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functional and authentic skills and knowledge, and it should be linked to intervention design and programme planning. Care should be exercised in choosing assessment tools to ensure that they are adequate for the intended purpose, demonstrate technical adequacy, and meet the needs of assessment with young children. These needs in particular include accurate screening of children in need of further assessment, accurate identification of children in need of special support programmes, clear linkages to intervention and education strategies, and sensitivity to progress and change over time.

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RELATED ENTRIES

APPLIED FIELDS: EDUCATION, CHILD AND ADOLESCENT ASSESSMENT IN CLINICAL SETTINGS, DEVELOPMENT (GENERAL)

PROBLEM SOLVING

INTRODUCTION

The question of how people solve problems has traditionally been one of the main areas of research in the psychology of thinking. Duncker (1945) defined a problem as occurring when a living creature has a goal but does not know how to achieve it – there is a 'barrier' to be overcome between the given state and the desired goal state. Dörner (1976) differentiated between various types of barriers in terms of whether or not the goal state on the one hand and the means to achieve it on the other are clear to the problem solver. On the basis of these different types of barriers, the four types of problems in Table 1 can be distinguished (the table includes at least one example for each type of problem).

Interpolation problems are well-defined problems, while the other types of problems are ill defined in the sense used by Simon (1973).

Problem solving research explores aspects such as the cognitive processes involved in problem solving, e.g. typical stages of problem solving, general or specific problem solving strategies (e.g. means–end analysis, Newell & Simon, 1972), typical errors (Greeno, 1978), and differences in the problem solving skills of experts and novices (e.g. Chi, Glaser & Rees, 1982). Research also focuses on the relation between problem solving skills and personality characteristics, as well as the relation between problem solving ability on the one hand and intelligence and knowledge on the other.

In the present entry, some of the tasks used in the context of problem solving assessment will be described, with particular emphasis being placed on complex problems embedded in computer-simulated scenarios.

Table 1. Four types of problems according to Dörner (1976). See the following text for the explanations of the examples given

Goal state	Means	
	Known	Unknown
Known	Interpolation problem Examples: chess; 'tower of Hanoi'; anagram tasks	Synthetic problem Example: 'radiation problem'
Unknown	Dialectic problem Example: producing as many different words as possible from a given set of letters	Dialectic and synthetic problem Example: 'Lohhausen'

PROBLEM SOLVING ASSESSMENT

The tasks used in problem solving assessment can be classified according to the four different types of barriers mentioned above. At the beginning of the twentieth century a group of German psychologists, the so called 'Gestalt' psychologists, first investigated problem solving using 'insight problems', where the solution – the overcoming of an interpolation barrier – was restricted to a few decisive steps. Examples include the radiation problem (rays converge to destroy a tumour without destroying the surrounding healthy tissue), the candle problem (supporting a candle on a door, using only the candle, a box of matches, and tacks: the solution required using the box as a platform to support the candle) and the water jug problem. In later research, problems required the application of several steps, with no single step being 'decisive'. Classic problem solving research focused primarily on 'transformation problems'. Problem solvers were presented with a clear given state, a clear goal state, and a precisely defined set of allowable transformations – the task thus again consisted in overcoming an interpolation barrier. The 'tower of Hanoi' is probably the most well-researched problem of this kind; the Chinese 'tangram' puzzle is an everyday example.

To give an example, one version of the 'tower of Hanoi' problem can be stated as follows (see Figure 1): there are three pegs and three rings, each with a different diameter. The goal is to move the stack of rings from the left peg to the right, with the restriction that a larger ring must never be moved on top of a smaller one. You are permitted to move only one ring at a time from one peg to another.

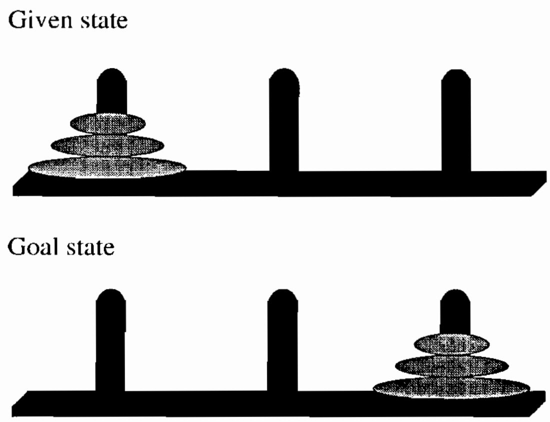

Figure 1. The 'tower of Hanoi' problem.

These kinds of 'move problems' or 'puzzle problems' have, in result-oriented form, found application in the context of practical diagnostics – the 'block design' and 'object assembly' subtests of the Wechsler Adult Intelligence Scale (WAIS), for instance.

Dialectic problems are used in contexts such as creativity research. A typical task with a dialectic barrier would, for example, involve producing as many different words as possible from a given set of letters.

Complex Problems

In the 1980s, divergent approaches were adopted in North American and European problem solving research. North American psychologists placed particular emphasis on domain-specific problems such as physics problems and algebra word problems, and on questions of expertise in specific domains such as chess.

In contrast, European research conducted over the past decades – particularly in England and Germany – has focused on problems with synthetic or synthetic-dialectic barriers rather than interpolation barriers. Such tasks have been termed 'complex' problems. The European approaches have been summarized in a volume edited by Frensch and Funke (1995). Reasons cited for the shift in focus to complex problem solving include the argument that interpolation problems have little in common with 'real life' problems. Above all, the fact that most interpolation problems are largely independent of (prior) knowledge was perceived as a serious limitation (Chi et al., 1982).

According to Dörner, Kreuzig, Reither and Stäudel (1983), complex problems can be described and simulated as systems of interconnected variables. These problems have the following characteristics:

- *Complexity:* Numerous aspects of a situation have to be taken into account at the same time.
- *Interconnectivity:* The various aspects of a situation are not independent and cannot, therefore, be independently influenced. Interconnectivity also includes the important role of feedback loops and side effects.
- *Dynamics:* Changes in the system conditions also occur without intervention from the problem solver.
- *Intransparency:* A situation is labelled intransparent when only a part of the relevant information is made available to the problem solver.
- *Polytely:* Sometimes the problem solver must simultaneously pursue multiple and even contradictory goals.

Computer-simulated scenarios are used as a way of translating such complex problems into an assessment context. Subjects have to run a city 'transportation system' (Broadbent, 1977) or manage a small factory. Funke (1991) provides an overview on the various scenarios. The most prominent example is the simulation called 'Lohhausen', where subjects have to act as the mayor of a small simulated town with the name 'Lohhausen' (Dörner et al., 1983). Subjects are able to manipulate taxes, influence production and sales policies of the city factory or the housing policy and so on. They are simply told to take care of the future prosperity of the town over a simulated ten year period within eight two-hour experimental sessions.

Advantages and Disadvantages of Using Computer-Based Scenarios for Diagnostic Purposes

In Europe, and especially in the German-speaking countries, computer-based scenarios are used as assessment tools in both research and practice. Some of the complex problem solving scenarios used in the context of personnel selection are presented by Funke (1995), and a discussion of the advantages and disadvantages of this form of application can be found in Funke (1998).

The main advantages of using computer-based scenarios as diagnostic tools are that the tasks (1) are highly motivating and (2) involve novel demands which (3) are deemed to have higher face validity than intelligence tests, and (4) that testtakers enjoy working with the simulations (see Kersting, 1999).

However, the diagnostic use of computer-based scenarios also entails serious difficulties that have yet to be overcome.

1. The central question of appropriate approaches to the operationalization of problem solving quality remains largely unanswered.
2. The reliability of the measurements obtained with some of the computer-based scenarios is less than satisfactory.
3. The existence of a task-independent and thus generalizable problem solving ability has not yet been substantiated. This indicates that the ability to direct the system is dependent not only on the skills of the problem solver him- or herself, but evidently also on the nature of the task in question.
4. The main problem is that of construct validity. It is still unclear which skills are actually measured by means of the computer-based scenarios. Either the measurement is interpreted as an indicator for an independent *ability construct* (as suggested by newly coined terms such as 'networked thinking', 'heuristic competence', 'operative intelligence', etc.), or the scenarios are regarded as a new *measurement method*

which, in a certain respect, is better able to measure established constructs such as intelligence than has previously been the case (e.g. in a more differentiated manner or with a higher level of acceptance). Beckmann and Guthke (1995) have summarized the European research dealing with the controversial relation between traditional measures of intelligence and problem solving skills.

5 Evidence for the criterion validity of the measures used is also urgently needed. Thus far, only a single study (Kersting, 1999) has directly compared the predictive criterion validity of computer-based scenarios with the validity of existing procedures deemed to have overlapping coverage.

FUTURE PERSPECTIVES

Significant progress in the domain of problem solving assessment cannot be expected until both the operationalization of problem solving quality and the psychometric quality of the diagnostic instruments have been improved. Above all, it is essential to classify the ability tapped by the performance measures within the existing nomological network. Studies are required in which sufficiently reliable measurements are implemented by means of *different* computer-based scenarios, and differentiated measures of intelligence are administered in sufficiently large samples. At the same time, tests of other theoretically relevant constructs such as knowledge also need to be administered. In investigations of this kind – for instance, the study conducted by Wittmann and Süß (1999) – it has emerged that the systematic variance captured by problem solving scenarios can be attributed to intelligence and prior knowledge, and that there is no empirical evidence for the existence of problem solving ability as an independent construct.

CONCLUSIONS

Tasks have been constructed with the objective of providing insights into problem solving behaviour since the times of Gestalt psychology. In recent decades, the computer has opened up new diagnostic possibilities to this effect. The new types of task are associated with new problems, however. For most problem solving tasks, further insights into aspects such as the reliable measurement of problem solving ability and construct and criterion validity are required before the tasks can be responsibly used in diagnostic practice.

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RELATED ENTRIES

INTELLIGENCE ASSESSMENT (GENERAL), THEORETICAL PERSPECTIVE: COGNITIVE, COGNITIVE PROCESSES: CURRENT STATUS, COGNITIVE PROCESSES: HISTORICAL PERSPECTIVES

PROJECTIVE TECHNIQUES

INTRODUCTION

In the presentation of *projective techniques* four steps will be taken:

1 The first step focuses on the definition, general characteristics, classification and dominant theoretical perspectives on projective techniques.
2 Given the high number and diversity of these techniques it was decided to elect the one most known and used among them, the Rorschach Inkblot Method, for a larger appreciation of its development. Particular emphasis will also be given here to the Exner Comprehensive System that was gradually developed as from the late 1960s.
3 The third step considers the impact of and reactions to the Comprehensive System in the scope of projective techniques and psychological measurement.
4 The final step includes some comments about the future of projective techniques.

DEFINITION AND GENERAL CHARACTERISTICS

Projective techniques designate a set of instruments whose main objective is to describe and characterize personality.

The adjective *projective* is a derivative of 'projection', a concept introduced by Freud in the vocabulary of psychology to describe the design of a defence mechanism leading the subject to transfer to another person, or thing, his urges, feelings, etc., that he cannot accept as belonging to him. However, this concept is not commonly used in the field of projective techniques. Rather, another concept with a less restrictive and specific meaning is used. This means that, in responding to the stimulus-situation, the subject reveals or externalizes aspects of his own personal life, such as motives, interests, feelings, emotions, conflicts and the like.

To a large extent, the characteristics of the stimuli of the projectives are responsible for this externalization and have an important effect on the nature and content of the subject's responses. Two such characteristics are the structure and ambiguity of stimuli. The structure refers to the degree of organization of the stimulus: incompleteness, nearly an organized whole or fully divided, close to or far from being a real representation, etc. The ambiguity concerns the number and variability of responses each stimulus elicits.

Due to the different nature of the material and response modalities that these techniques involve, they have been classified in many ways. Table 1 presents Fernández-Ballesteros' classification, and includes the most representative examples of each class. For many years, they have been controversial in the sphere of assessment and measurement in Psychology.

Multiple factors of intrinsic and extrinsic nature have contributed to this state of affairs. Where the extrinsic factors are concerned, they are integrated