquiry, implies knowledge of science and the scientific aspects of a particular topic. Therefore, the challenges faced by teachers are how to apply the scientific approach in the classroom. The main emphasis is the scientific approach 1) raise questions from students that can be investigated, 2) to train students to use the skills, 3) train students to reason and think critically, and 4) trains students to work together and communicate.

3. CONCLUSION

1) The definition of scientific literacy is an individual scientific knowledge and the use of knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues, an understanding of the characteristic features of science as a form of human knowledge and inquiry , awareness of how science and technology, intellectual, and cultural environments, and willingness to engage in issue-science related, and with the ideas of science, as a citizen reflective, 2) aspects of scientific literacy includes knowledge, knowledge discovery , the knowledge gained through the process of knowing, the interaction between science, society and technology, 3) Various scientific literacy e.g. literacy nominal, functional, conceptual and procedural, multidimensional. Miller's three aspects of scientific literacy: the nature of science, key science terms, and science's relevance to society, 4) Curriculum 2013 developing scientific literacy with emphasis on the learning process by suggesting the use of the scientific approach (scientific approach) or could be interpreted as an approach to inquiry scientific. In government regulation No. 81A

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in 2013 explained that the process of learning the scientific approach consists of five learning experience that is: a). observed; b). ask; c). gather information; d). associate; and e) communicate.

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