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ABSTRACT

This study, part of a larger research project, explored the knowledge of the general population regarding cloning. It also sought to determine where people gather information on cloning. Such awareness of the general public's knowledge of important scientific topics and sources from which people retrieve information can help scientific and educational communities develop strategies that foster scientific literacy among the public. The sample population contained 156 individuals, 76.3% of which were associated with a college or university. Several themes emerged from the study. First, most people realize their knowledge about cloning is limited and inadequate for making informed decisions about it. Second, most people were not able to define cloning completely, especially in words or terms that they were comfortable using. Third, few people were able to relate cloning to all its applications and uses. Fourth, most people were unsure if they used products developed or made from cloning technology. The most frequently reported source of information was television news and magazines; however, in followup interviews, respondents cited libraries and the Internet as resources for the most factual information. Contains 21 references. (PVD)

CLONING:

What Do They Know?

A Report on the General Knowledge of a Sample of Midwestern Citizens

Presented at the Annual Conference of the

National Association for Research in Science Teaching (NARST)

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Introduction

The topic of cloning, once a theme for science fiction novels, has entered the mainstream of scientific literature and conversation. In the United States congressional legislation is pending and President Clinton is proposing a five year ban on human cloning, while Dr. Seed is promising parents the possibility of cloning their children. Television and other forms of media also introduce cloning in story lines and talk shows. And finally, recent successes in genetic engineering involving multicellular organisms has brought human cloning into the "realm of the possible" in the approaching decades.

Cloning entered the daily conversations of the general population with the publicity surrounding molecular biotechnology used by I. Wilmit et al (1997) in the cloning of a sheep named Dolly. Wilmit's work was intended to be used as a tool for animal husbandry and the development of sheep that could produce useful proteins in their milk. But does the general public realize this use for genetic technology? Marker (1993) discusses how technology expands our policy options and how public policy, which is controlled by humans, does make a difference in how we develop and use such innovations. In our capitalistic society, the responsibility of the outcomes, positive and negative is not placed in the hands of vendors who profit from such technology. This reiterates the need for an educated and scientifically literate population of citizens. Citizens should have information regarding the capabilities and possible abuses of such advances in this area of biotechnology.

This discussion in science education has gained importance in recent reform efforts under the label of "scientific literacy." Literacy generally implies a set of cognitive, affective, and behavioral outcomes needed for a citizen to live in our technologically oriented society (Welch, 1985). Hurd (1958) first used the phrase "scientific literacy" to describe an understanding of science and its applications to our social experience. In their guidebook to active meaningful science learning, the Midwest Consortium for Mathematics and Science Education (1994) states that scientifically literate citizens will be able to understand key concepts of science and technology, use this knowledge in everyday life, understand complex policy issues, and grasp the complexities of rapid change. There is a growing recognition that in the industrialized world scientific literacy is an important component of long-term economic growth and of effective citizenship. However, studies have indicated that relatively few citizens in the United States and other nations understand basic scientific terms or can make sense of conflicting arguments from experts on science issues relevant to society (Miller, 1989). Cutliffe (1990) has stated that "science and technology are complex enterprises taking place in specific social contexts shaped by and in turn shaping, human values as reflected and refracted in cultural, political, and economic institutions." In these references to scientific literacy, we see the importance of the cognitive domain of science knowledge, as well as the affective domain encompassing attitudes toward science. This study explored the knowledge and attitudes of the general population regarding cloning. It also sought to discover where people gather information on cloning. The investigators explored such questions in an effort to begin to develop a clearer understanding of the knowledge level, attitudes, and resources that help people gathering information and form beliefs.

Theoretical Framework

In today's rapidly advancing technological world, the products of technology along with their sociological and environmental implications, are essential features of daily life (Hofstein & Yager, 1982). It is becoming increasingly important for citizens to keep pace with recent

advances in science and technology. Bybee (1985) states that citizens have a genuine need to understand the impact of science and technology on society and the social issues they must evaluate. This is important since a population's misunderstandings of science can impact the political process and influence a wide range of issues from funding for scientific research to misguided regulations and unrealistic expectations (Prewitt, 1983). It is important for citizens to be able to apply scientific knowledge and technical vocabulary when considering social-scientific problems or issues (Wraga & Hlebowitsh, 1991).

Knowledge of cloning encompasses a wide range of topics. Biotechnologists are involved in environmental concerns such as those dealing with herbicides, disease prevention, creating specialized or designer genes (especially in plant and bacterial organisms), experimenting with biological catalysts and enzymes, developing agricultural products, as well as research involving nitrogen fixation, monoclonal antibodies and viruses. These areas of research are seldom mentioned. All of these research efforts involve cloning or processes that require cloning. Biotechnology efforts have contributed to the identification and isolation of specific proteins which can be utilized to fight disease, increase agricultural yield, and for culturing new tissues (Skena, 1992). Knowledge of cloning then, should include an understanding of some of these applications, and not merely focus on future implications.

Where do people acquire their knowledge on biotechnology issues and specifically cloning? The general population acquires knowledge in a variety of ways. Part of this learning is in traditional settings, but a major portion also is from informal sources. Such sources can include: popular periodicals, television news broadcasts, news shows, the internet, and from others. Marien (1985) argues that adult learning of science or scientific literacy is necessarily an informal learning process. For even the most comprehensive formal education cannot possibly equip an individual for a scientifically literate lifetime (Hacker & Harris, 1992).

For a scientifically literate populace capable of making informed decisions about cloning, people must be knowledgeable about basic genetic and biological concepts. One difficulty in this area is the jargon and technological verbiage utilized in the media to describe cloning and genetics. People are intimidated by "genetics related terms" used to describe processes. In one ***Time*** magazine article related to bioethics, 64 terms (ranging from polymorphism to nitrogenous bases) were used to describe the chemical and biological processes. Often the general public uses these resources as a significant source of science information (Mertens & Hendrix, 1990).

This study also investigated people's attitudes toward cloning. McCormack (1992) states that new perspectives on learning offer central places for both thinking skills and knowledge, and also give appropriate recognition to the domains of attitudes, creativity, and applications. In the last few decades we have witnessed a shift in the educational system from one that emphasized on the cognitive outcomes of education to one that places equal emphasis on affective outcomes (MacMillan & May, 1979). This shift stems from the belief that affective variables are as important as cognitive variables in influencing learning outcomes and behavioral outcomes. This study sought to explore of the ethical, moral, and political dimensions of the people regarding the issues of cloning.

Significance of this Study

Although people are being presented with scientific topics in the news daily, very little learning appears to be occurring from such exposures (Shamos, 1990). Studies have shown that there is a negative attitude toward science among the general public (Ford & Tebbutt, 1993). This attitude is particularly evident among women. Many adults do not consider careers in science and

technological fields as a result of these attitudes. There is a greater need for scientifically literate people (Bracey, 1997) because the world is becoming increasingly more technologically and scientifically dependent. Adult literacy in these areas influences decision-making and issues that impact everyone.

This also involves the issue of not only attitude measures but also, sources of scientific information. Where do people get information on scientific topics? How can the educational and scientific communities best serve the public and their needs? The educational and scientific communities in the United States have been searching for ways to advance general scientific literacy for everyone in response to the publication of ***Science for All Americans.***

Hacker & Harris (1992) state that most adult learning is informal learning and that any research into adult science learning must concern itself with informal styles. The popular media is often the source of science information. Repeated media attention given to some of the topics, such as the harmful effects of ultraviolet light on the skin and energy conservation, can contribute to the common culture of literate adults. Shamos (1990) and Griffin (1989) found that adults are likely to recall science facts that have been presented to them repeatedly in the media.

Such an awareness of the general public's knowledge of important science topics, their attitudes toward such topics, and the sources where people retrieve their information can help the scientific and educational communities develop strategies that foster higher levels of scientific literacy among the general population.

Methodology

This study was based on both quantitative and qualitative data gathering methods. It examined the relationships between demographics and knowledge of cloning, attitudes toward cloning, and sources of information on cloning/cloning issues. The survey was initially developed over the summer of 1997 and field tested, evaluated, and revised. It consisted of eighteen items, most of which were Likert scale or multiple category response items. One item was a free response question that initially asked participants to define "cloning." The initial survey instrument was field tested with a sample of thirty individuals and was found to be statistically reliable. The instrument included four items designed to assess knowledge of and uses of cloning, three items on the sources of information on cloning research, and twelve items on attitudes toward cloning research.

The results were analyzed using the SPSS Base 7.5 for Windows software. Correlations included Spearman and Pearson correlations, as well as the use of crosstab and descriptive statistic features. Items were analyzed in relationship to the demographic information, as well as, to the specific elements of knowledge, attitudes, and sources of information.

Qualitative data was also gathered from follow-up interviews and from the open-ended item that asked: "What do you think cloning is?" The follow-up interview participants were selected from among those who completed a survey and gave their first name and phone number to be contacted for a possible interview. Eight individuals were successfully contacted and given follow-up interviews. The interviewers asked participants questions on the following areas of cloning and cloning research:

-their definition of cloning in everyday language;
-where they would obtain factual information on cloning;

-whether they considered themselves knowledgeable enough to make informed decisions about cloning and cloning research;
-where they learned about cloning or cloning research recently;
-what they thought the greatest benefit (if any) of cloning; and,
-what their greatest concern was about cloning.

The interview data was then coded and compared to that obtained from the surveys. The responses to individual interviews were analyzed by teams of investigators involved in one of the three areas of exploration: knowledge, attitudes, and sources of information.

A team of ten researchers helped distribute and collect surveys from college campuses in the Columbus, Ohio area, from local business and clerical offices, and from public gathering places. Investigators exercised care to assure that participants were randomly selected. Demographic information allowed researchers to attempt to contact as many individuals from different backgrounds, age groups, and educational levels.

Another important part of this survey was the attempt to administer it on a person by person basis. It was not intended to be administered without the guidance of one of the investigators. Thus, assuring that the participants would take greater care and seriousness than might otherwise have been given.

Demographics of the Research Sample

The sample consisted of 156 individuals. Males made up 41.9% of the sample and females 55.5%. The ages of the participants were: 18-23 years 17.8%, 24-29 years 21.5%, 30-34 years 14.7%, 35-39 years 13.6%, 40-44 years 8.4%, 45-49 years 3.7%, 50-54 years 3.7%, 55-64 years 7.3%, and 65+ years 5.8% with 3.7% of respondents not giving their age.

Of the participants, 76.3% were associated with a college or university and 20.5% were not. There were 37 different college degrees represented as well as 25 different college majors. 29.5% of the respondents indicated that they had completed some college level courses, 12.8% had a two year college degree, 17.9% had a four year college degree, 8.3% had completed some graduate level work with 15.4% having completed a Masters degree, 1.3% having completed a professional degree, and 1.3% having completed a Ph.D. degree. A further 0.6% had only completed education through the 11th grade and 9.0% had completed through the 12th grade.

Of those indicating that they were on the faculty at a college or university, there were 8 different faculty departments represented. There were also 25 different occupations represented including teachers and students. This sample was drawn from 13 different locations of which there were 6 different institutions of higher learning represented.

Overview of Specific Survey Items on One's Knowledge of Cloning

The study was designed to assess the general knowledge of a sample of citizens living in the Midwest area of the United States. The knowledge items were part of a survey that assessed individual attitudes and where people received information regarding the issue of cloning as well. Knowledge about cloning was collected using a survey, along with follow-up telephone interviews. The survey included free response and Likert scale items.

The first item on the survey was an open-ended question asking the participant to define cloning. This was done first to avoid misleading or influencing them with information contained in

following items. And since it was a free-response item, it enabled the researchers to follow-up that response in the telephone interviews that followed.

The open-ended response item was also coded using a numeric system of: 1 for a definition that contained or explained one element of the definition of cloning, 2 for a definition that included two elements, and 3 for the most complete definition of cloning. The essential components of the definition of the term "cloning," were decided using peer review and the dictionary definition of the term.

When it came to defining the term "cloning," participants responded in various ways. It was decided in the pilot study to devise a way of rating their responses. This was done by analyzing the definition using its three significant parts. In rating and evaluating each participant's definition, the researchers looked for indicators and words that demonstrated the understanding that cloning included the following:

- Organisms or cells arising from a single individual;
- By asexual reproductive means; and,
- Are therefore, genetically identical.

This is the definition given in the ***Concise Science Dictionary (3rd edition)*** as well as, in ***The American Heritage Dictionary of the English Language (New College edition).***

Definitions were then evaluated based upon their completeness and were assigned a number ranging from zero to three. Zero for a definition that did not contain any of the parts listed previously or for a response that did not address the issue of defining the term. Many participants chose to immediately write responses that did not address the question, but instead expressed their ideas and beliefs regarding the use or process of cloning living organisms. These will be discussed in detail under the results section. A number, one through three was given for definitions that included one, two, or three parts of the acceptable definition of cloning among the scientific community. A rating of three therefore, was the rating that demonstrated the greatest understanding of the term.

The second item from the survey that was designed to assess participant knowledge about cloning was item number two which asked the participant to assess their own level of understanding of cloning. They were given five choices offered in response to this item:

- Very knowledgeable
- Knowledgeable
- Know all I need to know
- Little knowledge
- No knowledge

The third item concerned the participant's knowledge of the uses of cloning at present. The survey asked participants to as many of the choices that indicated how cloning was currently being used. The choices included: animal husbandry (animal breeding); environmental management; agriculture (food production); medical use; and for research. This item was designed to assess whether individuals understood how or where cloning research is being applied. All of the categories are areas in which cloning research is being employed.

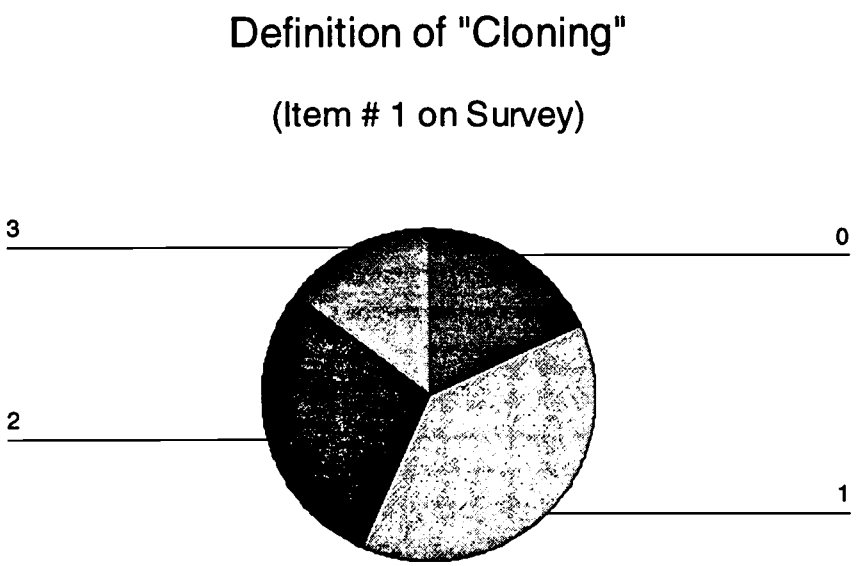
The fourth item assessing the participant's knowledge of cloning was intended to discover whether individuals realized the pervasive use of products or benefits of past and present cloning

research. It asked individuals to respond to the statement "I currently use products made from cloning," by checking either yes, no, or unsure.

Results of the Knowledge Items

The items on the survey were first described and analyzed for their usefulness in giving a general snapshot of what participants knew about cloning. Each item was analyzed individually and collectively to look for frequencies and trends among the sample. Then, as a second phase of analysis, the data were compared and correlated with data obtained from items designed to assess participant attitudes and where they obtained information regarding the topic of cloning.

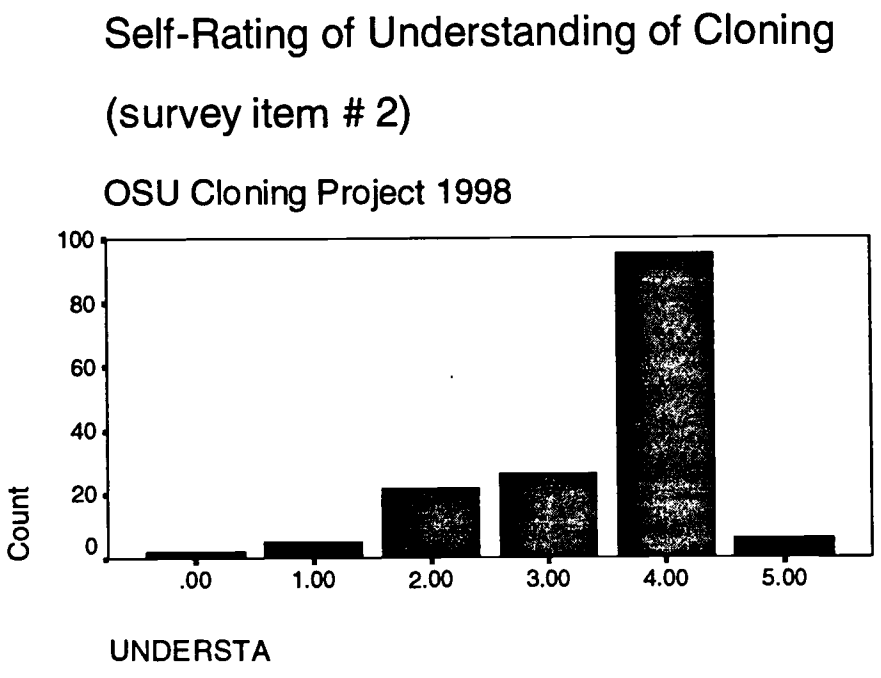
The following chart illustrates the data obtained on participant understanding of the term "cloning." It was surprising in many ways, because a surprising number of participants responded to this first item, an item designed to assess knowledge, with a comment that expressed their personal belief or attitude. Some respondents appeared to be more intent on explaining their opinion rather than conveying their understanding of cloning.



A significant number of survey participants either did not know how to define the term cloning or did not choose to define it. Twenty-eight individuals (17.9%) of those who took this survey did not give or gave an inaccurate definition of cloning. Ten individuals chose to express their beliefs, often their disapproval of cloning research, rather than offer a definition. Three individuals elected not to give any response at all.

Over thirty-eight percent of those surveyed were able to define cloning with at least one of the correct parts. Twenty-eight percent were able to give two parts of the complete definition of

cloning. And over fourteen percent were able to a complete definition of cloning including the three important elements.



1= very knowledgeable; 2= knowledgeable; 3= know all I need to know; 4= little knowledge; 5= no knowledge

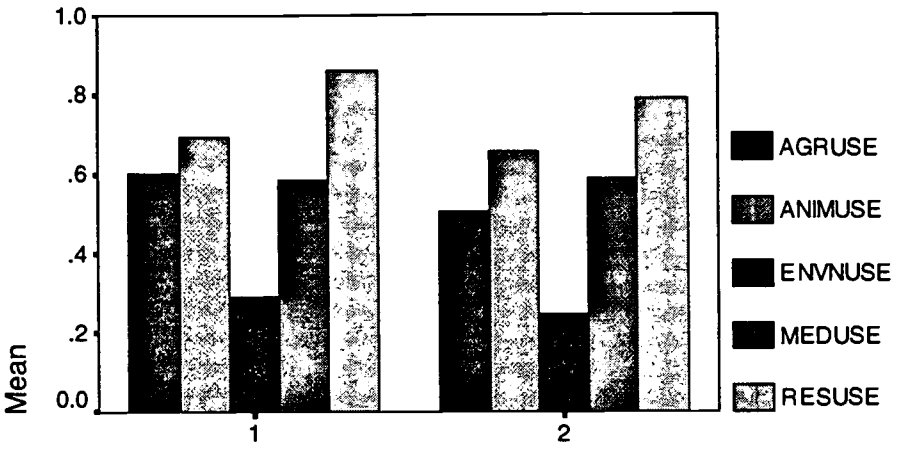
The second item on the survey had covered participant's self-rating of their understanding of cloning. There were five choices from which individuals could select to describe their level of knowledge of the topic of cloning. The coding was done so that one corresponds to "very knowledgeable," two corresponds to "knowledgeable," three corresponds to "know all I need to know," four corresponds to "little knowledge," and five corresponds to "no knowledge."

Most (60.3%) selected "little knowledge" as the most appropriate descriptor of their understanding of cloning. This is consistent with participant responses to the definition of cloning in item one. The largest representation in this sample are lacking a basic understanding of the constituent elements of cloning, but they are aware of their lack of understanding. Only 3.2 percent rated themselves as very knowledgeable about cloning, while 3.8 percent rated themselves as having "no knowledge" of cloning. And almost 17% considered themselves as knowing "all I need to know" about the topic.

Another item on the survey asked respondents to identify ways in which cloning is presently used. The following graph shows the similarity of the responses of males and females. The results indicate that most participants in this sample indicate that cloning is mostly a research technique and not necessarily application oriented. Most people were able to associate cloning with animal and research applications, but few associated cloning with environmental management applications. Medical and agricultural uses were not the most frequently marked.

Knowledge of the Use of Cloning

(Item # 3 on Survey)



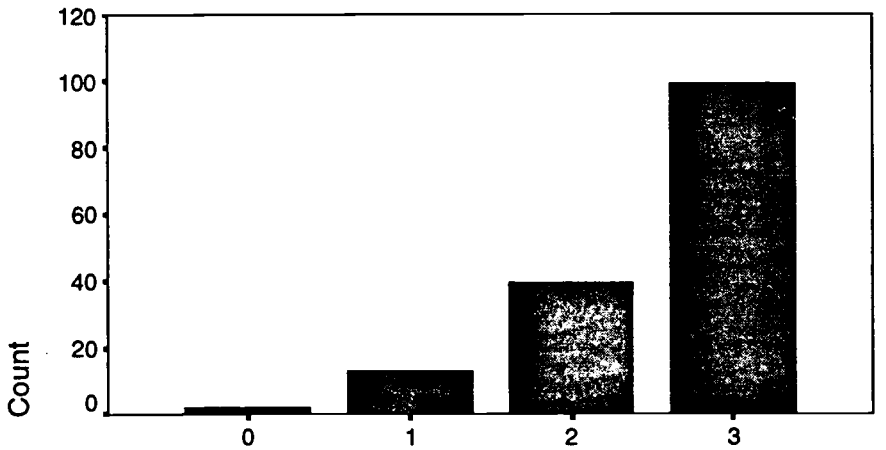
GENDER

1= male; 2 = female

The last item on the survey designed to assess participant knowledge was item fifteen, which asked individuals if they "currently use products made from cloning." Only eight percent of the respondents marked "yes" on this item, twenty-five percent marked "no." However, the vast majority of this sample (64%) were unsure whether they use products made from cloning research. Two individuals left this item uncompleted on the surveys.

I Currently Use Products Made from Cloning

(Item # 15 on Survey)



DO.USE

1 = Yes; 2 = No; 3 = Unsure

Knowledge Items and Follow-up Interviews

The follow-up interviews provided an opportunity for researchers to check the general understanding, attitudes and resources that participants said were important in discussing the issue of cloning. It provided many interesting insights into what participants were thinking. Findings relating directly to participant's knowledge of cloning are briefly discussed in the section that follows.

Participant definitions of cloning were consistent with those open-ended items on the survey. All of the eight individuals interviewed were able to give at least one of the component parts of the accurate definition of the term. Five of the eight were able to give at least two elements of the definition. And one individual was able to explain the three components. All participants were able to use their own words and common language to explain the term to some degree.

All of those interviewed agreed that they did not have sufficient knowledge to make "informed decisions" regarding cloning and related research. Some commented that the issues involving cloning were clouded with issues of "soul," or ethical concerns, or lack of familiarity with current research efforts. One individual was especially knowledgeable but stressed that they too, felt like they did not know enough factual information. This same person commented that part of her decision making process on such issues would have to consider her beliefs about issues of faith and identity. She was aware, however; of the uses and applications of such cloning technology, mentioning two specific agricultural news events involving cloning, one involving agricultural crops (corn) and the other involving animals (sheep).

Five of the people interviewed explained that the most recent information they'd heard involving cloning had to do with the cloning of mammals. One also mentioned learning recently that plants were cloned and part of the ongoing agricultural research. This was the same individual who mentioned the struggle between having factual information and matters of personal belief and identity. One individual said they had not learned anything lately about the topic of cloning.

Many of the interview responses matched the results of the surveys. However, as an interesting sidelight, some (3) of the interview participants did not want to be tape recorded and wanted to make sure their identities would be kept confidential.

Correlations of Knowledge Items with Attitude and Sources of Information Items

The most significant findings between knowledge and attitudes and sources of information were those reported in the follow-up interviews. Many of the spoken responses in the interviews were representative of survey responses. For example, people who rated themselves as having less than adequate knowledge to make informed decisions in the interview and those who rated their understanding as having "little knowledge," were often able to give only partial definitions of the term "cloning." They were also seldom able to point out uses of cloning, other than to replicate animals, which many respondents did in making references to Dolly, the sheep.

The interviews also clarified the source of most of the respondents knowledge about cloning. The most frequently reported source, according to the survey was TV news and magazines, however, when asked on the follow-up interviews the source for obtaining the most "factual" information, the library and the internet were cited as resources. This was a small sample and these results are not indicative of the survey sample as a group, but there were distinctions between where people received knowledge about cloning and where they'd go to find "factual" information.

In all the interviews, there was a pervasive concern toward the possible misuse of cloning technology. This part of one's attitude did not show a correlation with one's knowledge of cloning or their ability to define cloning. All interview participants expressed concerns, even on questions that did not directly address this area.

Concluding Remarks and Emergent Themes from this Study on Cloning Knowledge

The following bullets summarize the themes that emerged from the survey and follow-up interview questions. These are thought to be a beginning to our understanding of what people know and understand about cloning. These are themes based on our sample of 156 individuals.

- Most people realize their knowledge about cloning is limited and inadequate for making informed decisions about it.
- Most people were not able to define cloning completely, especially in words or terms that they were comfortable using.
- Few people were able to relate cloning to all its applications or uses.
- Most people are unsure if they use products developed or made from cloning technology.

Future studies could investigate these issues further to discover if changes in knowledge about cloning change over time. The connections and usefulness of sources of knowledge and the attitudes of people could also investigated further using in-depth interviews and other methods of inquiry.

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