Moderator - Lonty Bryant

Introduction to Critical Thinking and Problem Solving

K. G. Odde, *DVM, PhD*
Senior Veterinarian
Livestock Technical Services
Pfizer Animal Health
Pollock, SD

Veterinarians with excellent critical thinking skills and problem solving abilities will be better equipped to compete as providers of service to the cattle industry in the future. We live in an age of dramatic increases in information generated through scientific investigation. Additionally, this information is more quickly available to us than ever before. We and our clients can access wide varieties of information that may be applicable to a problem we've encountered. Furthermore, we can collect massive amounts of data with current computer technological capabilities. The exponential growth of scientific publications, the ability to rapidly retrieve this information, and the ability to use current computer capabilities to collect large data sets in cow-calf and feedlot operations have created greater need for critical thinking skills in feedlot and cow-calf veterinarians. Veterinarians must be capable of bringing the best information to a particular situation, determining the relevance of the information, and providing a recommendation with high liklihood of success. The purpose of this presentation is to provide an overview of critical thinking and problem solving as it relates to beef cattle veterinarians.

It is perhaps useful to examine traditional approaches to problem solving in veterinary medicine. Historically, veterinary medicine has been very "knowledge focused" and educational efforts designed to train students in critical thinking have been limited. This educational approach is certainly not limited to veterinary medicine. In fact, Benjamin Bloom in *Taxonomy of Educational Objectives*, 1956[1] stated that the acquisition of facts is "the most common educational objective in American education." He also maintained that "the more complex and higher categories of the cognitive domain require far more sophisticated learning experiences" than the simple recall of facts. He further stated that much more motivation is required and "much more activity and participation on the part of the learner is necessary" if students are to become effective critical thinkers.

"Knowledge focused" education also perpetuates the myth that knowledge is certain. Another way of saying this is that issues are true or false (or black and white, rather than gray). Experience in the real world tells us that rarely (perhaps never) are we 100% certain. We never know "absolute truth." Charles Van Doren, philosopher and mathematician and author of *A History of Knowledge*, 1991[2] states that "knowledge can never be certain." Bart Kosko is a professor at the University of Southern California with degrees in philosophy, economics, mathematics and electrical engineering. He is the author of *Fuzzy Thinking, The New Science of Fuzzy Logic*, 1993.[3] He defines the "Fuzzy Principle" as "everything is a matter of degree." In the Preface of his book, he describes the path that took him to the "Fuzzy Principle." He states "there was a mistake and everyone in science seemed to make it. They said that all things were true or false. They were not always sure which things were true and which were false. But they were sure that all the things were either true or false. In fact, they were matters of degree. All facts were matters of degree. The facts were always *fuzzy* or vague or inexact to some degree. Science treated the gray or fuzzy facts as if they were black-white facts of math."

In veterinary medicine today, we frequently hear that we must use a research-oriented or scientific-based approach to problem solving. Obviously, the development and use of scientific methods has resulted in enormous advances in the knowledge base. Rene Descartes, a 17th century French philosopher, is generally credited with the development of scientific method. Descartes said that to solve any problem, it is helpful to divide the question into a set of, or series of smaller problems, and solve each of them in turn. His search for certainty was based on the principle that everything should be doubted. He discovered a method of problem solving based on the reduction of all problems to a mathematical form and solution.[2] Science is an intellectual discipline which proceeds from accurate, exact, and methodic experience on the empirical level to a rational and economic synthesis of determining principles in order to construct a mathematical image of the universe that will be both useful and satisfying.[4] Scientific method relies on observation that is (1) objective, (2) accurate, and (3) exact. The objectivity of scientific observation is achieved by measurement. Science deals with the measurable, and for this reason, mathematics is the language of science. There are two kinds of observation. The first kind is observation without modifying that which is observed. Astronomy is the classical example. In veterinary medicine, analytical epidemiology provides us with this kind of approach. The second kind of observation is experimental, where variables are controlled. This approach allows us to answer precise questions. The experimental approach is the scientific method that is used in almost all of agricultural, biomedical and veterinary research. In fact, to most researchers in these communities, it is the "only" scientific method.

There are tremendous opportunities to use methods in analytical epidemiology (observational research) for problem solving in both cow-calf and feedlot practice. Analytical epidemiological techniques employed include risk factor analysis, mathematical modeling and multiple regression.[5] These methods are particularly appropriate for addressing complex, multifactored issues. They allow us to quantitatively identify risk factors for a particular disease or condition. We can identify "significant" risk factors as well as identify the relative importance of various risk factors. These techniques require appropriate record keeping and expertise in the analytical methods.

Critical Thinking

What is critical thinking? J. E. McPeck, in *Critical Thinking and Education*[6] defines critical thinking ability as "the skill to engage in an activity with reflective skepticism." McPeck further states that "critical thinking always manifests itself in connection with some identifiable activity or subject area and never in isolation."

Whimbey and Lochhead (1982)[7] define critical thinking as "those mental habits or skills, essential to all academic and professional disciplines, including the ability to concentrate, to search for and test alternatives, to break down large and complex problems into smaller parts, to look for analogues when confronting the unfamiliar, and to check the accuracy of the thought process when reaching a conclusion."

Critical thinking involves not only the ability to evaluate information analytically and objectively, it also requires the individual to evaluate one's own thought processes and beliefs with "reflective skepticism." Why is this necessary? This need is perhaps best captured in the following statement made by Francis Bacon- **"Man prefers to believe what he prefers to be true."**[8] There are numerous examples that demonstrate the inconsistencies between beliefs and "facts." A survey of one million high school seniors found that 70% thought they were above average in leadership ability, and only 2% thought they were below average. In terms of ability to get along with others, all students thought they were above average, 60% thought they were in the top 10%, and 25% thought they were in the top 1%.[9] A survey of college professors found that 94% thought they were better at their jobs than their average colleague.[10] Recognition of one's desire to believe what one would prefer to be true is an important step in becoming a more objective person.

If critical thinking is "reflective skepticism", isn't critical thinking equivalent to negativism? Not at all. Reflective skepticism requires constant evaluation of one's own ideas as well as information that one reads or hears. Reflective skepticism is best cultivated by constant debate about one's own ideas as well as new information. Acquiring the skill of polite debate will allow one to maintain friendships even when disagreements occur. This skill requires a respect for all people and for their right to express a view. This respect is not reserved for the educated or the powerful.

Doesn't experience make one a critical thinker and more effective problem solver? Not necessarily. Eileen D. Gambrill, in *Critical Thinking in Clinical Practice,* 1990[11] states that "experience does not necessarily result in improved performance." She explains this by further stating "experience does not offer systematic data about what works with...what problems." I suspect that we could begin a major debate on the value of experience. I believe that what is ultimately important is placing our experiences in context. If we have evidence developed through rigorous scientific methods, that evidence must be weighed with our experiences as we address a particular problem.

Perhaps the best way to summarize critical thinking is to again quote McPeck.[6] He states that "critical thinking requires the judicious use of skepticism, tempered by experience, such that it

is productive of a more satisfactory solution to, or insight into, the problem at hand."

Problem Solving

By now, it is obvious that I believe that critical thinking is a prerequisite to effective problem solving. It is important to recognize, however, that critical thinking ability does not by itself make one an effective problem solver. A broad knowledge base in the subject area and a network of experts to call on are also essential.

To explore problem solving in more detail, I have chosen to break it down into four categories: (1) problem identification; (2) problem definition; (3) evaluation and implementation of solutions; and (4) monitoring the effect.

1. Problem Identification

The first step in problem solving is problem identification. Problems may be identified by the producer, the veterinarian or other interested parties. Problems may be as obvious as a disease outbreak or as subtle as elevated production costs or lost opportunity. If problems are only identified by the producer, opportunities for veterinarians in problem solving are going to be limited by the producer's perception of his/her veterinarian (or veterinarians in general). Cow-calf producers frequently think of veterinarians as experts in infectious disease and reproduction. This perception means that the opportunities for veterinarians will frequently be limited to these kinds of problems in cow-calf operations. On the other hand, if the veterinarian currently serves the producer as a paid consultant, the opportunity to address problems becomes much greater, both because the veterinarian can enhance his/her role because of more opportunity to demonstrate economically viable assistance and because the veterinarian is now in a position to identify more subtle problems.

2. Problem Definition

Another important step in problem solving is problem definition. This may seem obvious and transparent, however, my experience indicates that unresolved problems are frequently a result of inadequate definition. Problem definition means that the producer and veterinarian agree on the nature and scope of the problem.

3. Evaluation and Implementation of Solutions

It is clear that some problems are simple and do have solutions that are easily identified and implemented. However, many problems are complex and do not lend themselves to quick and simple solutions. If we attempt to solve these with a quick solution, we have high liklihood of being wrong. For example, if a rancher is having an infertility problem in a cowherd, and we (attempt to) diagnose the problem over the telephone, our chances of arriving at the correct diagnosis are not high. We increase our chances when we add a thorough history to our information bank. However, experience also tells us that a ranchers "read" of a situation is not always consistent with data obtained from records. If we obtain records that include calving dates, condition scores, cow ages, pregnancy examination data, bull information, and other appropriate diagnostic information, our odds of arriving at the correct diagnosis get considerably higher.

We must also remember that the "correct" solution may be to provide short-term recommendations based on available information, and at the same time, to put the record keeping and data collection system in place to arrive at a better long-term solution. An example of this kind of approach is a situation that I worked on with Dr. Jim Clement, Mandan Veterinary Clinic, Mandan, ND in 1992-1993.[12] Dr. Clement had five cow-calf herds with histories of chronic calf scour problems. Potential risk factors were identified, and the data collection system was put into place. The potential risk factors evaluated for incidence of calf diarrhea were dam age, time of calving within the calving season, dystocia, spring body condition score of the dam, birth type (twins or singles), and sex of the calf. Additionally, data were collected on nutrient content of feedstuffs, feed intake, cow serum Cu status and calf serum IgG1 concentrations. Using appropriate statistical methods, we were able to identify significant risk factors for calf diarrhea, and implement corrective management procedures. The important point here is that we were able to be more accurate in our assessment of the problem and therefore make better recommendations than if we simply took a "snapshot" picture of the situation and made recommendations.

4. Monitoring the Effect

No problem solving activity is complete without a mechanism in place to evaluate the effects of the recommendations. This may be as simple as a telephone call to the client to get his/her assessment of the effect. When record keeping and data collection systems have been put in place to assess the problem, new information is continually available that can be used by the veterinarian to determine the effectiveness of the recommendations, modify recommendations if necessary, and build a consulting relationship between the veterinarian and the client.

Summary

Veterinarians that are critical thinkers and effective problem solvers will be in an excellent position to compete as providers of service to the

cattle industry in the future. Enhancing one's skills in these areas is an on going process. This process requires continually updating one's knowledge base by reading, listening, observing and maintaining a network of experts to call on, and ; continually evaluating one's beliefs and thought processes by thinking and engaging in debate with respected colleagues.

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Abstract

Direct effects of induced parturition on subsequent reproductive performance of dairy cows from commercial herds in south-western Victoria

J.M. Morton and K.L. Butler
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Reproductive performance was compared between cows whose previous parturition was induced and non-induced cows with similar calving dates, in 49 winter-calving, pasture-fed, commercial dairy herds in south-western Victoria. Parturition was induced in winter when most cows were between 27 and 35 weeks of pregnancy. Reproductive performance was assessed during the next mating period after induction which was mainly in spring of the same year.

Percentages of cows in induced and untreated groups that were not pregnant after the mating period (9.0% and 7.2%, respectively) did not differ significantly. Induction tended to increase the percentage of cows of unknown pregnancy status. Mean percentages for induced and untreated groups were 11.5% and 7.9%, respectively. Induced and untreated groups calved at similar intervals after the planned start of calving in the following year, and the percentages of groups that required induction in that year did not differ significantly. The direct effects of induced parturition on reproduction were therefore concluded to be minimal. In seasonal calving herds, improvements in reproductive performance could be expected among cows whose calving dates were altered substantially by induction, due to increased intervals from calving to mating start date.