Cognition, perception and action: processes underlying problem-solving and well-being in single and double worlds

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Abstract: What are the basic systems people use to solve problems? How does knowledge and learning come into it? What are the roles of emotions and beliefs? How does one make a good "fit" with the surrounding world in a way that enhances the ability to solve problems? How does it relate to leadership? What is transferable to "other" worlds? So what anyway—how does that help one's well-being? This paper addresses these questions by integrating concepts derived from psychology and biology into a model that focuses on how humans solve problems effectively. It then extends the model to the bi-cultural dimension. The final aim is to share these perspectives so that their own "fit" with current considerations of practices and solutions may be considered.

Keywords: action, culture, knowledge, perception, well-being

Introduction

The primary purpose of this paper is to highlight the interactive nature of key systems and processes that underlie problem-solving behaviour. The approach taken is to address a series of questions in a manner that permits us to build a general model. While this model is designed for broad application, it will also permit us to examine its implications for problem-solving in bi-cultural environments as well as its relationship to well-being.

What is problem-solving?

We can begin by thinking of problem-solving as a goal-directed process that creates change from state A to state B. The nature of the change may be described according to its quality using terms like "development", "advancement", "increase" or of course by their opposites.

The word "transformation" is a useful one because it refers to a change in state. Moreover, we can readily think of some kind of "action" or "movement" being required to effect transformation of state or position A into state or position B. It is also noted that often there are many choices available in the technique, style and approach for achieving transformation. Sometimes the style does not matter, sometimes it does.

As an example we may refer to the vision and conceptual basis of Ngā Pae o te Māramatanga as outlined in Figure 1. The bottom of this diagram shows that we aim to develop knowledge, capability and capacity through programmes of research and training to create change in the Māori and wider communities. Such change aims to fulfil the vision of achieving full participation in society and the economy.

A key feature of the diagram is the part labelled "transformative leadership". While the word "leadership" usually raises the notion of following someone or something, it is emphasised that any individual or group can lead simply by recognising that there is a problem to be addressed and then by going ahead and doing so.

Therefore, individuals and collections of individuals who are trained, knowledgeable and capable can provide transformative leadership as a matter of course. From this perspective, transformations

can be seen as instances of individual or collective problem-solving, with leadership being distributed in the same manner. In short, when a system desires to effect change, it exhibits goal-directed behaviour and uses a problem-solving process.

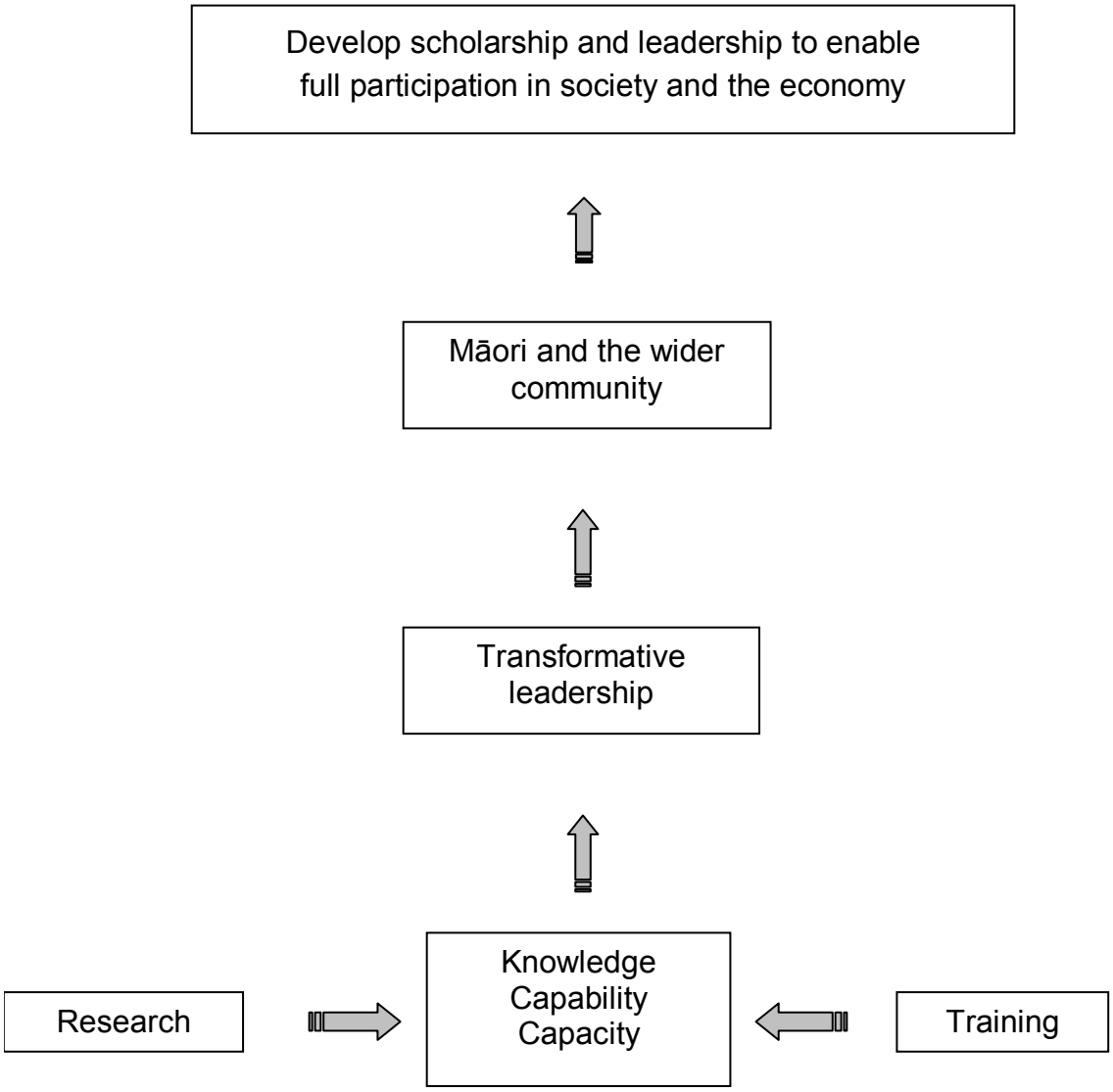

Figure 1. Ngā Pae o te Māramatanga: Vision and conceptual basis

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What are the basic systems people use to solve problems?

Problem-solving behaviour emerges from the interaction of cognitive, perceptual, emotional and action systems. An outline of this interaction follows.

The person is central to any model of problem-solving. Figure 2 shows the person as a triangle surrounded by the environment. The environment (or "surround") is shown as having four domains that are relevant to the particular problem being addressed (knowledge, professional, political-economic and socio-cultural). The circular band between the person and the surround represents the perceptual system through which the person receives information. That information can take many forms (e.g. visual, semantic, aural, touch) and the task of the receiver is to analyse, organise, and interpret it so that it becomes understandable.

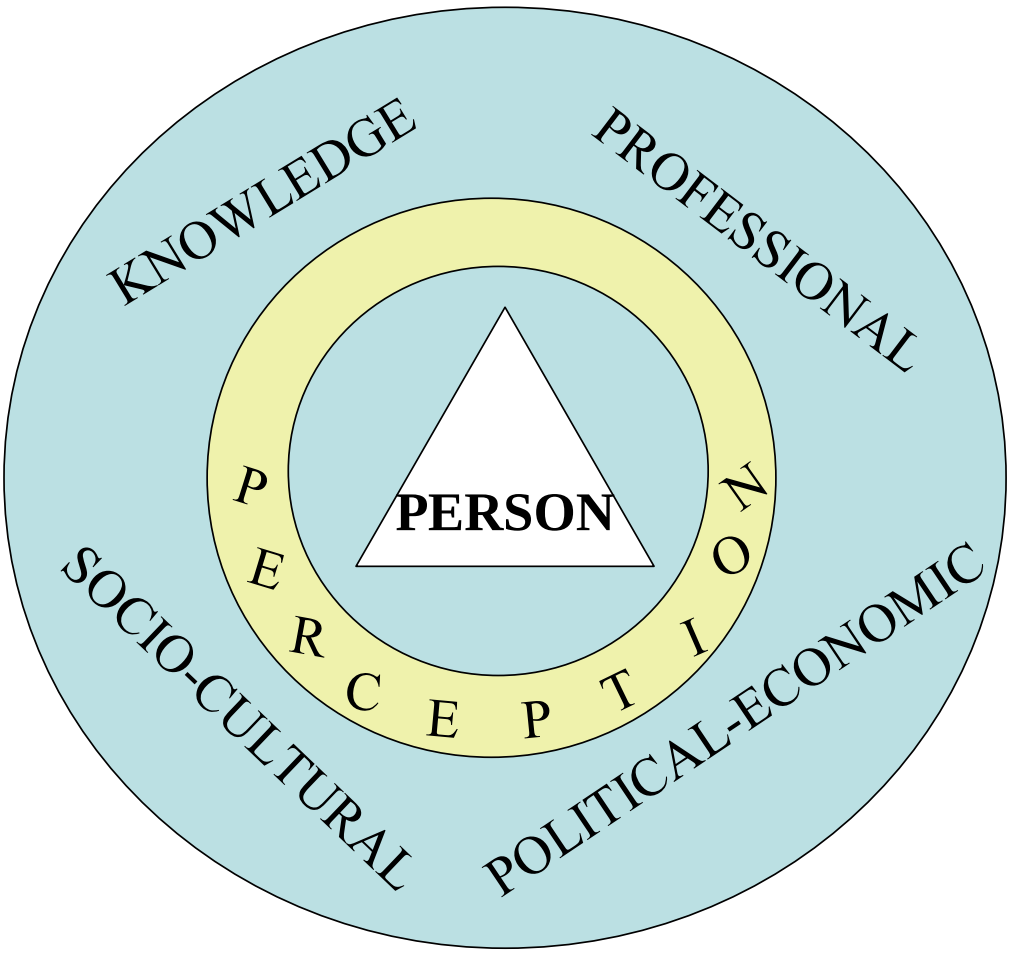

Figure 2. Person-environment relationships

Perceptual processes therefore link directly to cognitive processes where a person needs to learn (through practice and training) and to develop knowledge, understanding and the recognition of deeper levels of meaning. Such cognitive processes facilitate decision-making so that appropriate action processes are brought into play to realise the transformation (see the top part of Table 1).

How does a person make the transformation?

The simple answer is, by impacting on the specific part(s) of the environment in a way that transforms the situation in line with the desired goal. Imagine taking the top point of the person-triangle in Figure 2 and stretching the point right up and into the surrounding environment. That process requires perception, cognition and then energy to produce the action (Table 1).

Table 1. Perception-to-action: A self-organising process

PERCEPTION	
Receiving	Analysing
Organising	Interpreting
COGNITION	
Learning	Knowing
Understanding	Meaning
Wisdom	Decision-making
AFFECT	
Emotions	Beliefs
Attitudes	Values, Self-reflection
ACTION FIT	
Affordances	Critical points
Coordination	Optimal points
Control	Performance skill
REGULATING ACTION	
Reflexive systems	Dynamical systems
Pre-programming	(feedforward)
Corrective control	(feedback)
Ongoing control	(continuous guidance)
SYSTEM-SURROUND INTERACTION	
Constraints	Relative invariance
Adaptability	Stability

Figure 3 summarises these central processes and introduces the role of the emotions by showing "affect" as the third part of the person-triangle. We are all well aware that our emotions, beliefs, biases, attitudes and values shape the way we handle problems. Furthermore, we usually know that in trying to organise ourselves so that we can be successful in transforming things we need to control the affective side. Self-reflection is a key component here because it should facilitate understanding of the self, and enhance the overall process of problem-solving.

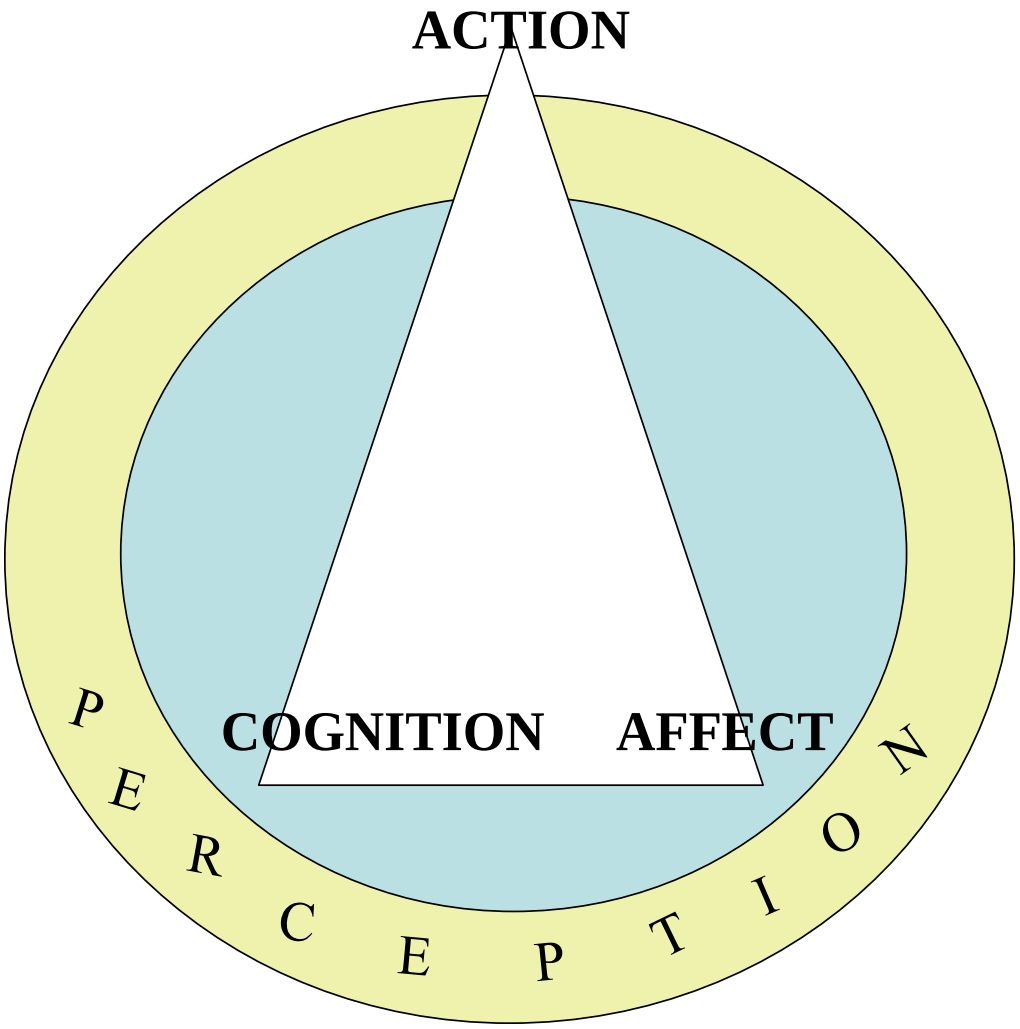

Figure 3. Perceptual, cognitive and affective systems leading to action.

Table 1 summarises the roles of the perceptual, cognitive and affective dimensions as discussed up to this point, and it leads to a closer consideration of the action-point of the triangle. The cognitive processes culminate in decision-making usually followed by planning and initiation of an action or series of actions designed to achieve the goal(s). However, these processes should be characterised by seeking the best "fit" between the action plan and the results of perceptual, cognitive and affective processes.

What are the main requirements for making an action fit?

There are several key concepts that enable making the right "fit" between perception and action. One of these is "affordances" which are potential relations between an organism and its environment (Gibson, 1979; Reed, 1982). That is whether the situation or objects in the environment afford you the opportunity of realising an action. Or, put another way, is what you want to do "doable"?

As an example, consider the situation where you want to cross a busy highway and there is no pedestrian crossing. The traffic is heavy and you are waiting for an opportunity to cross. The first level of decision is whether crossing is "doable". If yes, then you "fit" your own situation to this dynamic moving environment and try to decide when it affords you the opportunity to cross. If it does not afford you that opportunity you need to find another way. Note that in making your judgement you would usually take account of some of the specifics of your own system and relate it to the planned objective. For example, if the highway is wide and you are wearing inappropriate footwear or if you have a sprained ankle, your judgement might be that it is not achievable.

Related to affordances are "critical points". In the highway crossing situation, assume that you are very fit, halfway through a nice run and well warmed up. So yes, crossing is now judged to be achievable. So you wait to recognise a "critical point" in the display of oncoming vehicles. This point is probably defined by the gap between vehicles and their speed of approach. In effect, you make the decision (of "go /no go") by judging key critical points in the relationship between the environment and yourself as the potential "actor". Such critical points are defined by "margin values". In the present example, the space-time gap between oncoming vehicles needs to exceed a certain value that sets the margin between "go" and "no go". The literature contains a great deal of research in support of these aspects of perception-action theory and shows that the principles hold over a wide range of animal species (Reed, 1982).

Another feature of behaviour that assists the "action fit" is "optimal points". This is to do with minimising the expenditure of energy and/or other important resources. It is a feature of biology that animals are especially good at optimising their energy use. After chasing the zebra for a certain time, the hungry lion may decide that it not sensible to keep on with the chase because the benefits outweigh the ultimate energy cost. So too in our problem-solving, we need to be aware of the key resources that are available and the ways in which we can make optimal use of them.

The remaining terms listed under "action fit" in Table 1 draw attention to the fact that for skilled performance, one needs to be trained and practised. As a consequence, it includes being able to control and coordinate the actions to produce a successful sequence.

How are actions fine-tuned?

Given that we have made the right "fit" and reached the stage of initiating the appropriate action(s), what mechanisms allow us a high degree of regulation and control over the unfolding action sequence?

To address these questions, refer to the section headed "regulating action" in Table 1. Although these five systems are drawn from the literature on movement control, they appear to be applicable to other transformative situations. The reflexive systems are the most automatic ones. They are "hard-wired" connections that do not require any cognitive consideration. When established, they have the advantage of being extremely fast and efficient.

While reflexes are part of the "hardware" of a system, it is possible that with a great deal of practice, one can learn a high degree of automaticity that is reflex-like. This is achieved through "pre-programming" mechanisms where one has learned that a certain set of information (nearly) always requires a certain response. So the response is known and prepared in advance and when the key information arrives it simply triggers the pre-programmed action in a "feed-forward" manner. The quality of the resulting action is highly related to the amount of prior practice and training.

In contrast to feed-forward mechanisms, there are feed-back mechanisms that follow the responding action. For example, you have received the information, related it specifically to the environment, decided on the course of action and carried out that action. In evaluating your response you realise that it could have been better, so the cause is identified and the information fed back into your cognitive and memory systems so that the next response will be more accurate. This method of "corrective control" allows one to "fine-tune" responses through practice and experience.

A fourth mechanism for regulating action is through "ongoing control" where the flow of information over time allows you to make corrections during the response. An example is driving a car. However, for continuous guidance to be successful there needs to be adequate time for the perception-action-correction loop to occur.

The dynamical systems approach is more wholistic than the other four systems because it considers the organism in relation to the broad dimensions of space, force, time and energy. Like the lion chasing the zebra, it includes the need to optimise function and energy expenditure. It recognises that when certain resources are being over-taxed, then a change in action mode becomes necessary. For example, when we are walking at a comfortable pace, our system is in a "steady-state" with everything working efficiently. However, if we were then required to keep increasing walking speed, a point is reached when we feel the need to change the action mode to a jog because it is a more comfortable gait at that speed. Similarly, an untrained horse will change gait from a trot to a gallop when its speed reaches a certain level. There are times therefore, when changing action mode is necessary to preserve efficient transformation.

System-surround interaction

In outlining the basic systems people use to solve problems, we have so far linked perceptual, cognitive, affective and action processes into a broad model. We have also outlined the kinds of mechanisms used to regulate action. To complete this section, we return to Figure 2 where we have the person (or system) in the centre with the environment as the surround. The reason is to describe briefly some fundamental features of system-surround interaction (Table 1).

There are always constraints in systems and structures for both individuals and for groups of people. However, although constraints set limits for action and define what cannot be done, they also set the degrees of freedom for action. Therefore, in considering the interaction of a person or a group of persons with a given environment, identifying the constraints and degrees of freedom is a useful starting point.

The term "relative invariance" refers to the level of constancy in the relationships between the essential elements making up a structure. For example, a triangle is defined by the angular relationships of the three points in geometrical space. If one point shifted its position, the others also shift in a manner that maintains the invariant geometrical relationships so that the structure maintains its form.

Similarly, the lower case letter "d" has two essential elements--one is the "c-type" curving line and the other is the vertical stroke. Those two elements are constrained by positioning one relative to the other (joined at the open side of the "c" with a common baseline). The triangle and the letter "d" may be made to any size and they can tolerate a range of styles, because as long as the relative invariances in their structure remain they will be recognised for what they are. Thus, identifying the

essential features of an environment and understanding the relatively invariant relationships that constitute its "form" enables a person to interact more specifically in seeking a transformation.

The stability of a system or structure is about controlling its degrees of freedom. If a structure is like a triangle and has three elements linked in an invariant manner, we have a very stable structure. However, if the triangle had several other bits tacked on to it, while they provide degrees of freedom for various actions, there are redundant because they do not affect the fundamental structure. If something does change the essential form of the relationship of the three points, say by adding a fourth point between two others, then we have a change of form and a new structure. It is useful therefore to differentiate between the essential and non-essential parts of a system. Stability is about defining the essential and controlling the nonessential.

The final concept in this consideration of system-surround interaction is "adaptability". It is notable that while living organisms usually learn to interact successfully with their environment by seeking understanding, stability, control and certainty as part of a self-organising process, it is also necessary to be adaptable to changing circumstances. Sometimes, a part of an action system is lost so that the remaining parts have to adjust and maintain the goal-directed behaviour. Sometimes, something completely unexpected occurs and provides a major challenge.

How can we prepare for the unexpected? One way is to model such scenarios as a city council might do in planning for disaster. By modelling the perception-to-action processes and by treating the unexpected as a problem of the present, then good progress to appropriate solutions are achievable. Another way is to create training situations where the learner is required to handle a range of different situations as well as criterion ones. Variability is a part of living and it requires a certain readiness.

To conclude this section, it is pointed out that while these concepts arise from aspects of psychology, biology and movement science, it is suggested that together, they form a general model of a self-organising process that is applicable to both individual and group problem-solving behaviour.

How does this problem-solving model fit double worlds?

When a person of one culture lives in a society where there is a significant other culture, there is a need to make a good "fit" to both. Figure 4 suggests that the usual approaches to understanding different worlds focus on differences, equity or power and that the respective methods of analysis are categorical, distributive and relational.

Although such approaches are helpful in a general sense, it should be recognised that to solve a problem at the individual level, the necessary approach is to form a specific and goal-directed set of intentions that are followed by regulated actions. Given that the systems and processes previously outlined are fundamental to problem-solving, they are clearly applicable for understanding, stabilising and controlling one's place in another world.

Figure 5 shows that each world has a part that is entirely specific to itself and a part that is shared with the other world. The sum of these three sources of variance is the total variance. It is worth noting that in statistics, a correlation (or co-relation) is the ratio of common variance to total variance. The greater the co-relation, the greater the common variance and the sharing of the two worlds. Therefore, successful actions in a double world situation, require understandings, abilities and skills that fit appropriately with both the specificities and commonalites of each world.

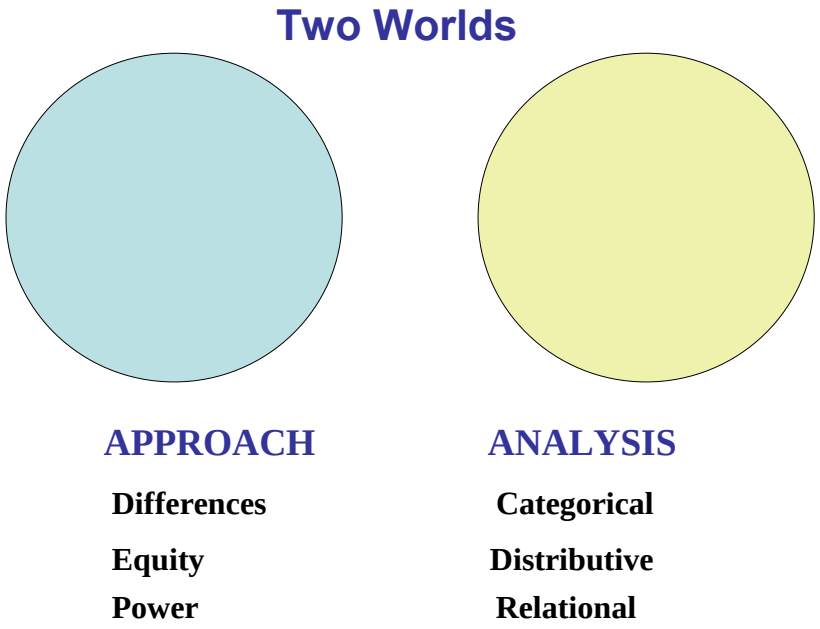

Figure 4. Problem-solving in two worlds.

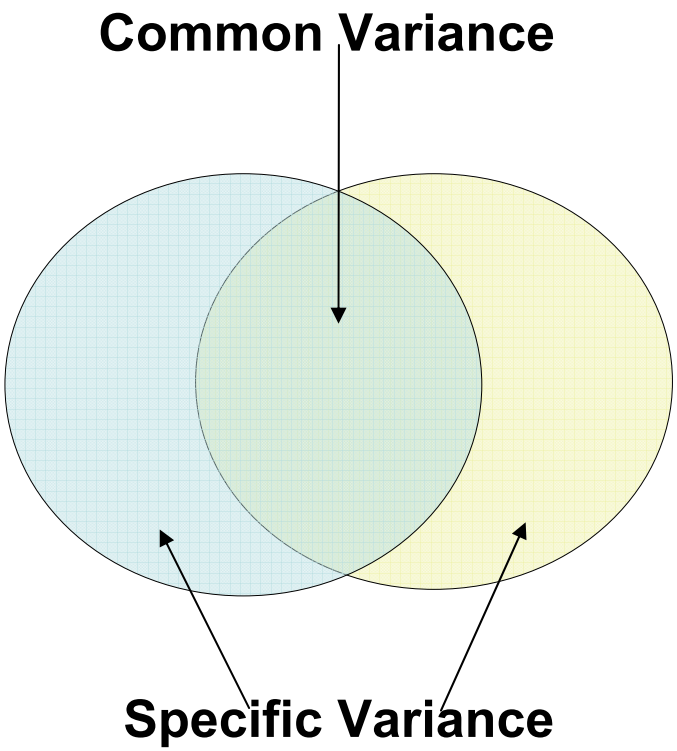

Figure 5. The commonalities and specificities of two worlds.

What are the implications for well-being?

Solving problems in one's world or worlds confirms that one has a measure of mastery over their environment. As a result, there is a sense of confidence, stability and of being in control. A sense of well-being seems to emerge naturally from successful problem-solving as well as from being "in tune" with the key parts of one's environment.

If we were to construct a list of qualities that are necessary for successful problem-solving and well-being, it would probably be very long and include terms like those listed in Table 2. However, although each of these terms is meaningful, it is proposed that we could shorten such a list and try to capture its major dimensions. It is suggested therefore that the following four dimensions do so.

Table 2. **Some (in)tangible qualities for successful problem-solving**

Regard for the present	Integrity
Respect for the future	Vulnerability
Predictability	Reliability
Breadth	Courage in relationships
Intellectual energy	Sense of humour
Discernment	Tolerance of ambiguity
Presence (being there)	Awareness of the human spirit

The first dimension is "Heart" which refers to being sensitive. It is the ability to "feel". The second dimension is "Mind" which is the ability to think, to reason and to apply logic. The third dimension is the ability to communicate effectively; and while we name it "Voice" it is noted that there is a wide range of communication methods. The final dimension is called "Touch". It goes well beyond physical touch and refers to the ability to relate to others and to convey that in a variety of ways.

If one is able to learn how to solve problems successfully in a well-balanced way and to be stable with a good measure of control in the variable world(s), then well-being should emerge. It is suggested that such attainments are enhanced by qualities of heart, mind, voice and touch. Furthermore, if we are really lucky and able, we should find:

PEACE
HARMONY
and

JOY.

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