Critically consider psychological research into problem solving

The Gestalt approach to problem solving (PS) looked at how we impose structure on problems by understanding how their elements are related to each other. PS occurs through the perceptual restructuring of the problem, resulting in insight.

Functional fixedness is a type of mental set in which we fail to see that an object may have functions other than its normal ones. Duncker (1926, 1945) gave participants a candle and a box of drawing pins and instructed them to attach the candle to the wall so that it would not drip when lit. Few participants thought of using the inside of the tack-box as a candle holder. Participants were 'fixated' on the box's normal function and they needed to reconceptualise it. Their past experience was leading them away from the solution. When people are shown an empty box and the drawing pins are scattered on the table, the box is much more likely to be used as a candle-holder (Glucksberg & Weisberg, 1966).

Mental set is a form of functional fixedness, in which we tend to continue using a previously successful strategy to solve new problems, even when more efficient strategies exist; this was demonstrated by Luchins (1942) and Luchins & Luchins (1959). Once participants discovered a solution to a problem they continued to use that solution for subsequent problems even when it was less efficient or when it did not apply. In Gestalt terms, mental set produces reproductive thinking when in fact a problem calls for productive thinking (Maier, 1931; Scheerer, 1963). In productive thinking, problems are solved by the principle of reorganisation, or solving a problem by perceiving new relationships among its elements.

While Gestalt psychologists made a significant contribution to our understanding of the processes involved in solving certain types of problem, they did not develop a theory that applies to all aspects of PS. Although the concepts of 'insight' and 'reorganisation' are attractive because they are easily understood, especially when accompanied by perceptual demonstrations, they are extremely vague and ill-defined theoretical constructs (Eysenck & Keane, 1995). Thus, it is very unclear under what conditions they occur and exactly what insight involves. However, in many ways, the spirit of Gestalt research, with its emphasis on the goal-directed and non-associationist nature of thinking, provides a basis for the information-processing approach. It also left a large body of experimental problems and evidence, which any later theory had to be able to account for: '...the legacy of the school was, therefore, substantial' (Eysenck & Keane, 1995).

Information processing approaches analyse cognitive processes in terms of a series of separate stages. In the case of PS, the stages are representing the problem, generating possible solutions and evaluating those solutions.

An algorithm is a systematic exploration of every possible solution until the correct one is found. Algorithms guarantee a solution to a problem, and are effective when the number of possible solutions is small, but when the number of possible solutions is large, algorithms are time consuming – unless the solution happens to be found early.

Heuristics are 'rules of thumb'. While not guaranteeing a solution to a problem, heuristics can result in solutions being reached more quickly (Newell *et al.,* 1958). These procedures are based on intuition, past experience, and any other relevant information. Heuristic devices include means-end analysis (MEA) (Newell & Simon, 1972). In MEA, the search for a solution begins at the goal and works backwards to the original state. But as it is often not possible to achieve the main goal all in one step, another important characteristic of MEA is to break down the main problem into sub-problems, each of which has to be solved before the final solution can be reached. This form of MEA is called problem-reduction representation. However, what the sub-goals are is not always clear: the well-known ‘missionaries and cannibals’ problem provides a good example of this. A further problem with MEA as a heuristic for PS is that it is sometimes necessary to move further away from a goal in order to achieve a solution; again, this is illustrated in the ‘missionaries and cannibals’ problem.

An expert system (ES) is a computer programme that embodies some of the knowledge of a human expert in domains in which expertise comes with experience (Garnham, 1988). In fields such as medicine, it is difficult to formulate explicitly an expert’s knowledge – otherwise human experts would be easier to train. ESs are intended to do some of the work of human experts. Therefore, if a problem is to be addressed by an ES it should have a number of features, as the example of medical diagnosis illustrates. There are recognised experts whose performance is demonstrably better than that of non-experts, for example a medical consultant compared to a lay person. Consultants have to draw on wide experience of the connection between manifestations of illnesses and underlying causes, rather than following a set of rules. A single manifestation may indicate one of several diseases, but is unlikely to be associated with any one of them in every case. Further, some of the data that diagnosis is based on may be misleading, irrelevant or incorrect. Diagnosis requires a large but manageable amount of domain-specific knowledge.

The process of encoding knowledge into an expert system is called transfer of expertise. However, experts cannot always formulate explicitly the knowledge they use, nor can they say how they combine different items of information to make a judgement about a particular case. Lengthy interviews, in which experts discuss sample cases, together with survey data such as correlating patterns of medical symptoms and test results with eventual diagnosis, need to be conducted. This makes the process of writing ESs difficult and time-consuming.

According to Boden (1987), ESs are much less flexible than their human counterparts. Some researchers are trying to provide ESs with causal reasoning, so that they not only arrive at a conclusion but can also explain the reason to the user. Boden claims that ESs can’t integrate knowledge from distinct domains, using concepts and patterns of inference from one domain to reason in another. Genuine expertise requires both high-level knowledge and analogical thinking.