Validity and Credibility of Information

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Information Age Education

Information Age Education (IAE) is a non-profit company in the state of Oregon that was established in 2007 by David Moursund. Its goal is to help improve worldwide informal and formal education at all levels. Its current list of free resources and activities includes:

- Free books published by IAE. See http://iae-pedia.org/David_Moursund_Books; http://iae-pedia.org/IAE_Newsletter#Free_IAE_Books_by_David_Moursund_and_Robert_Sylwester; and http://iae-pedia.org/Robert_Albrecht#Free_Books_by_Bob_Albrecht.
- Free *IAE Newsletter* published twice a month. See http://iae-pedia.org/IAE_Newsletter.
- *IAE Blog*. See http://iae-pedia.org/IAE_Blog and http://iae-pedia.org/IAE_Blog.
- *IAE-pedia*. See http://iae-pedia.org/index.php?title=Special:PopularPages&limit=250&offset=0 for a list of pages ordered by popularity.
- Other IAE documents. See http://i-a-e.org/downloads.html.

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Part 1

An Introduction to *Validity* and *Credibility*

We have organized our treatment of *Validity and Credibility of Information* into five major parts. We begin each part with a brief introduction/summary of its main ideas. Each part is divided into one or more chapters. Part 1 introduces two key ideas: *Validity* and *Credibility.*

Validity describes concepts, conclusions, and/or measurements that are logically and factually sound. They are based on good reasoning, careful research, accurate information, and informed judgment. A research instrument or test is considered to be valid if it adequately measures what it purports to measure.

Credible is an adjective meaning believable, plausible, tenable, likely, probable, reasonable, and so on. We talk about the credibility of a person in terms of the credibility of the person's allegations and claims. A person who routinely makes invalid allegations and claims is considered to not be credible. A number of websites do fact checking (often focusing on what politicians are saying and/or on common myths) and we can make use of these sites as an aid to determining the credibility of a person.

In our everyday lives, we encounter "information" that we make use of as if it were valid and credible. However, often it lacks one or both of these characteristics. Thus, people, organizations, and countries often make poor decisions due to a lack of well-considered, valid and credible information.

Our informal and formal educational systems can be considerably improved by helping students learn to seek out and make use of valid, credible information in their everyday lives.

Chapter 1

IAE Newsletter # 147 and *IAE Newsletter # 148*

The Complexities of the *Objective Validity* and *Subjective Credibility* Concepts

Robert Sylwester
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University of Oregon

This book focuses on the objective and subjective ways in which people arrive at and then act out decisions. The concepts of *objective validity* and *subjective credibility* play important roles in this determination.

Objective validity emerges out of rational research-based processes. The word *valid* is used in two somewhat different ways:

1. Valid concepts, conclusions, or measurements are logically or factually sound. They are based on good reasoning, information, or judgment.
2. A research instrument or test is considered valid if it measures what it is purported to measure.

Subjective credibility focuses on a belief that a person who made an allegation about a phenomenon is believable and can indeed be trusted with reference to the allegation.

Anyone can currently post anything on the Internet at practically no cost, and self-publishing is relatively simple and inexpensive. Editorial oversight for accuracy and truth that was historically so important in print media has declined. The biases of those who read/view many of today's websites coincide with the biases of those who write for the site. A similar situation now exists in television and radio broadcasting. In TV, for example, many channels (such as FOX and MSNBC) focus on very specific biased demographics. "Viewer Beware" is the new watchword.

This book explores the validity and credibility challenges that 21st century students and adults confront as they cope with this flood of information coming from the global reach of the Internet and the rapidly increasing number of television channels and radio stations. Students must learn to recognize the bias that individuals or advocacy groups reflect in their materials.

Students must also realize that, no matter how much they like their favorite athletes or musicians, being a celebrity or pundit does not make one an instant expert whose pronouncements should be treated as valid or credible in fields beyond their expertise. Assessing objective validity and subjective credibility is a complex challenge.

A Generation Ago

Imagine late mid-20th-century high school students confronting their first research paper. Their teacher had explained the principal sources, cultural biases, and APA or MLA guidelines. Teachers knew and students learned that the major available resources for student papers (such

as the school and public library books and periodicals) would have been vetted for credibility before the librarians would purchase them.

Published material was printed on paper, and distributed books and journals can't easily be changed. Editors generally required authors to provide suitable support to insure that their information and allegations were factually acceptable prior to publication. Teachers tended to know the principal sources and cultural biases in the field they taught and so could guide students to a clear understanding of charts, graphs, statistics, and logic. This allowed otherwise naive students to assume that most published material available to them was credible and valid from the perspective of current scholarship.

Pre-adolescent children tended to accept their parents' beliefs because their parents supposedly had a superior understanding of such things as true/false, right/wrong, and fair/unfair. Parental and religious beliefs tended to be reasonably similar in homogeneous communities, and this was reflected in school curricula. The conflicts between what students learned at home and what they learned at school thus tended to be minor.

Analogy, Caricature, and Validity/Credibility

We have long been a society in which analogy plays a central explanatory role. Children learn about and from tales about Santa Claus, Aesop's fables, and religious parables. We tend to prefer fiction over non-fiction, and narrative films over documentaries. Songs and much visual art are narrative-driven. We want fact but prefer analogy.

Analogy and caricature identify common elements between an understood concept and one that's not yet understood, and so they can play key roles in helping people understand (or, alas, misunderstand) issues involved in assessing validity and credibility.

Our ability to understand and make such analogical comparisons may be what cognitively separates humans from other primates and social mammals (Sylwester & Moursund, 2014). Analogies can help move us away from mysteries towards scientific/technological discoveries, cultural/artistic explorations, and governmental variability.

Analogy and caricature might lead to (but they aren't the same thing as) factual understanding, but they seem to dominate much of current cultural discourse (Sylwester & Moursund, 2014). An analogy isn't true at the valid and credible levels. At best, it's just a representation of truth, but that representation can move us closer to credible and/or valid truth.

The World Confronts Validity and Credibility in the Olympics

The Olympic Games seek to identify the best athletes in the world. Judges use two different techniques to determine winning athletes: They use objective (or valid) measurements in some events and subjective (or credible) measurements in others.

The determination of validity is straightforward with runners, jumpers, throwers, speed skaters, etc. They go through multiple competitions before arriving at the finals. Very precise timing instruments are used to get very valid objective measurements of performance data. Speed or distance determines the winner—provided the athlete passes drug testing and doesn’t violate such rules as obstructing a competitor.

The second approach to Olympics credibility is the use of subjective measurements to determine how well the athlete performed. Events such as gymnastics, figure skating, and diving

come to mind. A panel of judges observes each athlete's performance and a scaled response form is used to score various elements.

Each judge assigns a score based on requirements in the event, the difficulty of various components, the quality of performance of individual components, and the overall performance. The highest and lowest of the scores are eliminated, and the remaining scores are averaged. The elimination process is used to reduce the effects of judges being strongly biased in favor of or against a particular athlete. The final result is a score that can be compared with the scores of other competitors.

Thus, either objective measurements or subjective measurements are used as appropriate for each Olympic event. The results are considered appropriate to determine gold, silver, and bronze medalists. The first-place winner gets the gold medal and bragging rights until someone else wins in a future Olympic event.

This kind of determination is somewhat similar to the search for objective scientific credibility in some areas of discovery. For example, the scientific winner is whoever first made an important discovery, but again no claim is made that the current discovery will be forever valid or credible. The Nobel Prize is the scientific equivalent of an Olympic gold medal. It suggests that the discovery is exceptionally good. However, it may be superseded by subsequent scientific discoveries.

Perhaps what the Olympics provide is an analogy for life itself–the yin/yang of subjective/objective decision-making about what is actually credible/valid/useful.

Validity and Credibility in Science and the Humanities

Science may appear to be based on solid objective validity. The belief that scientific discoveries are true, however, misses the point of what science is. Scientific discovery involves a search for truth, not truth itself. The world's mysteries encompass both unknown and known elements/ideas. A newly discovered element/idea was previously unknown, but it may have been somewhat analogous to and an extension of what we already "knew."

Science thus begins with the analogical germ of an explanation to an unknown element. This can lead to a hypothesis, which can lead to a theory, which can eventually lead to the overwhelming scientific support that a valid law might have (such as in the Law of Gravity). But even that upper level of validity is always open to further discoveries that might modify or even replace the original discovery. Newton's Law of Gravity had to be modified to reflect Einstein's work in relativity theory.

This determination of acceptance may seem similar to acceptance within the humanities (social sciences, literature, the arts, philosophy), but it isn't. The upper levels of credibility in the humanities seems to go to allegations that have high subjective levels of collegial support. Scientific acceptance also has that, but it's based on support that has a universally accepted objective scientific base.

Credibility in Governance

Pre-human governance in human societies began with Alpha males (and sometimes females). It evolved as human tribes, communities, and nations increased the complexity of assessing ownership and ensuring appropriate behavior. Oligarchies gradually emerged as a dominant political force (with theocracies, royal families, and wealth predominating).

Medieval Europe provided an example of what can happen when oligarchies over-reach and lose political credibility. Over several centuries, uprisings and revolts accompanied the gradual emergence of a middle class. Many dissatisfied families decided to sail west to America and begin life anew in a country far away from the power that the ruling royal family or the established church had to make decisions about their present and potential life.

By 1788, when the U.S. Constitution was ratified, the United States had become sufficiently independent of England and folks had to decide how to proceed politically. The basic secular pattern that emerged was that periodic elections would occur and the winners could govern until the next election. The general assembly (from Congress to city council) would argue an issue before they voted on it. The majority would win, but it would rarely be unanimous. Each vote was acceptable, and credibility in argument rather than wealth or inheritance would thus remain important. A majority vote would determine the credibility of the argument.

The court system would provide Constitutional redress for those who lost a legislative argument. If those charged with criminal or civil offenses believed they were wrongfully charged, a series of court decisions would determine whether the charge was credible. Again, it's important to be able to rationally argue in a credible manner.

This first genuine global democracy had a rocky beginning, but by the end of the 19th century a dozen more countries had moved towards a representative democracy. The 20th century saw the number increase dramatically to about 200 and the 21st century is adding even more. Rocky beginnings in democracies seem almost universal.

Democratic societies believe that the votes of all registered voters are credibly acceptable, regardless of how individual voters arrived at their determination.

Post-2000

The emergence of new forms of independence in adolescents, and of mass media innovations in society, have profoundly changed the locus of responsibility for determining validity and credibility.

It's a good thing that adolescence has long been the period during which adolescent humans tend to question the validity and credibility of adult discoveries and beliefs. If we didn't have such a volatile rejection of adult beliefs just prior to adulthood, our society probably wouldn't have moved forward in culture, science, and technology. For example, each generation redefines popular music. It's thus been important that the current shift in responsibility for determining credibility began in such communication areas as music that especially intrigue adolescents before it moved into determining the credibility of such more complex areas such as governance.

Each of us gets a brain, and all brains come to think differently. Scientific and technological advances, as well as our cultural and artistic diversity, have provided human life with the incredible diversity it now has.

We each must constantly convince others to hire us, marry us, vote for us, buy our merchandise, and attend to our teaching. To become cognitively credible is thus essential in a democratic society, and even more so since young people are now going to have to develop a greater competency in assessing the validity and credibility of the information they get. Good advice is available, such as in the following two books by Daniel Kahneman and Alex Pentland.

Daniel Kahneman and Objective Validity

Nobel laureate Daniel Kahneman wrote in his book, *Thinking, Fast and Slow* (2013), that our initial response to imminent danger or opportunity is our innate emotionally-driven rapid reflexive response strategy that Kahneman calls System 1. If, however, the challenge is complex but not imminent, we may use a delayed reflective System 2 response strategy that uses rational thought processes. The two systems in balance provide a typically useful means for self-preservation and a qualitative life. The key task is to know which system is better with a given challenge. Our K-12 curriculum is more tuned to mastering System 2 than System 1.

This dual response system is reflected in our government's organizational attempts at checks and balances. For example, the House of Representatives is perhaps somewhat like System 1 in its responses to issues, but the more deliberative Senate and Supreme Court are more oriented to System 2 responses. Note how often fear of imminent consequences is inserted into issues to quickly activate System 1 responses before folks take the time to rationally think out the issue. The issue could probably be solved by negotiated rational discussion, but many seem to prefer an emotionally-driven reflexive response.

As our country has grown from a population of about four million to well over three hundred million people, and the issues confronting it became increasingly complicated, it's perhaps not surprising that political parties representing broadly differentiated beliefs emerged to take over the analysis of issues, and many citizens found it easier to simply identify with a political party (or a religion or other cultural commitment group) that came closest to their beliefs. The belief that we rationally and individually respond to complex challenges is thus probably not correct. Kahneman argues that we're a social species and so we must also look to how a society itself makes decisions.

Alex Pentland on Subjective Credibility

The concept of Social Physics emerged from the respected work that MIT professor Alex Pentland has done to study how individuals and groups make decisions. His perspective is probably best represented in his book, *Social Physics: How Good Ideas Spread–The Lessons from a New Science* (2014).

The social sciences have historically depended on such indirect means as surveys and observations that sometimes push the bar on both validity and credibility. Recent advances in mobile digital technology provide stronger and more direct evidence of human decision-making and behavior within our social environment. More voices can be heard, and their analysis is becoming more accurate.

Big data from mass media and social networking can now describe what we actually do (a process called reality mining) rather than what we say we do. Pentland (4/5/2014) suggested that recent research is beginning to uncover the degree to which we act as independent individuals. By combining big data from cell phones, credit cards, social media and other sources, we can now observe humans in the same way that biologists can observe animals in their natural habitats using cameras or sonar. From these observations of people, we can derive mathematical rules of behavior – a "social physics" that provides a reliable understanding of how information and ideas flow from person to person. This social physics shows us how the flow of ideas shapes the culture, productivity and creative output of companies, cities, and societies.

Pentland discovered that we're group-oriented rather than self-oriented, tending to adapt our behavior to the behavior of our peers rather than to think and function individually. That's perhaps not surprising since we tend to associate with compatible folks. It's easier to copy those we trust who have invested time and effort into mastering something than to individually learn everything from scratch.

What kinds of groups are the most creatively productive? Pentland argues that it is those in which the members tend to be both cohesive within their group and interactive with diverse others outside of the group, not limiting their explorations to one biased side of an issue. By getting a sense of how others view the issue, they can positively affect those within their own group.

Pentland (4/5/2014) thus believes that "…it's time that we dropped the fiction of individuals as the unit of rationality, and recognize that our rationality is largely determined by the surrounding social fabric. Instead of being actors in markets, we are collaborators in determining the public good. Indeed, research has now demonstrated that people are much more influenced by their social networks than by individual incentives."

Curricular Elements

We are thus rationally autonomous individuals, but we're also part of a social species that's highly dependent on the knowledge and skills of others. We are capable of independent thought and decision (as our country's founders believed), but many of us also trust the judgment of those whose understanding we consider credibly superior (leaders of our political parties for example). Most of us realize that others may not always agree with us, but we're sometimes willing to go along with decisions that we independently consider wrong.

This sports analogy might be useful. The National Basketball Association (NBA) Playoffs include many of the best athletes in a very demanding game. A panel of three referees determines fouls, and fans are impressed by how players respond to incorrect calls that are typically shown via screened replays that fans and players can see. The fans tend to boo the referees but the players tend to play on. They consider the panel of referees as basically credible even when they're obviously wrong from time to time. Win one, lose one. Play on. It's a position that we also take when we pay taxes for some government activity of which we don't approve.

That's probably the way to think of the subjective credibility of a majority vote in a democratic society. If folks think the decision is manifestly wrong they can challenge those who made the decision in public forums, appeal to a higher court, or wait until the next election when repeal/replacement is a possibility. Otherwise, just play on and pay your taxes.

The curricular reality is that K-12 schools are going to have to prepare students to cast a wary eye at the credibility of what they read and hear in increasingly biased niche-driven media. Students will have to master the requisite rational and demographic analysis skills in addition to the skills needed in their own credible discourses with peers. That doesn't mean that students should ignore biased sources, but rather that they should recognize that others now broadly promote such biases as credible.

The acceptance of subjective democratic processes suggests that a curriculum that hopes to teach students how to respond to subjective credibility should include the following general concepts:

1. We're a representative democracy and qualified voters have the right and obligation to vote and the right to run for elective offices that don't have a precluding minimum age requirement and other legal requirements.
2. It's irrelevant how voters arrive at their vote, whether by independent study and rational thought or through a trusted friend's or political party's advice. Each voter subjectively determines personal credibility. Our Constitution has back-up systems to quickly or eventually change grievous majority errors (such as it did with slavery and universal gender suffrage).
3. Respected scholars provide useful information on how humans make decisions individually and collectively. Media formats provide alternate perspectives, either biased or unbiased (depending on one's personal view). Trusted friends can provide another perspective. Learning to recognize and respond to the varieties of subjective bias is a major task for folks who hope to live in an effective democracy.
4. Students should learn how to become rationally effective in discussion when they criticize decisions they consider to be inappropriate or wrong.
5. It's important for citizens to know when a credible majority actually exists. Polling techniques and statistical analysis have improved considerably in recent years, but even today many polls lack credibility because the research processes they use aren't valid.

Individually and in groups, we are being bombarded by a rapidly growing accumulation of information. Indeed, we all face the challenge called *information overload* (Moursund, 2015). Some information is objective, some is subjective, and some is a mixture of the two. The credibility of information sources, as well as the validity of the information they present, can often be difficult to determine.

We need to educate today's students to be aware of these difficulties and to consciously work to overcome them, both in their own learning and in their communications with other people.

References and Resources

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file from http://i-a-e.org/downloads/doc_download/256-understanding-and-mastering-complexity.html.

Part 2

Assessing Validity

Chapter 1 suggested that our rational processes emerged to get us beyond the belief that analogies are true, or that a credible person or organization per se can always determine the truth of an allegation.

The concept of rational process suggests that truth can also have an objective validity (beyond subjective credibility) that people will generally accept. In the Olympics metaphor used in chapter 1, people in Track and Field competitions accept a metric measuring system as objective validity when they determine winners in such competitions as shot put and high jump.

Chapter 1 thus suggested that objectively valid concepts, conclusions, and measurements emerge out of logically or factually sound research-based processes that are based on good reasoning, information, or judgment. Further, a research instrument or test is considered valid if it adequately measures what it purports to measure.

Chapters 2-5 focus on various areas in which objective validity is the norm for determining truth.

Chapter 2

IAE Newsletter # 150

Information Overload and Underload

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> "What is the use of having countless books and libraries, whose titles their owners can scarcely read through in a whole lifetime?" (Lucius Annaeus Seneca; Roman Stoic philosopher, statesman, dramatist; 4 BC-65 AD.)

The previous chapter suggested that future students will need to become much more personally responsible for determining the *validity* and *credibility* of information that they use.

> *Validity* is an important component of educational research. The word *valid* tends to be used in two somewhat different ways:
>
> 1. Validity is the quality of being logically or factually sound. Validity is the extent to which a concept, conclusion, or measurement is well founded.
> 2. A research instrument or test is valid if it measures what it is purported to measure.
>
> *Credibility* focuses on a belief that the person who made an allegation about a phenomenon is believable and can indeed be trusted. It is common to talk about a person and what the person writes/says as being valid and believable.

In brief summary, one can think of validity as having an objective base and credibility as having a subjective base.

This chapter discusses information overload and underload (Moursund, 2014). The quote given above indicates that the concept of *information overload* is a couple of thousand years old. My 9/27/2015 Google search of the expression *information overload underload* produced about 58 thousand hits.

A Digital Camera Example

I have a relatively inexpensive 16-megapixel camera. I use it to take a picture. The result is approximately 32 million bytes (256 million bits) of data. In one click of my camera I produce about 256 million zeros and ones. If my camera happens to be in video mode and I take five seconds of 24 frames/second video, I produce over 30 billion bits of data.

You have probably heard the statement, "A picture is worth a thousand words." Actually, the text in a 250-page novel requires less than a million bytes of computer storage. So, in some sense a color picture is worth 32 books!

If those numbers don't completely overwhelm you, then consider the Large Hadron Collider (LHC). When an experiment is being run, the equipment takes about 40 million pictures per

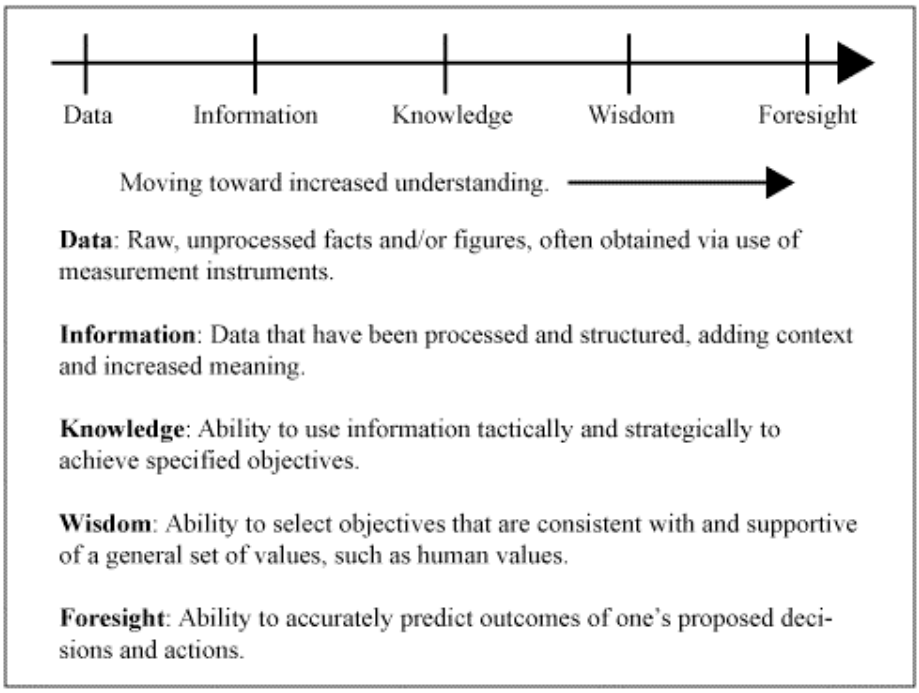
second. One second of data from the LCD is roughly equivalent to 13 years of high definition television or several hundred million books. That is a lot of data!

Data, Information, Knowledge, Wisdom, and Foresight

Here is a quote from Arthur C. Clarke that I have used many times in my writings:

> "Before you become too entranced with gorgeous gadgets and mesmerizing video displays, let me remind you that information is not knowledge, knowledge is not wisdom, and wisdom is not foresight. Each grows out of the other, and we need them all." (Arthur C. Clarke; British science fiction author, inventor, and futurist; 1917-2008.)

The following diagram expands on Clarke's statement and provides some short definitions.



People often use the term *information* to include all five of the categories: data, information, knowledge, wisdom, and foresight. Within any discipline of study we can inquire about the validity and credibility of its information.

The digital camera example of the previous section certainly indicates that we have data overload. Fortunately, we can use computers and other automated machines to process data. My digital camera snapshot can be made into a printed color photograph for about 15 to 20 cents or so. Then I can view and appreciate the picture, share it with friends, and save it in a photograph album. I am dealing with one printed photograph, rather than with 32 million bytes of data.

A Tidbit of Computer History

The first commercially-produced electronic digital computer in the United States was named the UNIVAC and became available in June, 1951. In those days, computers were considered to be *data processing machines.* Gradually, computers began to be regarded as information processing machines. In my early studies in Computer Science, I learned that "A computer is a

machine for the input, storage, processing, and output of *information.*" Over time, the discipline of Computer Science was renamed Computer and Information Science (CIS).

The field of CIS has grown substantially as computers have steadily become more capable. You may be surprised to learn that the Association for Computing Machinery held its 20th annual meeting on Knowledge and Data Mining on August 27, 2014. The 2011 success of IBM's computer named Watson in defeating human players of the TV game Jeopardy has made it clear that computers are now quite powerful *knowledge* processing machines.

We now think of a computer as a machine for the input, storage, processing, and output of data, information, and knowledge. The wisdom and foresight still must come from its users. Computer scientists and others continue to struggle with the nature and extent of current computer intelligence and the idea that eventually computers may (will) surpass humans in intelligence.

Information Overload

> "Everybody gets so much information all day long that they lose their common sense." (Gertrude Stein; American writer, poet, and feminist; 1874-1946.)

I remember the "good old days" when my wife and I bought the *Encyclopedia Britannica*. This seemed like a large investment at the time, and I built a special bookcase just to house this collection.

Now, the Wikipedia is available free on the Web. Quoting from the Wikipedia (Try not to laugh. I am quoting the Wikipedia about itself. Is this information credible and valid?):

> Currently, the English Wikipedia alone has over 4,975,051 articles of any length, and the combined Wikipedias for all other languages greatly exceed the English Wikipedia in size, giving more than 23 billion words in 35 million articles in 291 languages. The English Wikipedia alone has over 2.9 billion words, [3] over 60 times as many as the next largest English-language encyclopedia, *Encyclopædia Britannica*.

I routinely use Google to search the Web. Quoting from John Koetsier (11/1/2013):

> [A Google] search starts, of course, with crawling and indexing, and Google says that the Web now has 30 trillion unique individual pages. That is up an astonishing 30 times in five years: Google reported in 2008 that the Web had just one trillion pages. [Note added 9/27/2015. In Google (n.d.), Google indicated there are now 60 trillion individual pages.]

Google says that it stores information about those 30 trillion pages in the Google Index, which is now at 100 million gigabytes.

When you search, Google tries to figure out not just what you're typing into the box, but what you mean. So algorithms for spelling, autocompletion, synonyms, and query understanding jump into action. When Google thinks it knows what you want, it pulls results from those 30 trillion pages and 100 million gigabytes, but it doesn't just give you what it finds.

First, a ranking procedure uses over 200 closely guarded secret factors that look at the freshness of the results, quality of the website, age of the domain, safety and appropriateness of the content, and user context like location, prior searches, Google+ history and connections, and much more.

This last sentence is particularly important. In essence, it says that Google "screens" the hits it provides you so that the ones it considers will be most useful to you are at the top of the list. As Google learns more about you, it uses this knowledge in the screening process.

Information Underload

You might think that a Web search will answer any question you can think of and locate any information that you desired to find. But, that is not the case. Information underload is usually used to describe the situation in which a person cannot gain access to desired information that is known to exist. But, how does a person know what information exists?

I think it is better to think of information underload in terms of a combination of:

- **Not knowing what information exists**. When I pose a question or problem to the Web, it would be nice if the Web had enough intelligence to be able to tell me if, as of yet, there is no known answer to the question or problem. The information retrieval system could then go on to explain promising areas of research and development that are making progress in this area, and provide me with access to information about this progress.
- **Not being able to retrieve some of the information that is known to exist**. Much of the accumulated knowledge of the human race is not (yet) online, and much that is online is only available for a fee. In addition, there is much information that is proprietary or "secret." I want the information retrieval system to inform me about such situations and why I cannot have access to the information that I want.
- **Not having the knowledge and skills to make effective use of the information that one retrieves**. A good information retrieval system would have provisions for me to tell it my informal and formal educational background, my interests, and other information that would help the system to provide me with information at a level I can understand. (If I have just a high school education, I likely don't want an answer designed for Ph.D. research Biologists!) In the future, a good information retrieval system will also be a teaching machine. When I am exploring a topic, the system will apprise me of online instructional materials designed to help me learn more about the topic I am exploring.

Final Remarks

The total accumulation of information is huge and is growing rapidly. We suffer from both information overload and information underload. Broad-based browsers such as Google do not screen websites for content validity and credibility. Indeed, they don't even carry a warning sign such as: **Readers beware! This browser does not assume responsibility for the correctness of the website information it helps you locate**.

Here are some important points to consider:

1. As we search for needed information, we are faced by the problem of "Garbage in, garbage out" (GIGO). Much incorrect and/or very biased information is integrated into the total collection of information available to us. Even an expert in a particular small domain can have trouble separating the wheat from the chaff in his or her domain of expertise. It is not at all surprising that ordinary people often are so easily misled by what

they read on the Web. Our educational system is weak in helping students learn to assess the validity and credibility of information sources and the information they provide.

2. It takes substantial education and experience to make effective use of much of the accumulated information that is available. Contrast the current Web with a "smart" Web-of-the-future that provides answers suitable to the knowledge, experience, and contextual situation of the individual posing a question or problem. We have a very long way to go to provide this level of individualization.
3. Think about the difficulty of communicating a problem or question to a computer so that it retrieves just a quite limited number of good, useful answers. When I do a Web search, I am quite **displeased** when I get thousands or millions of hits. This problem can be addressed in two ways. One way is to provide students with substantial instruction and practice in communicating problems and questions to a computer system, and in refining their communication if it does not produce results that meet their needs. A second way is to make the information retrieval systems smarter. Progress in artificial intelligence is gradually doing this.

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Chapter 3

IAE Newsletter # 151

Determining Validity in Mathematics

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> "Mathematics is the queen of sciences…. She often condescends to render service to astronomy and other natural sciences, but in all relations she is entitled to the first rank." (Carl Friedrich Gauss; German mathematician, physicist, and prodigy; 1777-1855.)

To Refresh Your Memory

Credibility focuses on a belief that the person who made an allegation about a phenomenon is believable and can indeed be trusted. It is common to talk about a person and what the person writes and/or says as being credible and believable.

Validity is an important component of research. The word tends to be used in two somewhat different ways:

1. Validity is the quality of being logically or factually sound. Validity is the extent to which a concept, conclusion, or measurement is well-founded. Results produced by valid research can be tested by others repeating the research. Additional evidence of validity is produced by research designed to find contractions to the results, and that fail to find such contradictions.
2. In education, a research instrument or test is valid if it accurately measures what it is purported to measure.

In brief summary, one can think of credibility having a subjective base and validity having an objective base. The performance of a gymnast or dancer is determined by subjective methodologies, while mathematics and the sciences use objective methodologies to support their claims.

This chapter discusses validity in mathematics. You "know" with great certainty that 3 + 5 = 8 and that 3 x 4 = 12. These are examples of math "facts." They are math information that has a very high level of objective validity.

The math content in the discipline of mathematics gains its validity through objective methods that mathematicians call *proofs*, and from the refereeing process used in vetting and publishing their proofs. The objective validity of mathematics is rooted in:

1. Very carefully stated definitions, assumptions, and notation.
2. Developing, sharing, and building on math proofs that are openly available and can be checked by others who have the needed math knowledge and skills.

What Is Math?

See Moursund (2015a) to read some answers to the question, "What is math?" A very short answer is that math is a discipline in which people pose and attempt to solve problems that can be stated in the language of mathematics. See Moursund (2015b) for a discussion of the language of mathematics.

Math is a science, but in terms of validity and credibility it differs from the other sciences. Here is a quote that helps explain this situation:

> "God created the natural numbers. All the rest is the work of man." (Leopold Kronecker; German mathematician and logician; 1823-1891.)

Leopold Kronecker's statement posits that the natural numbers 1, 2, 3, etc., are part of nature, but that all of the rest of math was created by humans. We know that humans and many other animals have some innate ability to count small numbers of objects. The mathematical sciences that humans have created are much different from the natural and social sciences, where researchers observe the real world, design experiments, gather and analyze data, and draw conclusions.

Researchers in math produce results that are independent of our physical world and the people on it. These results have a very high level of validity in the world of mathematics. They constitute the "gold standard" of validity.

Research projects looking for extraterrestrial intelligence on far-away planets look for mathematical patterns of signals from space. Click here to read about the Search for Extraterrestrial Intelligence (SETI). Some of the SETI work is based on the assumption that math is somewhat the same throughout the universe. That is, SETI researchers tend to assume that any intelligence that creates a civilization that can broadcast and receive electronic signals necessarily has begun with counting and has developed math somewhat akin to our math.

Rote Memory Sometimes Fails Us

> "The strongest memory is not as strong as the weakest ink." (Confucius; Chinese thinker and social philosopher, whose teachings and philosophy have deeply influenced Chinese, Korean, Japanese, Taiwanese and Vietnamese thought and life; 551 BC-479 BC.)

One way to learn math is via rote memory. Another way is through understanding and being able to "figure it out." Here is an example. If I ask a representative sample of English-speaking adults in the U.S. what 9 times 7 is, some will give me a response other than 63. So, even though at one time in their lives they memorized that 9 x 7 = 63 and accepted that math fact as having great credibility, their memory is not perfect.

However, if I indicate to an adult that the answer they have provided is incorrect, most can "figure out" a correct answer—perhaps by counting by sevens or nines, perhaps by drawing an array of seven objects by nine objects and counting them, and perhaps by other methods.

This example illustrates a very important aspect of math. One can memorize math facts, definitions, formulas, and other math information. Unfortunately, our rote memory sometimes fails us. Indeed, this is so common that in some math testing situations, students are provided a list of formulas that might be relevant to the test questions. The test is designed to move beyond use of rote memory. Some math test situations allow students to use calculators.

In math—perhaps more so than in any other discipline—there are a variety of methods we can use to check our math rote memory and also to check the results we obtain when solving math problems. This checking process might be done mentally, by use of pencil and paper, by use of a calculator or computer, or by checking a credible source of math information. These checking processes can be thought of as informal proofs of correctness. Remember, however, that using a calculator in producing or checking an answer does not necessarily mean the answer is correct. The electronics of the calculator may be broken or the calculator user may have made a keyboarding error!

Some Math and Non-math Examples

Here are some statements that involve numbers. Think about the validity and credibility of each. Do some of the statements seem to you to have more validity and credibility than others?

1 There is no largest positive integer.

2. Seven is a lucky number and 13 is an unlucky number.
3. There is no positive integer which, when multiplied by itself, gives an answer of 7.
4. A math problem either has exactly one correct solution, or it has no correct solution.
5. If the three sides of a triangle in a plane have lengths of 3, 4, and 5 respectively, then the triangle is a right triangle (that is, one of the angles in the triangle is 90 degrees).

The statements 1, 3, 4, and 5 are all "pure" math statements. Their truth or falsehood is not a matter of opinion. Each can be (mathematically) proven to be a correct or incorrect statement.

For example, consider statement 3. You might observe that 1 x 1 = 1, 2 x 2 = 4, and 3 x 3 = 9. As you consider subsequent integers such as 4, 5, 6, and so on, the square of each is larger than the square of the proceeding, and the squares are increasingly larger than 7. Most people are convinced by this type of argument (this proof) that statement 3 is correct. So, statement 3 has the highest level of validity that math can produce. That is, mathematicians consider the arguments just given as an objective math proof.

However, although the two assertions in statement 2 contain some numbers, the statements are not pure math statements. They are statements that some people believe and some people do not believe. These statements cannot be proved or disproved by the use of mathematical reasoning. Each has nothing to do with math other than the fact that it happens to involve a positive integer in its statement. Do you believe in lucky and unlucky numbers? Have you ever told someone that a particular number is lucky and a different one is unlucky? If you do this, you are sharing a personal (subjective) belief. Click here to read more about lucky numbers.

Statement 1 is a rather deep, abstract aspect of mathematics. In grade school you probably were told that the positive integers go "on and on forever." You may have been introduced to the word *infinity* and/or the symbol ∞. We have evidence that mathematicians thought about and explored various aspects of ∞ nearly 2,500 years ago.

Can you prove statement 1 in a manner that meets your personal standards of "proof"? Can you explain your proof so that it is credible (understandable) to your peers or to students you teach?

Statement 5 is a more complex math challenge. In your mind, you may relate it to the Pythagorean theorem that you encountered in a Plane Geometry course you took a number of years ago. Quoting from *The History of Mathematics* (Allen, 2014):

> Arguably the most famous theorem in all of mathematics, the Pythagorean Theorem has an interesting history. Known to the Chinese and the Babylonians more than a millennium before Pythagoras lived, it is a "natural" result that has captivated mankind for 3000 years. More than 300 [different] proofs are known today.

So, the Pythagorean theorem is mathematically correct. However, it is a statement about a triangle in a plane. It is not correct for triangles drawn on the surface of a sphere or on the curved surface parts of a cylinder such as a "tin" can. One must use great care in taking results from math and applying them to problems that do not satisfy the assumptions of the math results.

Statement 4 Is an Incorrect Math Belief

Consider statement 4 in the list given in the previous section. Do you believe it is a correct statement? Can you prove that it is a correct (or incorrect) statement?

Actually, it is believed to be true by many students, but it is definitely incorrect. It is easy to disprove this assertion. To disprove a math assertion, one only needs to find one counter example.

Consider the "exactly one correct" answer assertion. Think about the math problem of finding a positive integer greater than 1 and less than 10. Hmm. That's easy enough. The integers 2, 3, … 9 are all correct answers. This math problem has more than one correct answer. So, we have proved that the assertion is incorrect. The next time you hear a student say that in math the goal is to find **the** correct answer, I hope that you will make use the opportunity to correct the student's misunderstanding.

Is it possible that a math problem has no solution? Consider the math problem of finding a positive integer that is greater than 4 and less than 5. Hmm. This problem has no solution. (Think about your thinking as you work to convince yourself of this assertion.) So, through these simple examples you are probably convinced that a math problem may have no solution, one solution, or more than one solution.

Undecidable Math Problems

This short section touches briefly on a relatively modern and very deep aspect of mathematics. There are *undecidable math problems.* Quoting from Bjorn Poonen's paper Undecidable Problems: A Sampler:

> A single [mathematics] statement is called undecidable if neither it nor its negation can be deduced using the rules of logic from the set of axioms [and definitions] being used.
>
> The goal of this survey article is to demonstrate that **undecidable decision problems arise naturally in many branches of mathematics**. [Bold added for emphasis.]
>
> In summary, a math problem may have no solution, one solution, more than one solution, or be undecidable.

Spend a little time thinking about whether this situation applies to some of the problems that people encounter in disciplines outside of mathematics. For example, we have problems such as hunger, homelessness, disease, bigotry, crime, sustainability, global warming, and so on. These

are not math problems, although people use math in attempting to deal with such problems. We can make progress toward solving such problems—but can any one of these problems be completely solved in the sense that we solve math problems and provide proofs that they are correctly solved?

Why Is Math One of the Basics of Education?

Reading, writing, and arithmetic (math) are considered the basics of education. Why is math in the list?

It is not because math is a human endeavor that has a long history, and that some people find math to be beautiful and a lot of fun. Rather, it is because math is so useful in our everyday lives. We use math to measure quantity, distance, time, and so on. If a "real world" problem can be represented as a math problem, then we may be able to build on the thousands of years of progress in math to help solve the real world problem.

Some real world problems are easily translated into math. Suppose that I can save $15 per week by making my lunch at home rather than buying it at a cafeteria. How much will I save in 12 weeks? In this question, we use 15 to represent $15, and we use 12 to represent 12 weeks. We solve the (pure) math calculation problem 15 x 12. We translate the result (180) back into an answer of $180.

Think about the complexities involved in this simple "story" problem. What is money, what is a dollar, what is a week, and what does it mean to save money? The arithmetic calculation is the simple part, and we can be quite comfortable in the math result that 15 x 12 = 180. Have we actually solved the real world problem?

Perhaps with all of that extra (non-spent) money in my pocket I buy a candy bar from a candy machine each day at work. Now I need to know how many days I work in a week, and what candy bars cost. And perhaps the machine sells candy bars of varying prices. Perhaps I should also be considering other real world issues such as the fact that carrying my lunch makes a significant change in my social life, and the daily candy bars may cause me to gain weight. My point is, the real world differs from the "pure" math world. Real world problems tend to be "messy."

Math teaching makes extensive use of story problems (word problems) that describe a problem that can be solved by the use of mathematics. Often the problems are over-simplified, such as the original version of the carrying lunch to work situation. Many students find that even the over-simplified problems are quite difficult. This suggests that many students find it difficult to do transfer of learning from "pure" math into applications of math. The statements "I can't do math," and "I hate math" usually come from students who have been taught rote memory approaches to learning math and who have not had much success in the transfer of learning from this rote memory math to math applications in the real world.

Final Remarks

The discipline of mathematics produces mathematical results (proven theorems and solved math problems) that have a very high level of validity. Such math can be very useful in representing and helping to solve problems in other disciplines. However, just because known (proven) math is used in helping to solve a problem in a discipline outside of math does not ensure the correctness or validity of the results.

Because math is so important in many non-math disciplines, students studying such non-math disciplines face the dual challenge of learning both their specific discipline and the necessary math. They also face the challenge of deciding on the validity and credibility of the results in their discipline of study and what role math plays in determining this credibility/validity.

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Chapter 4

IAE Newsletter # 152

Determining Validity in the Natural Sciences

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Confusing a Child's Mind

When I was quite young, an adult told me (facetiously, I hope) that the moon is made of green cheese. For me, this was a new piece of information that I didn't understand very well, and I filed it away in my head. Over a period of years I learned additional "facts" that my mind associated with the green cheese moon. These included the man in the moon, "blue" or moldy cheese, and still later that cheese that has not been aged very long is called green cheese. Still later, I watched television as the first man walked on the moon.

How does a young mind handle a steady stream of information with widely varying levels of validity and credibility? Humans have creative minds, and they seek explanations for what they observe in nature. Two thousand years ago, it was widely believed that the earth was flat, that the sun orbited the earth, and that the earth was the center of the universe. Children learned these "facts" from their parents and others. Their own observations did not provide obvious contradictions to what they were told.

I find the issue of whether the earth is the center of the universe and the sun orbits the earth to be particularly interesting. As scientists developed the telescope, theory of gravity, and calculus they were able to put together very strong arguments that the earth was not the center of the universe and that the sun did not orbit the earth. This led to major clashes between the established Catholic Church and these scientists.

Scientists eventually prevailed. But, even today many people believe that the sun orbits the earth. That is, it just does not seem credible to them that the earth orbits the sun. A person watches the sun "rise" in the east and "set" in the west. This observational data and vocabulary supports the contention that the sun orbits the earth. A research study funded by the National Science Foundation in 2012 and reported on in 2014 indicated that about a quarter of adults in the United States and a third of adults in Europe believe that the sun orbits the earth (Grossman, 2/16/2014).

Adult minds are also confused by the steady barrage of so-called "facts" that we receive through the media as well as directly from other people. What do you believe when you hear a politician giving an opinion about the correctness of forecasts of global warming and then telling us what we should do about the situation?

One thing you can do is to make use of the Web to investigate the correctness of the "facts." My 12/11/2014 Google search of *fact checking* produced more than 13 million hits. I refined my search to *fact checking global warming* and got over 270,000 hits.

Of course, we still face the difficulty that a fact-checking person or organization may be strongly biased in their research and reporting efforts. I spent some time exploring the Tampa Bay Times PolitiFact website available at http://www.politifact.com/truth-o-meter/article/2014/sep/23/10-fact-checks-about-climate-change/. Quoting from the site:

> Earlier this year we looked at a detailed video from Louisiana congressional candidate Lenar Whitney, who repeated the assertion that climate change is a hoax. We found—as we have before—that there's an overwhelming consensus among respected scientists that human-caused global warming is real. In this fact-check, we looked at some of Whitney's supporting evidence to argue that global warming is a hoax and found that it was weak. We rated her statement Pants on Fire.

Evidently "Pants on Fire" comes from the commonly used children's expression, "Liar, liar, pants on fire." Notice the statement, "there's an overwhelming consensus among respected scientists that human-caused global warming is real." Does an "overwhelming consensus" contribute to the validity and credibility of natural science research results?

Validity and Credibility in the Natural Sciences

How are validity and credibility determined for results developed by researchers in the natural sciences? See Understanding Science (n.d.) for a brief answer to the question, "What is science?" The natural sciences include disciplines such as astronomy, biology, chemistry, computer science, medicine, physics, and so on. Mathematics is usually considered to be a science, but it is not considered to be a natural science.

Natural scientists work to develop very accurate descriptive and predictive patterns, characteristics, and models of our natural world. The goal of researchers in the natural sciences is to discover results that stand the test of time and that others can confidently build upon (Moursund, 2015). For example, the current science of the earth orbiting the sun and the moon orbiting the earth is sufficiently accurate that it allows us to predict the time of sunrise, sunset, eclipses of the sun, and eclipses of the moon very accurately many years in advance.

As illustrated in the incorrect theory about the sun orbiting the earth, some results produced by scientists become widely accepted but eventually are proved to be wrong. Even though today's natural scientists make extensive use of valid mathematics, this by no means ensures that their pronouncements are always correct.

So, here are two important questions about natural science information:

1. How is the validity of information from natural science researchers determined?
2. How does holding a strong belief in and acting on natural science information that has little or no validity affect both the people taking such actions and other people?

Validity of Natural Science Research-based Information

Isaac Newton was one of the most brilliant science and mathematics researchers of all time. Among other things, he developed a *theory of gravitation.* His theory states that any two objects in the universe that have mass attract each other, and it provides details on the strength of this attraction.

The word *conjecture* is often used to describe some information or ideas that one believes might be correct. Natural scientists and mathematicians often use *conjecture* to describe an idea

or belief that they have thought carefully about, but have not produced valid arguments to support that their belief should be considered a valid theory.

The term *theory* is used to describe a conjecture that has been carefully studied and is supported by "strong" evidence that others can examine. This allows others to repeat the research and conduct additional related research.

Newton conjectured that there was a force which we now call gravity and that it applied to every particle of mass in our universe. His research on this topic produced a theory that was very precisely stated as a formula in the notation of mathematical physics. Many years of research efforts to find counter examples to this theory and many findings/discoveries based on use of the theory have led science researchers to believe very strongly in the correctness of Newton's *theory of gravitation.*

Scientists use the term *law* to describe a theory that has undergone such scrutiny for many years—one that has stood the test of time (Physical Laws, n.d.). Newton's 1687 conjecture became a theory and is now called the *Universal Law of Gravitation.* This law is certainly not like a law created by a governing body of politicians and enforced by a police force. Moreover, even though it has been carefully tested and applied for hundreds of years, this does not ensure that it is completely, absolutely, for sure valid. Perhaps it is safe to say that it has about the highest level of validity that discoveries in science can have.

However, in the early 1900s, Albert Einstein developed the *general theory of relativity.* It turns out that Newton's Universal Law of Gravitation is very close to correct for massive bodies. However, quoting from Universal Gravitation (n.d.):

> Newton's law has since been superseded by Einstein's theory of general relativity, but it continues to be used as an excellent approximation of the effects of gravity. Relativity is required only when there is a need for extreme precision, or when dealing with very strong gravitational fields, such as those found near extremely massive and dense objects, or at very close distances (such as Mercury's orbit around the sun).

Einstein's 1905 formula $E=mc^2$ has served the natural sciences well for over a hundred years. It has not yet achieved the status of being called a law of science. Many attempts to disprove the theory have failed, but this does not mean that eventually someone will succeed in disproving the theory. See, for example, Daniel Stolte's article on testing Einstein's theory (1/4/2013).

Acting On or Failing to Act On Natural Science Theories

Medical researchers discovered that the disease called scurvy is caused by a severe lack of vitamin C. Quoting from the *Encyclopaedia Britannica:*

> Although accounts of what was probably scurvy are found in ancient writings, the first clear-cut descriptions appear in the records of the medieval Crusades. Later, toward the end of the 15th century, scurvy became the major cause of disability and mortality among sailors on long sea voyages. In 1753 Scottish naval surgeon James Lind showed that scurvy could be cured and prevented by ingestion of the juice of oranges and lemons.

This is an excellent example of a medical research study leading to widespread use of the findings. It didn't make any difference whether an individual sailor believed that the research and medical treatment were either credible or valid. The non-believer who avoided getting the

necessary vitamin C could become ill, and perhaps die. Fortunately, scurvy was not transmitted from person to person, so those who got scurvy did not infect others.

Now, consider the situation of various diseases that have been well researched and that we now know are spread via bacteria and viruses. Researchers have developed vaccines for some of these diseases, and treatments using antibiotics and antivirals for others. This presents the medical world and all of us with challenges such as:

- If enough people fail to get vaccinated, they will be at risk of becoming ill, and thereby contributing to spreading the disease. Those at risk include people who did not get vaccinated for personal reasons/beliefs and those did not get vaccinated for medical reasons.

  This topic is much more complex than the previous sentences suggest. Vaccines are not 100% effective. But, a vaccine does not need to be 100% effective to prevent an epidemic spread of a disease. Each person for whom a vaccination proves ineffective is like a person who failed to get vaccinated. It the number of "failures to be effective" and the number "not getting a vaccination" is above some critical level, a disease can rapidly spread and perhaps even go epidemic.
- Over-use or inappropriate use of the drugs can help facilitate genetic modifications in the bacteria and viruses, and eventually make the drugs ineffective. This puts a great many people at risk.

Two Examples of Current Major Problems in the Natural Sciences

People in our world are routinely faced by science-related problems for which our current knowledge of science cannot provide definitive, "for very, very sure" answers. This short section uses global warming and Ebola to illustrate such challenges.

Global Warming

As noted earlier, a high percentage of scientists who have the scientific and technical knowledge to understand global warming research believe that global warming is occurring and that humans are one of the major causes. Forecasts of the effects that this warming will cause are scary!

Global warming is very complex because it involves so many variables acting over a long period of time. The computer models that have been developed in studying this situation do not have the credibility of Newton's law of gravitation or Einstein's theory of relativity. Moreover, weather forecasting is a very complex problem—much more difficult than accurately forecasting the time of tomorrow's sunrise or sunset at a specified place on the earth's surface.

There is considerable agreement among researchers that, if we are going to take action to decrease the level of global warming that is likely to occur, we need to be taking action now. However, many individuals and nations do not believe that statements about global warming are credible—they **do not accept the credibility of the researchers and/or the validity of the research studies** in the field of global warming.

So, from my point of view we have a situation in which:

1. We have a theory of global warming that is widely believed by "experts" but is disbelieved by many, and has not yet had the time to undergo the scrutiny of researchers over a long period of time.

2. Failure to take significant actions now may well prove disastrous to hundreds of millions of people over the current century.
3. We have good evidence of successful worldwide cooperation in medicine—for example, in dealing with smallpox and polio. The world's record in addressing many other global problems is "spotty."

A number of years have passed since leading scientists began to sound the warning (Climate Change, n.d.). Evidently we have passed the point of no return on the melting of some of the polar icecaps. Now, (finally, at last) a number of countries are beginning to show signs of taking action that can mitigate the still worse situations that are on the horizon (Gillis & Chang, 5/12/2014).

Ebola

Ebola is a terrible disease that is spread by contact with bodily fluids. It is very contagious and has a high mortality rate. This disease could potentially kill many millions of people. Evidently a large number of the West Africans who are currently most at risk believe that Ebola is a hoax (McCordic, 8/18/2014). However, the United Nations and a number of countries capable of providing aid are very convinced of the dangers of Ebola and are providing significant amounts of medical and humanitarian aid.

It now appears that good progress is being made in developing Ebola vaccines that can help prevent Ebola, and drugs that will be effective in treating Ebola. However, even if effective vaccines and drugs are developed, the world still faces the problem of getting widespread acceptance of their use.

A Source of Free Science Books

The National Academy of Sciences produces reports on a wide range of science topics. Quoting from their website:

> The National Academy of Sciences (NAS) is a private, non-profit society of distinguished scholars. Established by an Act of Congress, signed by President Abraham Lincoln in 1863, the NAS is charged with providing independent, objective advice to the nation on matters related to science and technology. Scientists are elected by their peers to membership in the NAS for outstanding contributions to research.

The National Academics Press is the publication arm of the National Academy of Sciences. Quoting from their website:

> The National Academies Press (NAP) was created by the National Academy of Sciences to publish the reports of the National Academies of Sciences, Engineering and Medicine, operating under a charter granted by the Congress of the United States. The NAP publishes more than 200 books a year on a wide range of topics in science, engineering, and medicine, providing authoritative information on important matters in science and health policy.

The NAP book, *On Being A Scientist*, is one of over 5,000 books available for free download from the National Academy Press. (Committee on Science…, 2007). Here is a description of the book:

> **The scientific research enterprise is built on a foundation of trust. Scientists trust that the results reported by others are valid.** Society trusts that the results of research

> reflect an honest attempt by scientists to describe the world accurately and without bias. But this trust will endure only if the scientific community devotes itself to exemplifying and transmitting the values associated with ethical scientific conduct.
>
> *On Being a Scientist* was designed to supplement the informal lessons in ethics provided by research supervisors and mentors. The book describes the ethical foundations of scientific practices and some of the personal and professional issues that researchers encounter in their work. It applies to all forms of research—whether in academic, industrial, or governmental settings—and to all scientific disciplines. [Bold added for emphasis.]

Final Remarks

Research and development in the natural sciences have contributed immensely to improvements in quality of life and standard of living in our world. That is one of the driving forces that lead scientists to devote their lives to advancing the frontiers of their fields of study.

However, there are many people who do not understand and/or who do not accept the validity and credibility of results from research in the natural sciences. This is a challenge to our informal and formal educational systems. History suggests that, over time, the validity of research in the natural sciences will eventually prevail with a dominant majority of people.

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Fact Checking. My 10/2/2015 Google search of *fact checking websites* produced over 21 million results. Here are a four examples (in alphabetical order) of sites listed near the top of the Google results:

- FactCheck.org. See http://www.factcheck.org/. Quoting from the Wikipedia https://en.wikipedia.org/wiki/FactCheck.org:

  FactCheck.org is a nonprofit website that describes itself as a non-partisan "'consumer advocate' for voters that aims to reduce the level of deception and confusion in U.S. politics". It is a project of the Annenberg Public Policy Center of the Annenberg School for Communication at the University of Pennsylvania, and is funded primarily by the Annenberg Foundation.

- OpenSecrets.org. Center for Responsible Politics. See https://www.opensecrets.org/. Quoting from the website:

  The Center for Responsive Politics is the nation's premier research group tracking money in U.S. politics and its effect on elections and public policy. Nonpartisan, independent and nonprofit, the organization aims to create a more educated voter, an involved citizenry and a more transparent and responsive government.

- Snopes.com: Rumor Has It. Retrieved 10/2/2015 from http://m.snopes.com/whats-new/. Quoting the site:

"Snopes.com is one of the best online resources that debunks Urban Legends and Rumors on a huge number of topics. It's run by Barbara and David P. Mikkelson, who established this website in 1995."

- *The Washington Post.* The Fact Checker column in *The Washington Post* began in 2008 and is written by Glenn Kessler. He has many years of experience as The Washington Post's State Department Reporter and as a business editor. The site covers a number of topics For example, quoting form the site:

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Chapter 5

IAE Newsletter # 153

Determining Validity in Computer and Information Science

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> "To err is human, to really foul things up requires a computer."
> (Bill Vaughan, American columnist and author; 1915-1977.)

In August, 1945, while Grace Hopper and some associates were working at Harvard on an experimental [computing] machine called the Mark I, a circuit malfunctioned. A researcher using tweezers located and removed the problem: a 2-in. long moth. Hopper taped the offending insect into her logbook. Says she: "From then on, when anything went wrong with a computer, we said it had bugs in it." (Google Doodle, n.d.)

Computer and Information Science (CIS)

> "Computer Science is no more about computers than astronomy is about telescopes."
> (Edsger Dijkstra; Dutch computer scientist; 1930-2002.)

The discipline of Computer and Information Science (CIS) is usually categorized as a science. However the quotation from Edsger Dijkstra given above captures the essence of the situation. Computers are general-purpose tools. I like the analogy of CIS being somewhat akin to reading and writing. Literacy is far more than writing symbols and the human mind learning to decode these symbols. CIS is now a ubiquitous aid to the human mind in every discipline of study.

Computers

A computer is a *machine* designed for the input, storage, automatic processing, and output of information. The "automatic processing" is done by the computer hardware following a detailed step-by-step set of instructions called a computer program (the computer software). Software reflects the thinking and problem-solving abilities of the programmers. However, the area of CIS called Artificial Intelligence or Machine Intelligence has progressed to the level that quite a bit of the "thinking" that goes into developing both hardware and software is aided by computers (Markoff, 12/15/2014). In a sense, computers are helping to develop their own hardware and software, and they are getting better at it!

Computers have become more reliable and more powerful over the years—but most people have come to understand that computers are not infallible. Indeed, in our everyday use of computers we have come to expect that computer software and hardware may contain "bugs" that can lead to the computer producing incorrect results.

Computer hardware can be designed to have a very high level of validity (very nearly but not completely error free). This topic is discussed later in this chapter.

While some computer programs are bug free, we routinely use computer programs that are not bug free. So, use of these programs on even the very best computer hardware does not guarantee valid results.

Incorrect (invalid) computer results can be caused by bugs in the hardware, bugs in the software, cosmic rays that change a bit of data stored in a computer memory (Dunietz, 5/9/2014), incorrect data/information, keyboarding errors, and/or the misreading, misunderstanding, or misuse of the results.

With all of these potentials for producing invalid results, how much faith should you place in the work computers perform for you and the information they provide to you? Just because a computer is used to help solve a problem does not guarantee that the results are valid or credible.

Validity in Computer and Information Science

Many of today's college and university CIS departments had their beginning in Mathematics and/or Engineering departments. The software and information science aspects of CIS are closely related to mathematics, and computer hardware is well rooted in Engineering and Physics. Should we expect results produced by computers to have a level of validity and credibility approximately the same as those we expect from mathematics, engineering, and the natural sciences?

The answer is no. In chapter 3, we differentiated between results in "pure" math and the results when math is used to represent and help solve problems outside the discipline of math (Moursund, 12/15/2014). We noted that strictly within the discipline of math, the math results have a very high level of validity. However, results produced by using math in other disciplines, such as applying statistics in educational research, do not gain automatic validity just because math is being used.

The next four sections explore various types of threats to the validity of results produced when computers are used.

Information Science

As noted earlier, a computer is a machine designed for processing *information*. It is common to use the term information to refer to a combination of data, information, and knowledge (Moursund, 2015). Nothing in these terms suggests the data, information, or knowledge being processed is correct (valid).

Quoting from the Wikipedia:

> An early definition of Information Science (going back to 1968, the year when the American Documentation Institute renamed itself as the American Society for Information Science and Technology) states:
>
> "Information science is that discipline that investigates the properties and behavior of information, the forces governing the flow of information, and the means of processing information for optimum accessibility and usability. It is concerned with that body of knowledge relating to the origination, collection, organization, storage, retrieval, interpretation, transmission, transformation, and utilization of information. This includes the investigation of information representations in both natural and artificial systems, the use of codes for efficient message transmission, and the study of information processing devices and techniques such as computers and their programming systems. It is an

> interdisciplinary science derived from and related to such fields as mathematics, logic, linguistics, psychology, computer technology, operations research, the graphic arts, communications, library science, management, and other similar fields. **It has both a pure science component**, which inquires into the subject without regard to its application, **and an applied science component**, which develops services and products." [Bold added for emphasis.]

As a pure science, validity of results in information science are similar to the validity of results in mathematics and the natural sciences. However, when information science is applied to real world problems, we find the same types of difficulties as when math is used to help solve real world problems.

I routinely make use of a search engine to look up information on the Web, despite knowing the Web contains a great deal of information that is not correct. The statement Garbage In, Garbage Out (GIGO) applies. For example, I make frequent use of the Wikipedia. But, I do so with full knowledge that it contains errors and biases. I evaluate what I read in terms of my knowledge and understanding. If I encounter something that just doesn't seem plausible or right, I check other sources. I am reminded of Thomas Jefferson's statement, "The price of freedom is never ending vigilance."

Errors in Computer Hardware

I use a medium priced desktop computer that is a couple of years old. The electronics of this hardware can carry out more than a billion operations (such as addition or multiplication) per second. Suppose such a computer makes a hardware error an average of once per 10 trillion operations it carries out. Hmm. An hour is 3,600 seconds. In 10 hours this machine could carry out well over 30 trillion operations—and would be quite likely to make an error. Are you comfortable about the thought of flying in an airplane that is on automatic pilot, or riding in a driverless car, guided by a computer with this error rate?

Of course, there are ways to reduce hardware errors. The combination of hardware and software can be designed to detect and/or circumvent many of the possible errors.

Moreover, the hardware can contain considerable redundancy. For example, suppose that the automatic pilot in an airplane or rocket ship actually contains three completely independent computers, each doing all of the computation. If all three agree on an action to be taken, one can have a great deal of confidence that no hardware error has occurred. If two of the three computers agree, the "trio" computer system can be programmed to go ahead and use the result, but also to inform the human pilot that something may be going wrong, and that human intervention is advised.

In summary, hardware errors can and do occur in computers. However, in situations in which an error might produce a catastrophically disastrous result, hardware and software can be designed so that such errors are very infrequent. Absolute perfection cannot be guaranteed.

You may have noticed that I focused on errors in the computational hardware. Suppose that you go to an ATM machine to make a cash withdrawal. The ATM machine contains a large supply of $20 bills, and it automatically counts off the correct number of bills from its supply. Such "paper handling" machines are quite accurate, but they can make mistakes. However, suppose an error does occur and you get too few or too many $20 bills. This is not what one would call a catastrophically disastrous result. Typically, the error rate in such machines is far

lower than the error rate of an average human clerk in a store counting out change. In addition, a bank has good procedures in place to handle such "minor" problems.

Bugs in Data and Data Input

My hand-eye coordination leaves much to be desired. When I am using a simple handheld calculator, I often make reading and/or keyboarding errors. Even when the calculator hardware and software work perfectly, the results from processing incorrect input are usually incorrect output.

GIGO describes this situation. Calculator and computer users need to be constantly alert to the possibility that they are making input errors and/or that the data itself is incorrect. Mental estimation of plausible/reasonable results is a valuable aid to detecting such errors.

Now, let me provide a variation on this problem. With a handwritten check endorsed with my name and "for deposit only," I go to an ATM machine. The machine takes my check, finds and reads the numbers giving the amount of the check, and deposits it in my account. Hmm. How good is the handwriting of the dollar amount on the check, and how good is the machine's number recognition system? Poor handwriting and/or poor handwritten number recognition skills can lead to an error.

Fortunately, the ATM machine shows you the results of its check reading and asks you to verify if its result is correct. This provides an excellent example of a human/machine interface in which both the human and the machine bear joint responsibility for the results that are produced.

However, now consider a voice input system that takes natural language input and changes it into printed text. A very good system might well produce 95 percent accuracy. That means that if you speak a short paragraph, say 50–60 words, an error is quite likely to occur. The voice input system may well include a spelling checker so there are no incorrectly spelled words in what it produces for you. But, the correctly spelled word may not be the word you said. You know about homonyms, words that sound nearly the same, so this is an easy error to have occur. Also, the fact that people have widely varying accents can cause added difficulty in converting speech to text.

This type of problem is considerably exacerbated if you are using a voice input *language translation system*. Language translation by computers is a very difficult task. Voice input and language translation systems are good enough to be quite useful. However, they are far from perfect. My message is: "User beware. Computer language text input and voice input translation systems now widely used make frequent errors."

Errors in Computer Software

I am pleasantly surprised when I spend a day using my computer and do not have a "crash" in an application I am using and/or in the operating system. I am using very long, complex programs, and such programs are very likely to contain bugs.

When the word processor I am using crashes, I am very, very annoyed. Of course, the computer system is often able to recover most of my document, and I can instruct my word processor to automatically make a backup copy every few minutes. So, a combination of proper programming of the computer and proper actions on my part can usually alleviate most of the pain from such crashes.

In some sense, a computer program is like a math proof. But, operating systems and a number of computer application programs are millions of instructions in length. Such a program may involve a hundred or more programmers and program testers working on its development over a period of years. I have considerable confidence in my statement that "they contain errors."

Final Remarks

Computer and Information Science is a powerful mind tool. Today's children are learning quite a bit about CIS because of its prevalence in their everyday lives. But, you can make the same statement about reading, writing, arithmetic, science, and the other areas of human knowledge and skills that are part of our K-12 school curriculum.

The various types of media and communication made possible by the use of CIS are exacerbating the challenge of dealing with problems in the validity and credibility of the information that we use while interacting with each other, making personal decisions, voting, purchasing goods and services, and so on.

Our schools need to integrate appropriate use of CIS into each discipline students are studying. Schools need to place considerable increased emphasis on the validity and credibility of the course content and the tools—such as CIS—of the disciplines being studied. One does not acquire the needed contemporary level of knowledge and understanding of these disciplines through osmosis. Organized teaching and learning help!

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Part 3

Assessing Credibility

The validity achieved by scientific objectivity arrived relatively recently in human life. We functioned well for many millennia with subjective assessment and decision-making. Earlier in this book we noted:

> *Credible* is an adjective meaning believable, plausible, tenable, likely, probable, reasonable, and so on. We talk about the credibility of a person in terms of the credibility of the person's allegations and claims. A person who routinely makes invalid allegations and claims is considered to not be credible. A number of websites do fact checking, and people can make use of these sites as an aid to determining the credibility of a person.

Part 3 of this book examines credibility in various disciplines of study. None of these chapters discusses cooking. But, think about recipes in a cookbook. The people who created the recipes were satisfied that they were good recipes. The people creating the cookbook are asserting that they are good recipes. It is appropriate to discuss the subjective credibility of the recipe creators and the authors. However, even a very high subjective credibility rating does not mean that every recipe will prove satisfactory to a particular cook or to the people eating food prepared by this cook.

The four chapters in Part 3 suggest that subjective assessment is still sufficient in many areas of human life that are often called the humanities and arts, but also in friendships and most other social exchanges.

Chapter 6

IAE Newsletter # 163

Determining Credibility in Religion

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One of my students came to me after class and asked if we could talk for a moment. As Roger and I walked toward my office he shared his concern. He was seriously dating a young Jewish woman, and he was a committed Christian. Since Jesus was a Jew, and since we share much of the Bible with the Jews as our authoritative text, don't Jews and Christians basically believe in the same God? And if so, would serious problems emerge if they got married?

I explained the commonalities between the two religions as well as their essential differences. The Jews, I explained, do not accept the New Testament as valid revelation from God. The Jewish tradition has rejected Jesus' message of salvation in God's coming Kingdom as a pure gift, rather than as the reward for keeping the Mosaic Covenant. Roger left my office dejected, because he had hoped that I might affirm his view that he and his fiancée believed essentially the same thing about a saving relationship with God. Similar religious beliefs, of course, do not necessarily define a successful marriage.

This chapter directly addresses the subject of validity and credibility in religion, and especially the theological bases that various religions use to assure their adherents that their beliefs are credible. Readers may also be interested in chapter 12, where the noted biologist E.O. Wilson discusses some of his insights into biology and religion.

The credibility of claims about religious truth is more complex and difficult than claims about scientific truth because a spiritual faith in a god is more obviously an existential matter that involves one's whole life, while the scientific enterprise can generally be seen as more limited to the rational cognitive investigation of causation within the natural realm.

However, in reality all of life involves some faith or trust. We trust environmental phenomena, other people's behavior, and received information that goes beyond absolute evidence. For example, a given bridge may hypothetically warrant a high level of confidence in its ability to hold you and your vehicle while driving over it. However, driving over that bridge is an existential act of faith; the reasonable probabilities are never 100%, whereas actually driving over the bridge is 100% existential commitment. Some faith or trust is actually implied in choosing to continue living at all; religious faith involves trusting in some transcendent spiritual reality.

The assertion that science is based on evidence derived from rigorous, objective, rational inquiry, while religion is based on unexamined authority, dogmatic pronouncements, subjective experience and blind faith that allows for no debate or inquiry, simply does not hold up under critical examination. The old Baconian model, according to which science "objectively" examines data that are independent of any beliefs or theories, and progresses strictly due to better

equipment and investigative techniques, is no longer tenable. Some trust or faith in an existing scientific theory, with its assumptions, definitions, rules, etc., will determine in advance what evidence will count as credible. Also in science then, as in other realms of inquiry, including religion, "believing is seeing."

Religious faith normally requires some form of evidence or corroborative grounding, and that evidence may be tested for its credibility. Four bases generally are called upon to support the credibility of most religious claims: religious writings (commonly called Scriptures), tradition, reason, and experience.

a. *Religious writings/Scriptures* may involve direct recordings of purported divine revelation, or records of divine action in history. Dealing with any Scriptures or religious texts involves interpretation, though some religionists may deny that they are interpreting, claiming rather to be reading their religious texts just as God dictated them. In any case, religious texts may make references to nature, history and logical arguments that can be tested for their credibility. For example, biblical archaeology tests the credibility of references to ancient locations and events. It was originally expected by rationalist scholars to debunk biblical references, but in fact has in many instances validated references to locations such as ancient Jericho.

b. Religions have their *distinct traditions,* often involving the appearance of a spiritual leader who is the founder of that religious tradition. One thinks of figures such as Mohammed, Buddha, Moses and Jesus. Their Scriptures generally arise in relationship to these leaders and the traditions growing from them. Their tradition continually transmits, develops, interprets, and embellishes the earlier Scriptures and traditions of the given religion. Again, truth claims are often embedded in these traditions, which must be tested for their veracity. For example, historical research has continued to unfold the complexities and nuances of the second temple period of Judaism, around the time of Jesus.

c. *Reason* generally develops, solidifies, tests, and modifies the Scriptures and developing traditions, though some religions involve reason and logic more explicitly and intentionally than others. All religions can be described in cognitive terms, and most religions have doctrinal and/or catechetical formulations that express and define their specific and unique truth claims. Such claims can be examined and evaluated for their inherent logic and credibility. Reason and logic, for example, challenge the Mormon claims of a lost tribe of Israel that landed in Mexico, and then migrated north to what is now upper New York State.

d. Finally, *experience in real life* corroborates the credibility of the given religion. The chief claims of the truth of various major living religions are validated by the experiences of their followers. Without that the religion would cease to exist. These experiential evidences of the various religions can be compared for their cogency and credibility. For example, the Buddhist understanding of life as pain and suffering can be tested phenomenologically against the daily life experiences of those who follow Buddhism.

Some religions are more contingent upon corroborating evidence than others, but all religions can be evaluated to some extent on the rationality and credibility of their beliefs. Christianity may be the most dependent of all the major religions upon the credibility of its claims, and of all religions is therefore most vulnerable to falsifiability. If Jesus did not teach what the Bible claims

he taught; if he did not do the miracles credited to him; if he did not die on a cross and rise again as claimed by Christianity; then Christianity was founded upon misrepresentation and/or misinterpretation. While ultimately all religious faith goes beyond any proofs or evidence from the four avenues of support discussed above, some evidentiary basis must exist for any given religion, evidence that can be examined and weighed against the truth claims of other religions and other disciplines. It is noteworthy that some common elements can be found in virtually all of the world's major religions—sacred spaces, worship rituals, prayer or meditation, spiritual leaders, sacred writings, and universal moral precepts. This could lend weight to the credibility of some deeper spiritual influence behind all of the major religious traditions, with all of their diversity.

This does not mean that people will continue to adhere to a religion only on the basis of its credibility. Given the cultural, familial and tribal pressures to remain within a particular religious tradition, a person may have compelling reasons to persist in practicing a religion that can otherwise be shown quite clearly to be founded on false claims, fiction, or specious logic. It still remains that the truth claims of the various world religions (and of the denominations or branches within a given religion) are rooted in a fundamental theistic belief in a higher or deeper spiritual reality. This belief transcends any evidence or proof that would convince an atheist. Similarly, an atheistic belief that no higher spiritual reality exists is a faith position that goes beyond any evidence or proof that would convince a theist. Nonetheless, religious beliefs generally are founded upon some evidence and logic that can be evaluated for the credibility of their claims.

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Chapter 7

IAE Newsletter # 164

Assessing the Credibility of Poetry and Poets

Lawrence Sylwester
Apex Learning

Roughly two hundred years ago the renowned poet John Keats finished his famous poem, *Ode on a Grecian Urn* with this statement:

> "Beauty is truth, truth beauty," – that is all
>
> Ye know on earth, and all ye need to know.

Now, I have nothing against John Keats, indeed, he was a wonderful poet, but the first thing we have to ask ourselves is: how does *he* know? Who made John Keats, barely even 24 years old when he wrote *Ode on a Grecian Urn* (Keats, 1819), the defining expert on what's Beauty and what's Truth? His youthful arrogance seemingly resolving the entire issue. That's *all ye need to know,* so Case closed. Mystery solved. Move along now, nothing left to see.

But isn't this Truth and Beauty business the sort of question that wise and deep-thinking people have been pursuing, examining, and debating for centuries, long before Keats, and still continue to do so two hundred years later?

Capturing truth and beauty has been elusive not only for Keats's fellow poets, both then and now, but also for philosophers, songwriters, novelists, dancers, actors, artists, photographers, playwrights, screenwriters, and everyone else who sets out to tackle the challenge of subjectively expressing reality and humanity and human emotion through art and literary narrative. But does Robert Frost *really* know that fences make good neighbors more than our own neighbors, and does Paul Laurence Dunbar *really* know why the caged bird sings? Are we absolutely certain that Allen Ginsburg saw:

> …the best minds of my generation destroyed by madness, starving hysterical naked,
>
> dragging themselves through the negro streets at dawn looking for an angry fix,

Can Picasso be trusted to paint the truth (not to mention the beauty) of *Guernica*, and for that matter, what should we make of DaVinci's stab at *The Last Supper* or Michelangelo's *David* standing curiously naked in the Valley of Elah? I mean, were any of them even *there*? When and why does artistic representation of historical people and events transcend their beauty while at the same time maintain credibility? Why do we celebrate and revere such poets and artists as Keats and Michelangelo and not so many others? What sets them apart?

Or perhaps Holden Caulfield was on to something in *The Catcher in the Rye* when he derided all the phonies and phoniness that surrounded him. Perhaps we're not only surrounded by what others think of Truth and Beauty, but fooled by it as well. Remember that Keats was only 24 when he wrote *Ode on a Grecian Urn,* Michelangelo was 26 when commissioned to sculpt

David, and Ginsberg was 29 when he wrote *Howl*. Is youth, then, more credible than age; is youth, like Holden Caulfield, better equipped to see through the cultural fog of pretension and societal norms and call *bullshit*?

Today's TV shows and video games have joined the pursuit of credibility with their audiences and critics. For example, the producers, writers, and actors of *Downton Abbey* have managed to earn historical credibility with 10 million faithful viewers worldwide by capturing the lives, lifestyles, dress, mannerisms, and even the language of the residents of a 1920s English manor during historical and tumultuous times. Similarly, the developers of the *Madden NFL Football* video-game series have been wildly successful in recreating the plays, strategies, players, and action of a NFL game. As technology advances, and it has been at breathtaking speed, entertainment has become amazingly more realistic, and subsequently more credible.

But art and literature aren't being helped by these technological advances because *their* credibility isn't necessarily linked to realism. Rather, their credibility is more subjective, interpretative, and open to debate. Their work is so experimental and unique that fame and esteem frequently arrive only posthumously, such as with Vincent Van Gogh and Emily Dickinson. Conversely, many who enjoyed fame and success during their lifetime have since been labeled by art and literary critics as minor or inconsequential artists and writers who did little or nothing to advance their art, or paled in comparison to their lesser known contemporaries. Think of Antonio Salieri who had the horrible misfortune of being a composer in the same time and place as Mozart. When it comes to art and literature and music and dance it's often the stuff that's jarringly different that eventually eclipses the stuff that's comfortably familiar, and that's what endures as artistically significant.

Poetry, Poets, and Credibility

I don't know how many people still read and appreciate poetry these days, much less buy it, but judging by the ever-shrinking Poetry section in Barnes & Noble it's fair to say that the audience and market for poetry are rapidly drying up. Indeed, Salt, one independent and well-regarded British publisher, made the decision last year to no longer publish single-author poetry collections. Poetry thus might be one good example of something in which most people will have difficulty assessing credibility if we define *credibility* as being artistically and technically sound, intellectually challenging, emotionally honest, and frankly, believable. In other words, how does someone who knows little about poetry assess whether a poem is *good* and is this contributing to the decline of poetry as a marketable art form? Googling *credible poetry and poets* will elicit almost a million hits on those who write about the issue, yet who among *them* is critically credible? Ginsberg's critics, in fact, far outnumbered his fans when *Howl* was published in 1956, yet the poem would become an anthem for the Beat Generation who significantly changed the cultural landscape in the late 50s and into the 60s, and inspired a legion of young writers, musicians, and artists.

Harking back to Keats, Frost, and Ginsberg, why should we believe *them*, and what is it about their work that influences and endures? I'm sorry to say that I don't know what the answer is. That will forever be elusive. In any event, this is not the forum to examine the technical aspects of the hundreds of different forms of poetry, from the structurally terse and humble haiku to the book-length and chest-beating epic poem.

Art is subjective and interpretative, and earning credibility from both readers and critics can be a long evolving process. Some readers find comfort in traditional poetic forms and others find new and experimental poetic forms more compelling and honest and inspiring. Free-form and non-lyrical poetry, such as prose poetry, took a long time to be accepted by the literary community. Ginsberg's exceptional *Howl* was considered by many at the time to be vulgar and even pornographic, and not at all artistic and more notable for its shock value than for its poetic value.

Indeed, perhaps that is where this is all heading. Recognizing good poetry *should be* more like recognizing hardcore porn, which Supreme Court Justice Potter Stewart once said he'd recognize on sight without benefit of any established legal or artistic definition. Poetry is more instinctual and emotional than it is academic, and that's part of what makes it so difficult to define and to determine its credibility

Perhaps poetry should also have to comply to the same low standards of what makes a joke good or bad—that is, a poem that needs to be explained is not a good poem. A joke told with easy and familiar references will naturally trigger a hearty laugh. A good poem—and for that matter, a good song or painting—should trigger a natural, effortless, emotional, and intellectual response.

Poetry—and that includes melodic poetry accompanied by musicians—embodies the concept of subjective credibility. Maybe Keats was right after all, Truth and Beauty should be seen as not only interchangeable, but also indistinguishable from each other. Intrinsically entwined, like lovers on a Grecian urn.

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Note: Perhaps you're unfamiliar with some of the names and illustrations this article uses. We now live in an era in which Google searches can instantly provide credible information on unfamiliar people or examples.

Chapter 8

IAE Newsletter # 165

Gaining and Assessing Non-Fiction Credibility

Robert Sylwester
Emeritus Professor of Education
University of Oregon

I've always enjoyed writing. My earliest vocational goal was to write the kind of books that I enjoyed reading. I was always happy when teachers assigned a writing assignment and couldn't understand why many of my classmates felt differently. By the time I completed college, I had been editor of the school newspaper, yet another branch of writing.

My other interest was in biology, more specifically in ecology: how organisms interact to the mutual advantage of all.

I became a teacher, which I later was pleased to realize is an ecological profession. My first (1949) teaching assignment involved 36 students in a one room eight grade rural school. I also drove the bus, which gave us wheels for our many field trip explorations. All of this for $2000 a year. I thought that I could add to my income by writing. Editors disagreed. Everything I submitted for several years was rejected. I was confused. I had always done well in all of my school writing assignments. I had studied Strunk and White's classic *The Elements of Style* (1959) and was especially captivated by their appropriately phrased suggestion: "Avoid needless words". I thought that I had written what I taught: simple explanations of complex concepts.

My mind finally grasped the fundamental rule of successful non-fiction writing: We are the world's leading authority on our own studies and experience, and we don't really understand much of anything else. To the extent that others are interested in good descriptions of our understandings and conclusions, we'll probably be able to write successfully. I then gradually realized that my writing base was focused on the interactive ecological principles exemplified in teaching, so I started to write about that in both my graduate courses and in magazine submissions.

My first accepted article was a happy event. A month or so later, I received a letter from an acquisitions editor at Prentice-Hall. Someone had alerted him to my article on imaginative things to do during the first day of the school year (Only 180 Days To Go). The editor told me that Prentice-Hall was planning to do a series of practical books for elementary teachers and he liked both my ideas and the way I described them. Would I be interested in writing a book?

I never looked back. I was fortunate to subsequently work with several outstanding editors who taught me how to write for publication. After a 50+ year extensive output of books/articles/columns/reviews/editing I think that I've developed a sense of what constitutes credible publishable writing. Much of my later writing focused on the relationships between cognition and schooling–basically on the ecological interactivity of neurons, and so also of the interactivity of students who inhabit schools.

Author Credibility

I started to read mystery novels during my early adolescence (Sherlock Holmes, Ellery Queen, etc.) and I'm still doing it. James Lee Burke, John Grisham, and such Scandinavian authors as Jo Nesbo and Henning Mankell are good current examples. I've never seriously thought of writing a mystery novel for the same reason that I've never wanted to go into police work. I'm a teacher and have no vocational interest in other careers. It's the difference between the mentality of being a producer or a consumer.

Credibility for an author begins with a passionate producer commitment. Why else would one spend the effort it takes to write? When I finally realized that biology and teaching were basically two important sides of a single ecological coin, I found I could write successfully about the ecology of both classrooms and brain systems.

The conventional wisdom is that we need to spend 10,000 hours in a committed exploration of a phenomenon before we really understand it (and perhaps can write authoritatively about it). Sean Sylwester's article, The Role of Video Games in the Education of Young People, described how spending 12 years playing video games taught the author things he probably wouldn't have learned in school (Sylwester, August, 2014). Sean's credibility as the author of this article comes from both the thousands of hours he played video games and because he experienced being a public school student during this time.

I could teach successfully as a young person because I had put in my initial experiential hours as a K-12 student. To advise teachers via writing, however, required me to spend enough teaching time to understand their other-side-of-the-desk perspective. Similarly, athletes are young, but head coaches tend to be older. Journalists may be young but those who write columns and editorials tend to be older. Extended experience certainly isn't the only way to achieve productive credibility. Innovation and invention come from those who can imagine a new way of perceiving and doing something, and those folks are often young.

Those who write effectively in science (or in other complex fields) must have a solid understanding of the dynamics of their field, but they must also be able to explain their work in non-technical terms to normal readers. Many scientists who have difficulty doing this now work with competent writers who can help them to clarify concepts and eliminate jargon.

Understanding Readers

Writing for readers who don't have a passionate commitment about a phenomenon but who want to know about elements that affect them means that effective writing should provide a clear jargon-free explanation of what the reader wants to know rather than descriptions of how much the writer knows.

The opening segment of a written document should thus provide a clear explanation of what elements the document will explore, and (if necessary) a sense of the level of understanding that reading the document requires. Readers should usually be able to determine after a paragraph or two whether or not to continue.

Consider the situation of an author writing for a research journal. The credibility of the author contributes to the credibility of the journal, and vice versa.

Now think about an author writing for mass media, such as radio, television, or a widely read website. The media site has an acceptable level of credibility to the majority of its

viewers/readers. However, current mass media tend to be focused on a narrow perspective of broad political/cultural issues. A writer's credibility currently seems to come from how well the writer can present the publication's often-biased perspective. This is a considerable change from the past when a writer's credibility tended to come from the breadth of understanding and balanced perspective of the material presented.

Writing for Readers

Master the mechanics and rhythms of writing. Verbal communication repeats single thoughts, writing compresses them. We can speak faster than others can comprehend so we tend to say something this way and that way until facial expressions suggest that the hearer understands, and that we should move on. Conversely, the reader controls the speed of written information, so good writers typically give each thought their best shot and then move on. The reader can reread a segment or stop to think about it.

When I sent my first book chapter to the editor at Prentice Hall, he wrote back that it was pretty good, but that it could and should be reduced considerably. I was writing expansively the way a teacher teaches rather than compressing the commentary the way a writer functions.

I wrote earlier that our ability to understand and make analogies is probably what separates us from primates and other social mammals (Sylwester & Moursund, 2014). We're storytellers, as exemplified by the domination of narrative forms in all of mass media. Non-fiction articles and books often use narratives to make non-narrative points.

Much writing tends to be formulaic, and mystery novels are an excellent example. Sixty+ years later I can generally predict how the plot of a mystery novel will evolve and what the last dozen or so pages will include. Why do I continue to read them? Plot is often secondary to me in a good mystery novel, and analyses of people, places, and interactions become central. I'm interested in how an ecosystem functions and how humans especially interact with each other and the environment. Readers thus bring different agendas. One reader is interested in a good mystery novel, another in reading a book on the flight home, another in the psychology of a series' recurring characters and settings. Really good fiction and non-fiction writing can thus satisfy the needs of several kinds of readers.

Editors constantly read manuscripts in search of potentially good articles and books. An article or book can frequently get rejected (e.g., the Harry Potter series) but then finally accepted, sometimes to great acclaim. One acquisitions editor saw what others missed. The same diversity of perspective occurs with readers, as an examination of the reader reviews in Amazon.com will demonstrate.

What's neat about writing today is that all sorts of venues are available for people who want to write–email, social media, online publications as well as through regular publications. But having written doesn't insure that you'll be read. Becoming a credible effective writer is necessary at that level.

In *The Sense of Style,* the renowned psycholinguist Steven Pinker (2014) has written an excellent needed update of Strunk and White's *Elements of Style* (1959). We had become an oral society, but social media have now made writing a daily experience for many. Pinker focuses on the need for clarity, precision, and style in word choice and punctuation. It's a humorously charming and informative book. Read it. Your email, Facebook correspondents, and possibly acquisitions editors will bless you for it.

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Chapter 9

IAE Newsletter # 166

Determining Credibility in the Selection of University Theatre Productions: What's a Grave Digger Supposed to Do?

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How do people who read scripts decide which film, T.V. show, or play should be produced? More specifically, how do directors who plan a season of productions know which of the excellent and available possibilities to include? How do they establish their professional credibility in determining their selections for productions?

I directed a university theatre program for 24 years. This chapter presents some factors that influenced my selections. You will see that many factors enter into my decisions.

The study and enactment of dramatic literature has been part of liberal arts higher education since the Renaissance. Students not only read and discuss plays, they also perform them. Just as children master frightening, mystifying, or thrilling experiences by acting them out in free dramatic play, young adult learners gain understanding of human experience by seeing, hearing, and enacting dramatic literature.

Drama in higher education currently has disparate, but inter-relating goals that influence the selection of plays for class syllabi as well as for campus performance. These goals include increasing knowledge of many cultures and eras, which encourages collaboration and cross-discipline study. More specifically, reading and performing plays develops empathy for others as well as critical and associative thinking.

Educational theatre artists play the roles of "historians, archaeologists, and time travelers, …grave-diggers working on the edge of the two extremes of destruction and preservation, throwing up the skulls of history and transforming them" (Birringer, 1991). Theatre educator/artists accomplish this not only in classrooms but also through theatrical production. Producing theatre entails in-depth interaction with colleagues, actors, designers, technicians, and audiences. This process shapes not only the performance, but also all engaged in it. The process begins with the selection of plays to be performed in an academic year, and possibly the consideration of a four- to six-year cycle of plays, with the goal of exposing students to a broad range of dramatic genres, periods, and styles.

Literature classes frequently include plays by classic and contemporary playwrights. In this article the term *classic* is broadly applied to plays that have been repeatedly performed for at least one hundred years, and the term *contemporary* denotes plays written and performed within the last 100 years. If one argues that classic plays performed today are those with meaning that has relevance for contemporary audiences, these performances represent a culture's present as well as past concerns.

University theatre programs may also focus on the concerns of their mostly young adult audience, an audience that continually evolves as students mature and graduate. Classic plays that address moral decision-making in complex social settings range from Antigone (BCE 441) and *A Doll's House* (1879), to such 20th and 21st century plays as *All My Sons* (1947) and *Water by the Spoonful* (2012). (See References and Resources section below for Internet access to cited plays.)

Theatre in higher education has sought to develop new plays as well as to conserve classic plays. College curricula have contained playwriting courses since the early 1900s. Eugene O'Neill, who studied playwriting at Harvard, gained worldwide recognition as an innovative playwright. Theatre artists in higher education today continue to experiment with new forms of performance that may combine multimedia with live actors.

Many universities with professional theatre training programs have a professional theatre in residence on campus. These theatres frequently stage new works. Six plays about 20th century African-American experience by August Wilson were first produced at the Yale Repertory Theatre. Wilson's plays subsequently had successful Broadway productions that won multiple awards including two Pulitzer Prizes. The annual Kennedy Center American College Theatre Festival encourages excellence in the performance of plays by students as well as by established playwrights. It also seeks to support revitalized or newly conceived classic play production as well as experimental works (http://www.kcaAls, 100ctf.org).

Campus administrators set theatre program budgets, making theatre production less financially dependent on ticket sales. However, theatre studies still must attract participants and audiences to justify their existence. The popularity of comedy and musical theatre influences their inclusion in university theatre production. Yet social critique occurs not only in "serious" drama but also in comedies that range from *Lysistrata* (BCE 411) to *It's Only a Play* (1986, revised 2014) (Als, 10/20/2014). Comedies and musicals have regularly won the Pulizer Prize, an affirmation of their merit as dramatic literature. The musical *Man of La Mancha,* based on Cervantes' *Don Quixote* (1605), may awaken interest in Cervantes as well as in the culture of chivalry and the Spanish Inquisition. Production of this musical invites collaboration among departments of music, theatre, history, and literature—thus enhancing interdisciplinary study. Performance of this musical can also present an alternative to cynicism through one of its themes: people can become better than they are when they are treated as people of worth.

In addition, theatre educators seek to introduce students to non-Western theatre and cultures. While it is possible to read Sanskrit plays in a literature class, dramatic performance in many Asian and African countries frequently has minimal or no scripting. A dramatic enactment is interactively passed from one performer to another. Performing traditional non-Western plays presents challenges because their performance conventions often demand years of training. American students typically have six to eight weeks, and at most a semester, to mount a production. Learning the complex movement conventions or any other aspect of Peking Opera or Kathakali is only possible at the most rudimentary level within these time constraints, and one must question whether appreciation for non-Western theatre is served by crude imitation.

Many schools address this by bringing non-Western theatre artists to perform on campus or by taking students to professional performances. Study abroad programs offer students more in-depth study. All of these increase knowledge of and appreciation for non-Western theatre. For Julie Taymor, undergraduate experiences began an exploration of non-Western theatre forms

such as Indonesian wayang kulit shadow puppetry, forms that she brilliantly incorporates in her work as a director and designer for theatre and film (Blumenthal & Taymor, 1995). *The Lion King* is an example of her ability to combine Western and non-Western theatre techniques in ways that enrich performance.

Theatre in higher education seeks to increase racial and gender diversity in plays studied and produced. American theatre has a history of racial prejudice that includes "white" actors portraying stereotyped characters of color in demeaning ways. The film *Breakfast at Tiffany's* (1961) records an example of this in Mickey Rooney's portrayal of an ill-tempered buck-toothed Japanese neighbor who wears thick-lensed glasses. Additionally, fewer roles exist for characters of color than for "white" characters. Conversely, casting a character of color can be problematic for schools with limited minority enrollment. Such schools might choose small cast shows or invite actors of color to be guest artists. The practice of color-blind casting in classic and contemporary plays has opened roles for actors of color in university as well as professional theatre.

Regrettably, the goals of educational theatre may become conflicting. A campus that has many students who audition will hesitate to produce a one-person show such as *I Am My Own Wife* (2003), even though it won many awards and is one of the few plays that respectfully stages transgender identity. In addition, male playwrights tend to write plays with more male than female roles. While more female playwrights are produced today, achieving gender equity in the quantity and quality of roles for women remains challenging. This may be addressed by cross gender casting of traditional plays that also exposes gender stereotyping. Campuses may also stage more productions in an academic year to increase racial and gender equity. This often requires assistance from guest artists as well as student directors and designers. It may also necessitate more frugal staging of every production.

Theatre facilities, budget, professional staff, and student population influence the selection of plays for production. Inadequate resources either eliminate plays with elaborate scenic and special effects, or necessitate stylized interpretations of these scripts. A small theatre program with minimal theatre facilities and staff would have difficulty staging Andrew Lloyd Webber's *Phantom of the Opera.* Conversely, schools with BFA and MFA programs are challenged to produce plays that give their candidates the myriad of experiences needed to begin careers in acting, directing, design, and technical fields.

In large and small theatre programs, uniquely gifted students appear who induce directors to find plays that will showcase extraordinary talent. In addition, the economics of current professional theatre has reduced the cast size of many recent plays. University theatres are torn between staging exciting new works that offer fewer students the opportunity to perform and older plays that offer more students performance experience. The history of theatre in higher education and the diversity of theatre programs today lead to the production of desperate genres of dramatic literature, diverse performance styles, and innovative use of media. These may move into other fields that include film studies and performance art.

The interests of faculty involved in directing and designing plays also affects play selection. In many theatre departments, choosing a season of plays can mean protracted negotiations. Many educational theatre artists would empathize with Francis Fergusson's 1928 letter to the Administration of the American Laboratory Theatre in which he argued for an "evolving drama which shall be vital and comprehensive to a public large enough and rich enough to support a

small theater full of frugal theatre artists…you can confidently expect me to look for and bring plays which seem to me significant."

No director wants to spend 200 hours of research, production meetings, and rehearsals on a play that would lack meaning for the actors, technical staff, and audiences. Given the multiple and sometimes competing goals of play production in liberal arts education, choosing an academic performance season can be a juggling act in which multiple players launch as many of these goals as they can. If they can keep them in play, they may captivate as well as educate their audiences. Those who spend their careers as theatre artist/educators seek credible plays of significance that both conserve and transform dramatic art. They are grave-diggers who juggle.

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Note: Summaries and brief production histories of plays cited in this article can be found at www.en.wikipedia.org by searching the play title.

Part 4

Assessing Validity and Credibility in Areas that Combine the Concepts

The chapters in Part 4 suggest that many assessments combine the objective validity found in scientific work with the subjectivity found in determining credibility. For example, the problems associated with global warming research are considered scientifically valid by an overwhelming number of climate scientists, but many others consider the concept to be a hoax, perhaps for ideological reasons. Other possible reasons include because some may profit from the current situation, or others are fearful of changes that a different response could entail or cause.

The following chapters thus discuss the roles that various advocacy groups and policies have on influencing individual beliefs and behavior, and how best to help students understand this phenomenon.

Chapter 10

IAE Newsletter # 160

Assessing Validity and Credibility of Advocacy Groups

David Moursund
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University of Oregon

> "Never doubt that a small group of thoughtful committed citizens can change the world; indeed it's the only thing that ever has." (Margaret Mead; an American cultural anthropologist, who was frequently a featured author and speaker in the mass media throughout the 1960s and 1970s; 1901-1978.)
>
> "Change happens by listening and then starting a dialogue with the people who are doing something you don't believe is right." (Jane Goodall; English anthropologist; 1934-.)

The Free Dictionary defines *advocacy* as:

> Noun—The act of pleading or arguing in favor of something, such as a cause, idea, or policy; active support.

I developed the Information Age Education company to support my advocacy work in improving education at all levels and throughout the world. I make use of my time, knowledge, skills, some of my money, and volunteers to carry out IAE advocacy. I make use of the Web, email, and social networking to help accomplish my advocacy work. The U.S. Constitution guarantees me the freedom to carry out these activities.

An advocacy group is composed of people who have joined together in a common cause. The cause may include a single issue or a collection of issues. If you belong to a political party, you belong to a multi-issue advocacy group. You may not be in favor of each of the issues that your party supports, but you agree with the underlying goals and principles of the party.

I think of all persons as being advocates for some or many of the things they believe in. Such individuality is an important aspect of humans. However, a number of advocacy groups build supportive cases that are particularly one-sided and/or lacking in validity and credibility. Some advocacy groups receive very large amounts of financial support from a small number of very wealthy individuals. Such groups are able to use their resources to shape public opinion through use of the media.

Here we will explore advocacy groups in terms of the validity and credibility of the information they provide to their members and to others.

Margaret Mead

The quote above from Margaret Mead captures the essence of a long-used approach to advocacy. A person or a small group of people work together to advocate changes that they

strongly believe should be made. They dedicate time, energy, and personal resources to convince others to follow their lead.

Margaret Mead practiced advocacy by using her writing and speaking abilities. In public speaking, information is presented to an audience. The audience members can form their own opinions about the credibility of the speaker. As they follow the chain of arguments in the presentation, they can do some mental checking on the validity of the information being presented. If the speaker also takes questions or interacts with the audience in other ways, the audience has additional opportunities to decide on the credibility of the speaker and the validity of the information being presented. We know, of course, that a very dynamic speaker can sometimes overwhelm the rationality of an audience.

An author's writings provide readers with an opportunity to more carefully analyze the information being presented. A learned paper or book typically contains references to other research work that can lend validity to the paper or book. Nowadays, it is relatively easy for a reader to check out these references to assess their validity and credibility.

In summary, considerable openness more often occurs when a person uses public speaking interaction with an audience and/or learned publications to further their own advocacy ideas. However, we are now living at a time when a decreasing amount of openness exists in some advocacy areas.

The U.S. National Elections in November 2014

Political advocacy includes activities such as lobbying, media campaigns, commissioning and publishing research. Political advocacy groups work to influence decisions within political, economic, and social systems and institutions.

You may have felt troubled by the vast amount of money spent on the 2014 state and national elections in the U.S. I suppose I was most bothered by reports that some individuals or very small groups spent hundreds of millions of dollars to support their interests. In Oregon, my home state, I noticed that a modest number of large out-of-state agricultural companies and related interests spent a huge amount in defeating a Genetically Modified Food (GMO) labeling measure that was on the ballot.

The New York Times provides an indication of how much political advocacy money we may see in the 2016 presidential election:

> The political network overseen by the conservative billionaires Charles G. and David H. Koch plans to spend close to $900 million on the 2016 campaign, an unparalleled effort by coordinated outside groups to shape a presidential election that is already on track to be the most expensive in history (Confessore, 1/26/2015).

Why might we be troubled by this situation? After all, such wealthy people are merely using their personal resources to advance causes they believe in. According to various decisions by the U.S. Supreme Court, a corporation has some of the rights of a person, and these corporations were merely using their own resources to advance their causes.

Part of my answer lies in the statement in the U.S. Declaration of Independence that "All men [all people] are created equal." Although our voting system has some major flaws, the general idea is "one voter, one vote." Advocacy groups with massive resources seem somewhat

contrary to these fundamental ideas. I have a strong feeling that our democratic system and process are being manipulated and somewhat marginalized by the big spenders.

A Growing "Science" of Spending Money to Influence People

A "science" now exists of effectively using huge amounts of money to influence the outcome of an election. These theories were certainly put to the test this past November [2014]. You can be sure that as the big spenders continue their research and analyze data from their past efforts, their effectiveness will increase.

The growing science of election spending is closely related to the science of advertising goods and services. We all experience an ongoing barrage of ads in the various media. The advertisers believe that such ads are a cost effective way to increase their sales and profits.

In early 2015, 30-second television ads for Super Bowl XLIX were selling for $4.5 million. In addition, an advertiser likely spends well over a million dollars developing such an ad. This ad may well have reached over a hundred million people. As I watched the game, I contemplated whether the advertiser was getting six or seven cents of value from my viewing an ad.

A Case Study

Voters in the state of Washington voted on an initiative to authorize Charter Schools in 2012 (Au & Ferrare, 2014). The initiative obtained a spot on the ballot through a petition signature drive funded by its supporters. It passed by obtaining about 50.7 percent of the votes cast in the general election.

Approximately 98 percent of the funds raised to support the measure were contributed by 21 large donors. Table 1 lists the top10 donors (Au & Ferrare, 2014). Some of the names will be familiar to you, and you may wonder why others were interested in supporting the creation of Charter Schools in Washington.

	Donor	Amount
1	Bill Gates Jr.—Microsoft cofounder and current chairman. [Microsoft is headquartered in Washington.]	$3,053,000
2	Alice Walton—heiress; daughter of Wal-Mart founder, Sam Walton.	$1,700,000
3	Vulcan Inc.—founded by Paul Allen, Microsoft cofounder.	$1,600,000
4	Nicolas Hanauer—venture capitalist.	$1,000,000
5	Mike Bezos—father of Amazon.com founder Jeff Bezos. [Amazon is headquartered in Washington.]	$500,000
6	Jackie Bezos—mother of Amazon.com founder Jeff Bezos.	$500,000
7	Connie Ballmer—wife of Microsoft CEO Steve Ballmer.	$500,000
8	Anne Dinning—managing director D.E. Shaw Investments.	$250,000
9	Michael Wolf—Yahoo! Inc. board of directors.	$250,000
10	Katherine Binder—EMFCO Holdings chairwoman.	$250,000

Table 1: **Yes On I-1240** campaign cash and in-kind contributions of $250k or more.

Quoting from the Implications and Conclusions part of the Au & Ferrare paper:

> …our findings and analysis raise serious concerns regarding the disproportionate power of super wealthy individuals and their related philanthropic organizations relative to public education policy and the democratic decision-making process of individual voters. In the case of the most recent Washington State charter school Initiative 1240, it is clear to us that these wealthy individuals wielded an inordinate amount of power well beyond that of the average person in the state of Washington. **Further, the power of these wealthy individuals extended largely from their vast resources and not because of any expertise on the subject of public education reform** (Bosworth, 2011). As such, the passage of I-1240 in Washington State raises concerns that billionaires and their philanthropies have become what Karier (1972) referred to as **a virtual "fourth branch of government"** that is able to carry its reform agenda and ideology forward into fully realized education policy through sheer force of material and symbolic sponsorship, but with little public accountability. [Bold added for emphasis.]

Follow the Money, and Fact Checking

One might argue that every advocacy group presents its case and information in a biased manner. However, certainly some are much more blatant than others. The years of legal wrangling about the relationship between cigarette smoking and lung cancer provide a vista in which to explore how "big money" was used to protect the interests of tobacco companies against a steadily growing collection of scientific research.

Follow the Money

Today's media make it possible for big-spending advocates for a cause to reach huge audiences. However, the Web enables people with very limited financial resources to search for bias and to widely disseminate their own findings.

One way to search for possible bias in the work of advocacy groups is to "follow the money." Where is the big money coming from? What financial gains might accrue to those providing the money?

I find it interesting to look at spending in various GMO elections in recent years. In Oregon's 2014 vote, opponents to requiring GMO labeling spent over $20 million. Proponents spent about $8 million. The measure was defeated by a margin of less than a tenth of one percent. The top five contributors toward defeating the measure were all out-of-state corporations. They contributed about $15 million.

Most advertising can be thought of as efforts by advocacy groups to provide information that will influence the opinions of their audience. While we have some Truth in Advertising and Consumer Protection laws and organizations, for the most part consumers are on their own to decide on the validity and credibility of ads, and to make decisions based on the information they are receiving.

My advice to people is to be especially suspicious of well-financed political campaigns. Look beyond the ads that tell you over and over again how good their candidate or issue is—or, how bad and flawed their opposition is.

Fact Checking

My recent Google search of the term *fact checking* produced over 14 million hits. My search of *fact checking.org* produced about 3.8 million hits. An amazing amount of information is available. Warning: Unfortunately, some of the information is biased. This is a user beware

situation. If you are serious about investigating a candidate or issue, use multiple sources and keep your thinking cap on!

As you investigate a particular candidate or issue, you can talk about what you find with your acquaintances. But, nowadays, "acquaintances" may include a very large number of "friends" in the social networking systems you use, your own personal mailing list, and other mailing lists you can access. Such grass roots approaches using social media can help to effectively combat biased big money.

Final Remarks

The validity and credibility series started with the relatively simple issue of helping students understand the need for using valid, credible information in the papers they write and the presentations they give for courses they are taking.

As you can see, we have progressed into more complex issues. How do we help students to become responsible adult citizens in a world where they are constantly bombarded by biased ads and other information designed to shape their opinions? We want them to become thoughtful and critical consumers of information. This is a very challenging educational task!

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Chapter 11

IAE Newsletter # 161

Teaching Students about Advocacy Processes

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The unifying theme of this book is that students can and should learn to judge the validity and credibility of information that they use, cite in their research papers, and communicate to others. This is an important goal for public education in a democracy.

Advocacy Is Ubiquitous

We all have opinions about many different things, and we communicate our opinions through our written and oral language, and through our actions. In a free and open society, advocacy is an everyday part of life. Within reason, we are free to "speak our minds." As we speak our minds, we draw on information stored in our heads and information that we retrieve from many sources.

Chapter 10 focused on advocacy groups, with special attention to well-funded political advocacy groups. These groups work to sway public opinion, and they often present information that is strongly biased toward their group's goals and points of view. We suggested some ways that a person can seek to determine the validity and credibility of information being provided by well-funded political advocacy groups.

Chapter 11 explores some approaches our public education system can take to help students learn to function well as personal advocates in a world of advocacy.

Wikipedia, a Widely Used Resource

In the "good old days," students learned to make use of various encyclopedias as sources of information. By and large, the articles in these encyclopedias were written by experts in their fields, were subject to review by other experts, and were carefully edited by staff of the publishing companies. Most students used these reference sources in their school or public libraries where they had been carefully selected by the librarians. Now, students frequently draw on the Wikipedia and other online resources. They consider the Wikipedia to be a supersized encyclopedia and accept it as a credible resource.

Over the years, the Wikipedia has come under attack for accuracy and bias. The Wikipedia has responded by putting checks and balances into place. Their approach provides useful information to teachers and students who are teaching about and/or learning about validity and credibility in information. Here are four quotes from the Wikipedia:

> Wikipedia articles should be based on reliable, published sources, making sure that all majority and significant minority views that have appeared in those sources are covered.
>
> …

> Wikipedia articles are required to present a neutral point of view. However, reliable sources are not required to be neutral, unbiased, or objective. Sometimes non-neutral sources are the best possible sources for supporting information about the different viewpoints held on a subject.
>
> …
>
> Common sources of bias include political, financial, religious, philosophical, or other beliefs. While a source may be biased, it may be reliable in the specific context. When dealing with a potentially biased source, editors should consider whether the source meets the normal requirements for reliable sources, such as editorial control and a reputation for fact checking.
>
> …
>
> Questionable sources are those with a poor reputation for checking the facts, or with no editorial oversight. **Such sources include websites and publications expressing views that are widely acknowledged as extremist, that are promotional in nature, or which rely heavily on rumors and personal opinions….** The proper uses of a questionable source are very limited. [Bold added for emphasis.]

I, personally, make extensive use of the Wikipedia. Of course, I do mental fact checking and generally draw on multiple resources if the topic I am researching is at all controversial.

Debating an Issue: A Personal Example

What do we want students to learn about the validity and credibility of the information they receive from advocacy groups? In what ways can we teach students to evaluate all information and information sources in terms of validity and credibility? I believe our schools should design curriculum, assessment, and evaluation so students gain a good understanding of "debatable" issues. Here is a personal example from my high school days.

I was on my school's Debate Team when I was a senior in high school. The topic for that year was direct election of the President of the U.S. versus the current Electoral College system.

Debaters were provided with a resource manual that discussed both sides of the issue and provided some references. Debaters had to learn to argue both sides of the case, and could draw on the manual and other resources, as they prepared and presented their own arguments and rebuttals.

I learned several important things from this experience:

1. In the topic being debated, as in many other "controversial" issues, two or more credible sides are often present. Each side can present strong and convincing arguments for its case.
2. This particular topic involved lots of data and different ways to represent the data. It proved to be a fertile ground to practice misleading, misrepresentation, and even lying with statistics. In retrospect, for me this suggests the value of students learning about statistics, probability, and graphical representation of data while in secondary school. The new SAT will include considerable more emphasis on this topic.
3. Some debaters are much better than others in organizing and presenting their cases. (I thought I was good at debate, but I encountered others who were much better.)

4. Careful research of the merits of the various sides of an issue, and looking carefully for valid information and credible arguments, can help greatly in winning a debate.

However, as I gained in maturity and in wisdom, I came to realize that even in our relatively open and democratic society, many important issues are not settled by free and open debate of people who are highly knowledgeable about the issues under consideration. Moreover, I have gained some understanding of the compromises—and give and take—that various interest groups make to achieve their aims. A congressperson might say, "I am against your bill, but will support it if you will support my bill." This may be good politics, but it certainly does not demonstrate the strength of moral character we hope our schools are building in our students.

School Curriculum as Advocacy

Secondary school teachers in any required course are apt to encounter students who ask, "Why do I have to learn this?" This might be followed by the question, "When will I ever use it?" The teacher is acting as an agent for people who advocate that the course and its content be required. Content, teaching methods, and assessment may be specified by the school, school district, or state. Part of the job of any teacher is to "sell" both the general subject area and the specific content they are teaching. An answer such as, "It will be on the test" or "You will need it in the next course" is not very satisfactory. My personal opinion is that, when quite a few students in a course are not convinced by arguments supporting that the course be required, then we should be rethinking the reasons why the course is required.

I think both the students and the teacher would benefit by open discussion or debate about the validity and credibility of required courses. A few weeks ago I was following an online discussion started by a teacher who was relatively new at teaching a particular math course and wanted help in answering the "Why" question. The discussion didn't seem to provide very good responses that the teacher could use. Our educational system tends to believe that the system can be improved by doing "more of the same—just do it better." This is certainly not the philosophy that has moved our country from the Industrial Age into the Information Age.

If we look at the K-3 math curriculum, most of its content is of immediate use to students. That certainly helps to answer the "Why" question. The required reading, writing, and arithmetic courses in the early grades all have the dual characteristic s of empowering students and being strongly supported by society's accumulated wisdom about what constitutes a good education.

It is only later in K-12 education that students begin to face required math—and other courses—in which the content may not appear to be of immediate use to students. What math, and how much math, should be required for high school graduation? A similar question can be asked about reading, writing, social sciences, science, physical education, art, music, and so on. Much of the required curriculum in secondary school is a compromise designed to meet the desires of various advocacy groups.

As students gain in their educational and cognitive levels, their natural curiosity and inquisitiveness may lead them to question authority. (If you have raised children, you have certainly encountered the "why and when" questions and their question of authority over and over again.)

The content, instructional processes, and assessment in a course can be a topic for discussion and debate in any course that students are required to take. Certainly preparing for such student discussions should be part of teacher education programs of study. A teacher should be familiar

with the research that stands behind the required content, teaching methods, and assessment of courses they are preparing to teach.

Students Checking the Credibility of Their Teachers

As we help students learn about determining the validity and credibility of information they find, and of the sources of that information, it seems to me we should give some thought to also helping students learn about the validity and credibility of their teachers and of the courses they take. Is the course itself a source of credible, valid information? Is the teacher credible and does the teacher have the knowledge and skills to provide students with valid information and ways to learn that information?

As I ponder these questions, I start thinking about myself as a teacher of teachers in the field of computers in education. I taught such courses for a great many years. Essentially all of what I taught I had learned on the job. My own transcripts contain no credits in Education or Teaching of Teachers, Computer and Information Science, or Psychology. Yet the courses I taught contained considerable information about human and computer intelligence and Brain Science. My conclusion is that a teacher's initial education and credentials are merely a starting point. All good teachers "grow" during their teaching careers.

I recall that in high school I wondered about the qualifications of some of my teachers, but then in college I believed my teachers to be well qualified in their content areas. Some were better teachers than others, but it didn't really occur to me to be concerned about that issue.

I don't recall ever having one of my college students ask for my own qualifications, and seldom did a student question the validity or credibility of information I presented in class. Perhaps they were awed by the fact that I had written the book for most of the courses I taught, and that my reputation included being a national leader in the field. (It may have helped that as the Web became well established, I made these books available as free downloads.)

It seems to me that, as students move up the educational and cognitive maturity scales, they should be learning that their teachers are not infallible. They should learn about the preparation and experience their teachers have had, and about their teachers' continuing efforts to maintain and increase their level of knowledge and skills relevant to being a good teacher in their field.

Final Remarks

Advocacy is an ongoing component of human life. In a free and open society children should grow up learning a variety of ways to handle advocacy situations. Our schools can help by making such exploration and debate a component of each course they offer.

A teacher can be thought of as being an advocate for what and how they teach. From this point of view, a student's day includes receiving and paying attention to a great deal of advocacy. Occasionally students ask, "Why do we have to learn this?" They may well think about other questions, such as "Why can't I text my friends or read a good book during class?" Think carefully about the nature and extent of the power of individual students or groups of students to challenge the validity and credibility of the power of the educational establishment.

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The *IAE Blog* is an advocacy vehicle. Here are some examples of advocacy blog entries. As you read some of these, ask yourself if the "call for action" resonates with you.

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Chapter 12

IAE Newsletter # 162

A Biologist Explores Validity and Credibility within the Meaning of Human Existence

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> "History makes little sense without prehistory, and prehistory makes little sense without biology…. Knowledge of prehistory and biology is increasing rapidly, bringing into focus how humanity originated and why a species like our own exists on this planet." (E.O. Wilson; American biologist, researcher, and author; 1929-.)

Since early times, humans have been mystified by such natural phenomena as weather cycles, illness, and life itself. They often ascribed spiritual forces as the cause.

The world-renowned biologist and two-time Pulitzer Prize winner E.O. Wilson suggests that religions developed across the world to explain these mysteries and emerging spiritual beliefs. He discusses this phenomenon in his book, *The Meaning of Human Existence* (2014). Although Wilson acknowledges the widespread credibility and probably innate reality of religious belief, he doesn't accept its objective validity. He supports what he considers to be valid scientific perspectives.

Wilson explains his beliefs from past, present, and future perspectives. The overriding issue relates to the meaning of life. Wilson argues that life is an accident of evolutionary history and not the intention of a designer. History's gradual unfolding is obedient only to the general laws of the Universe.

Our Past

At some point in the distant past the Big Bang initiated the earth's time/space journey. Our planet, capable of producing life as we have experienced it, emerged among the objects that eventually resulted from the Big Bang. Living forms emerged on earth 3.5 billion years ago and eukaryotes (cells with a nucleus) emerged about two billion years ago. The emergence of nuclear DNA/RNA allowed for differentiation within and among species.

Among the hundreds of thousands of animal species that emerged, only 20 are eusocial, cooperatively rearing their young and dividing labor. The division of labor basically involved risky foraging and safer nest-maintenance and parenting.

The eusocial species include: humans (homo sapiens); two species of African mole rats; fourteen insect species; and three coral dwelling marine shrimp. None of the non-human animals has a large enough brain to create a scientific/technological culture (Wilson, 2014).

Anatomically modern humans with advanced forms of consciousness emerged about 200,000 years ago. The expansion of our brain's cortex enhanced curiosity about such mysteries as those

mentioned above. Humans became a social species and so had to learn how to live together. This initially occurred through cooperative kinship interactions. Although humans wouldn't understand the biological mechanisms for many millennia, hormonal and cognitive systems (such as those regulated by oxytocin, vasopressin, and dopamine) emerged to support cooperative behavior. At some point, kin became tribe, and more complex patterns of ethical cooperative life occurred. For example, communities initiated and codified sanctions when various forms of misbehavior created negative social issues.

Absent physical explanations of mysteries, spiritual explanations emerged that were combined into religious beliefs. The beliefs were periodically adapted to new developments, but it wasn't until the last 200 years that scientific developments seriously threatened religious dogma.

Agriculture emerged somewhat over 10,000 years ago, and with it the need to compute costs and keep records, which required further advances in language and math. Written language began about 5,000 years ago. Such developments eventually set the stage for science.

So did we evolve as basically competitive or cooperative, helpful or hurtful, good or evil? Wilson suggests that our behavior exists across all those ranges, affected by the innateness of biology and the rationality of culture.

Our Present

Our search for an appropriate meaningful life led first to the humanities, whose methods tend towards the analogically speculative, critical, and historical. The empirical methods of science emerged several hundred years ago. Both approaches saw meaningful life as existing within their separate sets of borders. As indicated in earlier chapters, science sought objective validity and the humanities sought subjective credibility. Divisions occurred in each of the two systems. Over time, natural science became physics, chemistry, and biology; and then each of these further split (such as chemistry into organic and inorganic chemistry).

The same thing occurred in the humanities, which encompass literature, philosophy, religion, the arts, and the social sciences. Literature thus includes poetry and prose; and prose includes novels, short stories, non-fiction, biography, etc. The idea that life's meaning can be reduced to a unitary system or explanation disappeared.

As the early human brain increased in size and capability, it developed an improved memory that enhanced recognition, communication, bonding, and the continuous evaluation of cooperative/competitive behavior. It also developed technologies that enhanced our sensory/motor capabilities. From all of this came the intense pleasure of group membership—the capability to move beyond pure competition in order to achieve more through cooperation.

Our most extensive experience with the meaning of existence has come through very long explorations within the humanities. Science attempts to understand the basic systems that govern the universe. The humanities are cognitively grounded and so they demonstrate what we ourselves have discovered about existence through analogy and reality. Should we ever interact with extraterrestrials, the humanities would provide an explanation of who we are (given that the communicative aliens might be ahead of us in scientific understanding).

The Future

What's next? All organisms die and most species eventually become extinct if they don't evolve into another species. Will the earth itself be destroyed? Religions tend to suggest it and current global warming patterns give one pause.

Does life exist on other hospitable planets that we could colonize? Wilson suggests that within a decade or so, scientists will be able to detect life on other planets that are similarly situated near their star. "The existence of alien life will then pass from the well-reasoned hypothetical to the very probable" (Wilson, 2014). We or our robots will eventually attempt to visit such planets, because our individual and corporate minds shrivel without challenge.

Microbes will dominate life-bearing planets as they do on earth. Colonizing other planets is perilous. Each planet has evolved its own ecology. To insert ourselves into an inhospitable ecology would be destructive. Like it or not, we humans got only one hospitable planet for immortality. We thus need to tend to what we have.

Biodiversity refers to the earth's balanced variety in life, from ecosystems (such as lakes and forests) to the species that inhabit them, to the genes that prescribe traits in species. All are important to sustain life. Five factors signal a destruction of the earth's biodiversity:

1. Habitat loss, such as through deforestation or climate change,
2. Invasive plant/animal species brought from other parts of the world,
3. Air/water pollution,
4. Population growth, and
5. Over-harvesting of food from plants and animals.

These are the current problems. Politics will affect needed decisions.

Biology and the Meaning of Life

Our brain didn't evolve to solve the meaning of life. Our brain is a system for survival that uses both emotion and reason. It evolved gradually, each step responding to its immediate needs. What we call human nature is the base—the totality of our emotions and learning that bias the cultural beliefs of individuals and groups. Human nature is part instinct, part formative experience and learning, part who we associate with and where we live, and part mature reason.

We might also add music and religion to that. Both of these culturally exist in all civilizations, and the two are often entwined in practice. As indicated earlier, deities supposedly used priests and scriptures to explain mysterious occurrences, guide moral behavior, and promote a celestial afterlife. Within the last few centuries science has also explained many such mysteries and behaviors, but the deity explanations are deeply embedded. Further, churches provide a supportive tribal community that many people prefer in order to deal with genuine misfortunes.

Wilson suggests that a tribe is defined by its creation story. The deity favors a specific tribe above other tribes that worship a supposedly wrong god. The instinctual forces of tribalism can become stronger than the yearning for positive spirituality. The heated arguments and armed conflicts seem to have been going on forever. The ancient Roman philosopher Seneca the Younger said that common people considered religion true, the wise considered it false, and the rulers considered it useful. When asked about the Pope's 1950 infallible pronouncement that the Virgin Mary ascended bodily into heaven, the distinguished physiologist Anton Carlson replied

that he couldn't be sure because he wasn't there, but he was certain of one thing and that is that she would have lost consciousness at thirty thousand feet.

Religious belief survives, despite the ridicule of non-believers such as Anton Carlson. The enemy isn't so much the believers versus the non-believers, but more often dissension occurs among competing religions, Christianity and Islam now perhaps, but also competing Christian denominations, or two versions of the same denomination. Wilson suggests that religious belief has become so deeply ingrained in humans over many millennia that it won't be dislodged. He still believes that the best way to live in the real world is to free ourselves of demons and tribal gods.

How free are we to do that? Wilson indicates that the concept of free will is an element of consciousness that so far defies understanding. However, the neurobiology of consciousness itself is moving towards a probable solution through the current brain mapping initiative. That should provide the necessary background to solve the complexities involved in understanding free will, something that will require a general acceptance of solid scientific research.

Wilson argues that a global desire is necessary to reduce the religious and political tribalism that perhaps made sense in earlier times but not in the urbanism of the 21st century. Contemporary tribalism is destroying significant human capability. Wilson is particularly incensed by the damage that U.S. religious and political ideology are currently doing to reduce positive scientific exploration, and especially the advances that are occurring in biological evolution and personal identity. The United States has long lagged behind European nations in the acceptance of evolution. (See http://news.nationalgeographic.com/news/2006/08/060810-evolution.html.)

When disagreements occur in science and/or the humanities, the scholars involved typically seek a productive resolution. This is certainly preferable to futile tribal conflicts that may gain ravaged property at the cost of the lives of their own adherents in order to forcefully conquer those who will continue to despise the aggressors. It took many millennia for collaborative reason to finally evolve. It shouldn't be used wastefully.

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Chapter 13

IAE Newsletter # 167

Assessing and Responding to Marginal Teachers

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The International Olympics uses an objectively valid system to select medalists in timed and distance events (e.g., running), and a different subjectively credible system to select medalists in events that are based mostly on a performer's style (e.g., figure skating). One would think that identifying the capabilities of students and teachers could be similarly straightforward.

Alas, it's not that simple. An IAE free downloadable book on Common Core State Standards explores the complex issue of developing valid/credible ways to measure student success (Moursund & Sylwester, 2013). This chapter focuses on how to determine who are marginal teachers, and how to improve their skills.

Marginal teachers are exasperating. For example, parents complain and ask that their child be moved to a different teacher. A marginal teacher's poor instructional and classroom management skills reduce student learning. Student misbehavior, including bullying, is often rampant.

Unfettered use of Smartphones and computer tablets can similarly become a significant distraction. Parents and colleagues now expect technology to be used positively to facilitate interactive instruction and group work (Gleave, 2014). Parents get upset if they discover these deficiencies in their children's teachers. Colleagues often have mixed feelings about a marginal teacher, liking the teacher personally but aware of deficiencies. It's thus often not one thing, but the aggregate of deficiencies that defines a marginal teacher.

As a school district superintendent, I always expected that a marginal teacher and the teacher's principal would resolve issues. Alas, solutions were often multifaceted and thus very challenging.

Administrators have three obvious remedies: negotiated resignation, dismissal, or helping a marginal teacher to improve. Teaching improvements that remedy deficiencies would obviously satisfy all parties. Resignation or dismissal usually follows a prolonged evaluation of a substandard or marginal teacher. Let's examine the three possibilities within the context of three case studies that contain some elements of real life supervision experiences.

Resigning with Dignity

Ted was a long-time personal friend and a former teaching colleague. He could retire but chose to continue teaching (in an affluent community). His 5th grade teaching and management skills were now marginal. They were tuned to an earlier period, ignoring current provincial requirements and cultural changes. Parents expressed their concerns. Students were bored and misbehaved. Unfortunately, at this stage in his career Ted wasn't interested in making the effort to change his approach to meet current professional expectations. The level of criticism was credible: Nice person, poor teacher.

The principal asked that he be assigned to a different school to get a fresh start. The central office assigned him to an inner city school as an extra teacher. The principal assigned him to a small fourth grade classroom and visited his class at least once every morning and afternoon to monitor and assist Ted and his students. He also personally began the students' mornings with physical exercise so that they were ready to sit quietly in class.

Ted's teaching became acceptable with this high level of support. However, Ted's school got a new principal the following year. He assigned Ted to a regular classroom and eliminated intensive supervision and support. His annual evaluation then indicated that Ted's teaching was consistently substandard, and he recommended dismissal.

I reviewed all the data we had on Ted and found it valid and credible. When Ted met me in my office, I reaffirmed my friendship and my respect for his commitment to teaching over his career. I told him that his principal recommended dismissal. His teaching would be re-evaluated for possible dismissal the following year. It was his choice but as a friendly colleague I recommended that he retire with his dignity and reputation intact. He immediately responded that he intended to resign the next day. We reaffirmed our friendship and mutual respect as he left my office to begin the next phase of his life.

Dismissing an Incompetent Teacher

Rod was a grade nine science teacher. He demonstrated subject matter expertise, and skillfully used guided and independent practice followed by testing and remedial teaching. Students excelled in his class. His classroom control was exceptional. These positive attributes were viewed as valid and credible. Supervisory research (Darling-Hammond, et al., 2012) supports these attributes as effective.

Unfortunately, Rod's interpersonal relations with students and parents were decidedly autocratic. Supervisory research (Darling-Hammond, et al., 2012) supports this concern. Collaborative rather than autocratic classroom management is most effective for student learning. Students and parents occasionally complained to the principal about Rod's interpersonal relations, which added credibility to this concern.

One day Rod became exasperated and permanently removed a student from his class. The current issues with this student included being late and insolent. In fact, he had a long history of misbehaviour including being late for class, off task behaviour, chatting during instruction, texting friends in class, and rudeness. The student's mother complained about this expulsion to the assistant principal. The assistant principal investigated and reinstated the student with a set of clear expectations and consequences for future misbehaviour. Rod was incensed and informed the principal that he would not accept the student back into his classroom.

The principal contacted me, and I visited Rod in his classroom. I confirmed that the student's behaviour was clearly unacceptable. I told Rod that I supported the assistant principal's plan to deal with any future misconduct. I also made it clear that a teacher does not have the authority to permanently expel a student from class. I reaffirmed the principal's authority in this matter and gave Rod a letter documenting my decision. He responded that he refused to accept my decision. I wrote Rod a letter suspending him until he and the student returned to the classroom. He appealed his suspension and refused to return if the student was readmitted. I decided to lift Rod's suspension and I immediately transfer him to a new school for a fresh start. Rod bitterly refused this directive. He was immediately dismissed for being absent without leave and for

being insubordinate. Rod unsuccessfully appealed his dismissal to the Board of Education and a provincially legislated board of appeal.

Moving a Teacher from a Marginal to an Acceptable Level

A professional colleague contacted me to arrange instructional coaching for Bev, who was teaching in a small town near Saskatchewan. She had been a respected teacher in the school district. However, a professional malaise had set into her classroom performance. She now seemed bored, rather than enthused, about teaching. Parents preferred not have their children in her classroom. Her classroom curriculum and instruction were dated. Bev had become strident in dealing with her grade three students. The superintendent accepted the above concerns as valid and credible

The school district superintendent thought that in-classroom coaching by five exemplary grade three teachers in our city schools would complement the principal's developmental supervision. Bev received one day a week coaching over a protracted period of time. These visits by our district teachers invigorated her teaching career. She was motivated and modernized by the coaching experiences she experienced. Indeed, she maintained an ongoing professional association with two of our teachers.

My superintendent colleague told me at the end of the year that Bev was once again enthused about teaching. She was beginning to use the up-to-date curriculum and instruction she had observed in the progressive teachers' classrooms.

Credible and Valid Supervision for Marginal Teachers

Successful responses to Ted, Rod, and Bev depended on useful and persuasive supervision. Administrative responses to marginal teaching must be grounded in a clear understanding of what is most important and what works in the classroom. Research on instructional effectiveness provides this valid and credible grounding for supervisory and evaluative responses.

Research findings provide a great starting point for improvement efforts. Darling-Hammond, et al. (2012) has identified seven features from instructional research:

- Demonstrating expertise with the subject matter;
- Connecting to prior student learning;
- Providing models and learning platforms;
- Guided and independent practice;
- Ongoing diagnosis and re-teaching;
- Frequent testing, feedback and correction; and
- Collaborative classroom management.

Improvement begins when these findings are used as a credible and valid starting point for responding to marginal teaching. Peer coaching, portfolio development, interdisciplinary study, and cooperative learning are effective developmental supervision approaches to increase teacher competence. Current research in cognitive neuroscience supports these approaches and suggests complementary ways to assist marginal teachers learn and teach effectively (Sylwester, 1995).

Dismissal and voluntary resignation require that teacher evaluation be accurate and consistent. Darling-Hammond, et al. (2012) reported that current evaluation platforms are

accurate when the seven research findings listed above are the basis for assessment and appraisal. She also endorses regular classroom observations throughout the year by a school principal who is trained in using the factors above.

My decade of experience as a superintendent of schools convinced me that firing an incompetent teacher occurred infrequently. When necessary, it was often a brutal and painful process for everyone involved. The difficulty and pain are magnified when a teacher is marginally competent, as opposed to incompetent. Performance evaluation can leave any teacher distressed, confused, and anxious. Helping a teacher improve is a far more effective and satisfying alternative for all involved.

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Chapter 14

IAE Newsletter # 168

Medical Research and Medical Decisions

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Introduction

> The discipline of medicine applies biomedical sciences, biomedical research, genetics and medical technology to diagnose, treat, and prevent injury and disease, typically through pharmaceuticals or surgery, but also through therapies as diverse as psychotherapy, external splints and traction, prostheses, biologics, and ionizing radiation (Medicine, n.d.).

The definition given above is often called *standard medicine* or *standard care. Complementary and alternative medicine (CAM)* is the usual term for medical products and practices that are not part of standard care (Complementary…, n.d.).

Throughout the American health care system, people make decisions based on the knowledge and beliefs they have, and the information resources that they can access. This chapter takes a brief look at the validity and credibility of the information that is used to make health care decisions. The goal is to help you—an individual reader—to make better decisions and to better appreciate the complexities faced by our health care system. Of course, we hope you will share your increased knowledge with your students and others.

More than one-sixth of the yearly total U.S. gross national product is spent on health care. Each of us knows a great deal about health care and routinely makes personal decisions in this area. In addition, we have a huge infrastructure of health care professionals, hospitals and clinics, health care insurance, drug and health care products manufacturers and distributors, medical researchers, university medical schools, and so on. After all, it requires considerable effort and infrastructure to spend more than $2.8 trillion a year!

It is appropriate to ask about the credibility of people who offer health care and advice about health care. It is also appropriate to ask about the validity of the practices they employ and the information they use, as well as the proven effectiveness of the medicines and treatments they provide. The health care system is governed by a huge number of laws, rules, and regulations. Nevertheless, it unfortunately has its share of unethical and/or poorly prepared practitioners and ineffective treatments.

The short message is, "Let the buyer beware." I am reminded of the innumerable ads I have viewed and read about weight loss programs. Many people continue to want to believe in a magic pill or magic program for weight loss. My personal belief is that if there were a safe, easy-to-use, and not overly expensive "treatment" that required little or no effort on the part of the patient, it would be well supported by good research and widely available. So far, no such luck.

Comparing Health Care and Education

Most readers of this book are educators. As educators, we realize that education is both an art and a science. The art is displayed by millions of individual human teachers in their day-to-day interactions with their students. The science comes from a substantial amount of education and cognitive neuroscience research. Substantial progress is occurring in implementing some of the science of teaching and learning via computerized, intelligent teaching machines. IAE has published a seven-newsletter series comparing health care and education (Education and Health Care, 2010).

It is interesting to consider the parallels between the art and science of education, and the art and science of health care. Think about the complexities of improving either of these gigantic and complex systems!

Medicine Is Not an Exact Science

Although the "science" of medicine is large and growing, medicine is by no means an exact science. Moreover, the problems that medicine is addressing are very complex. The daily media has made this clear in its coverage of Alzheimer's and other dementia, autism, cancer, Ebola and other viruses, etc.

While most of us would like to believe that a magic pill, shot, vaccination, or other similar treatment will always work for each of these health problems, that definitely is not the case today. Nor is this apt to be the case for a great many years to come.

We do have some very effective preventative treatments. Quoting from The History of Vaccines (n.d.):

> Individual immune systems, however, are different enough that in some cases, a person's immune system will not generate an adequate response.
>
> That said, the effectiveness of most vaccines is high. After receiving the second dose of the MMR vaccine (measles, mumps and rubella) or the standalone measles vaccine, 99.7% of vaccinated individuals are immune to measles. The inactivated polio vaccine offers 99% effectiveness after three doses. The varicella (chickenpox) vaccine is between 85% and 90% effective in preventing all varicella infections, but 100% effective in preventing moderate and severe chicken pox.

For various reasons, some people want to opt out of having their children vaccinated and/or receive other forms of medical treatment. These people make a decision based on their knowledge and beliefs, yet this knowledge may well be based on information that is not valid. If enough children in a certain locality fail to receive a particular vaccination such as the MMR vaccine, a local epidemic is possible. So, we have a medical, religious, legal, and political conflict between the good of the many versus the rights of the individual.

Here is a somewhat similar example. Those of us who have grown up depending on the effectiveness of antibiotics are dismayed by the current growing ineffectiveness of widely used antibiotics (Boseley, 4/30/2014). Our misuse and overuse of some of these antibiotics has led to this decline in their effectiveness. Quoting from the article:

> Antibiotic resistance is a major threat to public health, says the WHO. It is no longer something to worry about in the future, but is happening now and could affect anybody, anywhere, of whatever age.

> "Without urgent, coordinated action by many stakeholders, the world is headed for a post-antibiotic era, in which common infections and minor injuries which have been treatable for decades can once again kill," said Dr Keiji Fukuda, the WHO's assistant director general for health security.

Decision Making Under Uncertainty

Because medicine and medical treatments are by no means an exact science, the decisions made at every level of medical care can be thought of as being decision making under uncertainty.

I am not feeling very well today. Should I: call 911; go to an Urgent Care facility or Emergency Center; schedule an appointment with my doctor; call a friend and ask for advice; go to work anyway; or just stay home and continue to monitor the situation? One approach is to think about the consequences of each of your possible decisions. For example, suppose you know some of the symptoms of a heart attack, and you think you might be experiencing some of these symptoms. Calling 911 might save your life.

The decision you make will depend on your accumulated knowledge and experience. So, you first draw on information stored in your head. How valid and up to date is it? Next, you think about accessing other sources of information. For example, you may take your temperature and check your heart rate. You may think carefully about your symptoms, and use the Web or other information source to look up information on possible meanings of these symptoms.

If the information resources you use are valid and you understand the information they provide, you are apt to make a better-informed decision. This observation supports the value of all students receiving sufficient health care education so they can make effective use of information resources that are generally available.

Growing Availability of Relatively Good Sources of Information

Many of us grew up with the medical help of Dr. Benjamin Spock (Spock, n.d.). Quoting from the reference:

> **Benjamin McLane Spock** (May 2, 1903-March 15, 1998) was an American pediatrician whose book *Baby and Child Care*, published in 1946, is one of the best-sellers of all time. Its message to mothers is that "you know more than you think you do."

Now we have access to many websites that are credible and strive to provide valid information. Here is a short list in alphabetical order. This is not intended to be a definitive list.

- Center for Disease Control and Prevention
- health.gov
- Mayo Clinic
- MedlinePlus
- NHS
- Patient
- Web MD

Part of your personal health care education, and that of your students, should include learning to make use of sources like these and/or others that you believe offer valid information and that you can communicate with effectively.

IBM's Watson: Part of the Future of Medicine

IBM's computer system named Watson is well known for defeating two human champion players of the TV game *Jeopardy* in 2011 (Best, n.d.). Since then the hardware of this computer system has been vastly improved, and large teams of researchers and practitioners have been developing software and databases to apply this compute power to a variety of problems. Watson is already showing its promise to significantly help in improving our health care system.

The general ideas behind Watson learning to play *Jeopardy* have been expanded into Watson learning to read and process both the medical research literature and individual patient records.

The U.S. National Institute of Health reports that it is now processing more than 700,000 new citable medical articles per year, and that its total library now contains 21 million articles (NIH MEDLINE, 2015). The current Watson medical system is designed to read and process such literature. Its "intelligence" in processing this literature, and then making use of it to analyze an individual patient's records, is growing steadily.

Quoting from Putting Watson to Work (IBM, n.d.):

> In fact, the amount of medical information available is doubling every five years and much of this data is unstructured—often in natural language. And physicians simply don't have time to read every journal that can help them keep up to date with the latest advances—81 percent report that they spend five hours per month or less reading journals.
>
> Watson uses natural language capabilities, hypothesis generation, and evidence-based learning to support medical professionals as they make decisions. For example, a physician can use Watson to assist in diagnosing and treating patients. First the physician might pose a query to the system, describing symptoms and other related factors. Watson begins by parsing the input to identify the key pieces of information. The system supports medical terminology by design, extending Watson's natural language processing capabilities.
>
> Watson then mines the patient data to find relevant facts about family history, current medications and other existing conditions. It combines this information with current findings from tests and instruments and then examines all available data sources to form hypotheses and test them. Watson can incorporate treatment guidelines, electronic medical record data, doctor's and nurse's notes, research, clinical studies, journal articles, and patient information into the data available for analysis.

This is a truly amazing project! Its use will spread beyond trained medical personnel. Here are two of my predictions:

1. More and more instrumentation will become available for everyday use by ordinary people. (I currently own an oral thermometer, a device for measuring pulse rate and blood oxygen content, and a blood pressure cuff.)
2. Ordinary people will gain more and more access to Watson-like computer systems that they can interact with, explain their medical problems, and get computer-based advice.

Final Remarks

Medicine is not an exact science. The decisions that health care workers and those receiving health care make can be thought of as decision making under uncertainty. Through education, experience, and drawing on valid sources of information, health care workers and patients can make better decisions. Through continuing research and development, our health care system can continue to be improved.

It is clear that patients and health care professionals are becoming more and more dependent on the use of computers in health care. Eventually a person at home who has a medical care problem will be able to talk to a Watson-type computer system rather than "merely" looking up information on the Web. That does not resolve the issue of the credibility of the information source and the validity of the information and recommendations it provides. This leads to a question I frequently hear, "Who gets sued if something goes wrong?"

These same statements hold true for our educational system. There are no magic vaccinations, shots, or pills that will cure the ailments of our educational system. Each of us individually bears considerable responsibility in gaining an education that meets our personal needs.

Our system of professional educators and schools can help a great deal in these individual endeavors. The system can be improved by helping students to better understand their roles and responsibilities in helping themselves to attain an education that will meet their current and future needs.

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Part 5

Validity and Credibility: Appropriate Assessments

The final two chapters provide examples of two approaches to providing valid, credible information. Chapter 15 recommends the *TED Talks* videos as valid and credible sources of information. Here, the presenters have a high level of credibility and their content tends to be well supported by their own research and/or the research of others. Chapter 16 offers the field of epidemiology as an example of how a discipline of study can set guidelines designed to help increase the validity and credibility of its research and the dissemination of its findings.

Chapter 15

IAE Newsletter # 169

Keeping Up: *Ted Talks* as a Personal Example

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> "I have made this letter longer than usual, only because I have not had the time to make it shorter." (Blaise Pascal; French mathematician, physicist, and religious philosopher; 1623–1662.)
>
> "If I have seen further it is by standing on the shoulders of giants." (Isaac Newton; English mathematician and physicist; 1642–1726.)

As Blaise Pascal so eloquently pointed out, it takes much more work to communicate concisely than to merely ramble on and on about a topic. And, Isaac Newton reminds us that a great many people are working to advance human knowledge. To keep up in and/or advance a field, we need to build on the work of others. But, whose work—and what parts of their work—are valid and credible?

I spend considerable time trying to keep up in my professional fields of study and writing. I look for concise, valid, credible sources of information that meet my personal needs. I feel great pleasure when I discover such an information source.

Of course, I belong to various professional societies and browse their publications. These give me a sense of what the professionals in my fields are doing. Frequently the articles are way over my head or so specialized that they lie outside my interest areas.

To a large extent, however, I find I need much more than just the professional society publications. Thus, I spend a substantial amount of time using other information sources. I subscribe to a variety of "popular" science-oriented magazines such a*s Scientific American*, *Science News*, *New Scientist*, *Smithsonian,* and *MIT Review*. These provide an interdisciplinary overview that I find particularly valuable. And, of course, I read a variety of Web-based "news briefs," blogs, and other short publications. These tend to give me a handle on what issues the media and others think are important.

Attention Span

As an aside, educational researchers know quite a bit about the typical student's span of attention. The attention span of precollege students receiving individual tutoring is discussed in a report from The Student Coalition for Action in Literacy Education (SCALE, n.d.). A summary of some of the research on college students is given in Are You with Me? Measuring Student Attention in the Classroom (Bunce, et al., 2010). Teachers (and parents) know from experience that young children have quite short attention spans.

With practice and increasing maturity, attention span increases. However, even college students are well served by breaking 50-minute lectures into much shorter segments, with

students engaging in small group discussions and/or in whole class discussions that provide both time and a vehicle for "digesting" the information that is being presented. One of the advantages of viewing the *TED Talks* discussed below on one's own computer or other device is the ability to pause and reflect as needed.

TED Talks

The *Technology, Entertainment, and Design (TED) Talks* are one of my favorite sources of information. Each *TED Talk* is generally 18 minutes or less in length. The 1,900 talks presented since TED began in 1984 are available free on the Web, and have had more than 2,000,000,000 views (About TED, 2015; Hochman, 3/7/2014).

I consider that the *TED Talks* I select as relevant to my personal areas of interest meet my criteria as useful and reliable resources. The talks are brief and they tend to be credible, valid, and up-to-date.

Typically, I browse through the titles of recently presented *TED Talks* until I hit one that "grabs" me and I am intrinsically motivated to look into the topic. Intrinsic motivation is a very valuable idea in teaching and learning. When our informal and formal educational systems create situations in which students are intrinsically motivated, students make great progress.

Almost always, a topic I select is one that I know something about. I am not using *TED Talks* as an introduction to topics that are completely new to me. Rather, I am using *TED Talks* as a quick and up-to-date overview designed to refresh and extend my current knowledge.

Constructivism

Here is another aside. Constructivism is a learning theory based on the idea that learners build on and extend their current knowledge. I select my learning materials based on a combination of my intrinsic motivation and my having appropriate prerequisite knowledge. The plethora of Web-based and other materials now available to students can help create this situation for all students.

A *TED Talk* by Fei-Fei Li

I will illustrate using Fei-Fei Li's *TED Talk,* How We're Teaching Computers to Understand Pictures (Li, March, 2015; Moursund, 4/13/2015). It caught my attention because it is about an important and challenging component of artificial intelligence (AI), a topic that has long been of interest to me. The very first book I read about AI was Feigenbaum and Feldman's 1963 anthology, *Computers and Human Thought* (Feigenbaum & Feldman, 1963). It provided an introduction to the field through a sequence of articles that were near the "cutting edge" but accessible to lay people. I suppose it was mainly just plain dumb luck that I happened to encounter this book—a book that kindled my initial and continuing interest in AI.

What this means is that, as I view a presentation about an AI topic, I can do mental "fact and idea" checking. I am able to judge validity based on my extensive background knowledge, and I am apt to catch major errors in the presentation. In addition, I can fit some of the ideas into what I already know, and I can tie the new ideas to my foundational knowledge.

The Presenters and Presentations

TED has a presenter selection group process designed to find well-qualified presenters. They are open to suggestions from outsiders. When I go to a *TED Talks* on the Web, I can read the credentials of the presenter. If I am curious, I can look up the presenter on the Web.

For example, Fei-Fei Li is Director of Stanford's Artificial Intelligence Lab and Vision Lab, and she has a doctorate from the California Institute of Technology (Cal Tech). Stanford is one of the leading universities in the world, and it is well known for its work in AI. Cal Tech also is a prestigious university. Wow, these are impressive credentials! Since her presentation topic is within her field of expertise, I consider her to be a very credible information source.

The *Ted Talks* videos are filmed before a live audience, and some of the talks have had millions of online viewers. This live audience and the potential huge number of online viewers put considerable pressure on the presenters to be well prepared. Most of the *TED Talks* presenters I have viewed are quite experienced speakers and make good use of well-designed visuals. This is certainly true for Li, who has both teaching and administrative duties at Stanford.

Each *TED Talks* video includes a transcript available online along with the free video. Thus, I can read the transcript at my leisure. I find the transcript helpful in reviewing details from the presentation and also useful if I want to quote from the presentation in an article I am writing.

An Activity to Do with Students

Here is an activity that you might want to carry out with middle school and older students. Ask your students to tell you about the sources they use in exploring and finding information about a topic that they currently find very interesting. (For example, they might be interested in the latest "hot" music or the performance of current and past great athletes.) Then ask about their insights into the validity and credibility of the information sources and the information they are retrieving. This activity can be used effectively in a classroom setting, with students working in pairs or small groups.

Final Remarks

These final remarks can be summarized by the following quotation:

> "Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it." (Samuel Johnson; British author and father of the English dictionary; 1709–1784.)

Our schools are moving toward providing all students with good connectivity both in and outside of school. The Web is already by far the world's largest library, and it continues its rapid growth. Aids to interacting with the Web and finding information continue to improve.

A good education and a good educational system provide students with the background knowledge to "look it up" and to understand the information one finds. It helps students learn to separate the wheat from the chaff—valid information from information that is questionable, biased, or just plain wrong. In addition, it helps students learn to learn on their own and to become responsible for their own learning.

Think about the previous paragraph in terms of how we are currently trying to assess student learning through state and national high-stakes tests. At the current time, this assessment system is certainly **not** aligned with the types of educational ideas discussed above.

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Chapter 16

IAE Newsletter # 170

Validity and Credibility: The Search for Truth

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Validity and *credibility* are the commonly used terms in the search for truth. Validity refers to the logical and factually sound nature of an assertion, and credibility refers to the level of trust one has in the assertion. It's thus possible to consider something as credible even though it lacks scientific and/or logical validity, and it's also possible that someone could deny the credibility of a valid discovery. For example, global warming discoveries have considerable scientific validity, but some people deny the credibility of the research (or of the researchers).

We began this book with the analogy of how the Olympics determines medalists. They use precise, objectively valid measurements to determine winners in such timed and distance events as running, leaping, and throwing. Conversely, a panel of supposedly credible judges subjectively determines winners in such events as figure skating and gymnastics. Such subjective judgments aren't based on who arrived first or jumped the highest, but rather on how well the winning athlete performed in the event. In either type of event, the medalist wins a legitimate Olympic medal. Winning a gold medal in the 1500-meter race is thus equal to winning a gold medal in a gymnastics event, even though objective validity determines one winner and subjective credibility the other.

Issues in Determining Validity and Credibility

Validity and credibility contribute to each other. For example, Olympic participants assume the credibility of the objective measurement devices used to determine winners. Similarly, subjective Olympic scoring systems can only become credible when judges employ valid mathematical methodology to precisely compute similar scores.

However, in our broader culture, validity and credibility are often employed independently of one another. *Credibility without genuine validity* is evident in partisan media outlets such as FOX, which solicits credibility from a politically conservative audience, or MSNBC, which does it for a politically progressive audience. Many Internet websites are similarly biased in their approach. Fact-checking organizations consistently challenge the validity that these outlets espouse, yet viewership remains strong. Each outlet seeks credibility from within their subjectively biased audience, despite any questionable validity.

Validity without credibility occurs when researchers measure accurately, but with an intent or method that could be deemed subjective. For example, a researcher can ask suspect questions in

a confusing manner, and then draw conclusions that are perfectly valid but lack convincing credibility. This is known as the Experimenter's Bias [1]. One example in recent history is the Climatic Research Unit email controversy [2]. Climate change skeptics unearthed emails among climate scientists who discussed self-proclaimed *tricks* they apparently used to "fix" tree-ring data to a foregone conclusion of climate change. Scientists use the width of tree rings to indicate weather differences during successive years. The *tricks* employed could represent statistically valid sound practices, but they were impeached by some folks due to their dubious credibility (including the casualness with which the scientists discussed them).

In both credibility *without* validity and validity *without* credibility the lacking component is not contributing an adequate amount of check and balance to the other. Either, without the other, is merely a shortcut to *truth*, and the result is obviously bias. So, why do people do it?

No one likes to be wrong. When we believe or say something that is demonstrably wrong, we are embarrassed or even humiliated by our misguided belief. Regret of being wrong can be hard to forget, perhaps becoming a lifelong haunt. The pangs of rumination can thus be a powerful motivator to be more certain of our beliefs. Unfortunately, credibility *with* validity and validity *with* credibility are difficult to achieve. Even more, the decisions we make often don't have a black-and-white simplicity. A lot of gray area exists in which validity and credibility must contribute to a thoughtfully weighed decision, and that requires time and effort. Realize that in the Olympics, subjective decisions must often be made very quickly.

Confirmation Bias [3] has been integral to human life since early tribalism emerged. We tend to view a group that we belong to (commonly called a tribe) as credibly correct when compared to the views of other tribes. This phenomenon is a systematic error in inductive reasoning, but it feels good anyway. We display this bias when we selectively use information. We tend to imply stronger bias-directed effects when issues are emotionally charged or our beliefs are deeply entrenched. We tend to assume that ambiguous evidence supports our existing beliefs.

Likewise, a phenomenon known as Frequency Illusion [4] has been observed as a sub-conscious means of reinforcing opinion by seeming to seek out evidence of validity wherever we look. When we're trying to solve a perplexing issue, we can be particularly attuned to noticing every related encounter. For example, a couple who are debating whether to start a family may suddenly seem to see babies and young families everywhere they look. Those babies and families were always there before, but the couple simply hadn't noticed them before they considered having a family of their own.

Several factors such as these can lead to error in the search for truth. For example, our attitudes may become polarized when others identify errors in the evidence we use. We may persist in our beliefs even when others explain their untenable nature. We may rely more on the value of earlier beliefs than on what emerged in later forms of investigation. We may perceive a predictable spurious connection between two events or situations,

When events occur that suggest that our beliefs about our tribe have been wrong, we may simply join another church or a different political party that agrees with us (or perhaps quit our job or seek a divorce).

A Solution from Epidemiology

It is incumbent upon research science to develop valid systems that will prove credible. The Bradford Hill Criteria [5] have provided a useful checklist of the minimal conditions that signal a

causal relationship between an incident and a possible consequence in epidemiology, an area in which scientific validity is essential. Epidemiology thus always questions every supposition, method, and technique. Researchers tirelessly defend every fact and figure because fund administrators and peer scientists require unimpeachable conclusions—as do the people who might otherwise get infections.

The Bradford Hill Criteria

The Bradford Hill criteria (1965, and paraphrased below) otherwise known as Hill's criteria for **causation**, are a group of minimal conditions necessary to provide adequate evidence of a causal relationship between an incidence and a possible consequence. It was established by the English epidemiologist Sir Austin Bradford Hill (1897–1991) in 1965.

1. **Strength**: A small association does not mean that there a causal effect doesn't exist. The larger the association, the more likely that it is causal.
2. **Consistency**: Consistent findings observed by different persons in different places with different samples strengthens the likelihood of an effect.
3. **Specificity**: Causation is likely if a very specific population at a specific site and disease includes no other likely explanation. The more specific an association exists between a factor and an effect, the better the probability of a causal relationship.
4. **Temporality**: The effect has to occur after the cause (and if an expected delay occurs between the cause and expected effect, the effect must occur after that delay).
5. **Biological gradient**: Greater exposure should generally lead to greater incidence of the effect. However, in some cases, the mere presence of the factor can trigger the effect. In other cases, an inverse proportion is observed: greater exposure leads to lower incidence.
6. **Plausibility**: A plausible mechanism between cause and effect is helpful but knowledge of the mechanism can be limited by current knowledge.
7. **Coherence**: Coherence between epidemiological and laboratory findings increases the likelihood of an effect. However, lack of such [laboratory] evidence cannot nullify the epidemiological effect on associations.
8. **Experiment**: It is occasionally possible to appeal to experimental evidence.
9. **Analogy**: The effect of similar factors may be considered.

Final Thoughts

Daniel Kahnman's *Thinking, Fast and Slow* (2011) [6] is considered to be one of this decade's best books on the issues related to valid/credible thought. The *IAE Newsletter* published a synthesis of the book: http://i-a-e.org/newsletters/IAE-Newsletter-2012-89.html.

Other topics discussed earlier in the book, such as assessing the validity of scientific and mathematical research, the value of poetry, the legitimacy of advocacy groups, and the credibility of religious dogma suggest that appropriately assessing validity and credibility will probably remain a complex (and a contentious) societal issue.

Here is an important suggestion: Those who intend to prove or disprove a scientific theory, method, or supposition, should demonstrate a similar level of diligence as was invested in developing the material they dispute.

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