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# Problem-Solving, CDT and Child-Centredness

## 1. The Problem

While practical problem-solving seems to be central to the notion of CDT objections can be heard concerning its value as a teaching method, particularly for the child of average and less than average ability. Those who favour it argue that it helps to develop the ability to think effectively as well as providing opportunities for initiative and creativity. Practical problem-solving, they say, leads to an understanding of various materials and resources that can be used to achieve human purposes, as well as providing insights into areas of related learning. In what follows I intend to examine some of the logical conditions necessary for problem-solving and apply some of these conclusions to the area of CDT. I offer these considerations as a continuation of conversations begun with teachers of this subject who feel uncertain about many of the changes that they perceive happening or about to occur.

## 2. Two Sources of Problem-Solving

There might be said to be two main sources of the concern with problem-solving in CDT, namely a) the work of the designer and the technological researcher and b) such movements within education itself as child-centredness. a) Traditionally some writers have distinguished between the craftsman whose concern is the realization of the end-product and the designer who draws up the ends to which the craftsman worked[1]. This view draws too sharp a distinction between ends and means and tends to support the view that it is the designer who does the thinking, thus underestimating the mental effort involved in the activity of craft. Those who have pointed out the ill-defined nature of design problems[2] were indicating among other things that in design there needs to be a progressive clarification of the ends. The term 'design' covers environmental, communication, fashion, system and product forms of design, while 'technology' covers a wide variety of primitive and modern means and activities by which man controls or transforms his physical environment. In some senses design and technological activity may overlap; hence the description of the school subject 'design-technology'. In both designing and technological research there is some form of problem-solving. That being the case it might be straightforward to argue that problem-solving is logically necessary for the study of these subjects. However one needs to ask what one's aims are in the teaching of the subject. Children may study history at quite a high level without encountering the primary sources and problems of evaluation faced by the professional historian, and even when collections of primary source material are looked at there is very little attempt at which might loosely be described as original work. Similarly one could develop or attempt to develop an awareness of the impact of design and technology on our lives by numerous means, such as what has been described as the 'transmission model of teaching', which need not involve problem-solving methods. Indeed even if one's aim is to enable one's pupils to solve design or technological problems there is no guarantee, as we will see, that this is best done through learning by problem-solving. Learning in school need not reproduce the research methods of the professionals.

b) An interest in problem-solving, however, antedates the present interest in design and technology. Even if we concentrate our attention on the twentieth century we find that it is strongly advocated as a method of learning for child-centred and open education from the beginning of the century. (Incidentally within previous centuries we find a sympathy being expressed by supporters of this view towards craft activities)[3]. In John Dewey this sympathy is maintained together with a conviction that education should be concerned with making children aware of the dynamic nature of knowledge which involves answers gathered for past and present problems[4]. Only in education never in the life of the practical man does knowledge mean a store of information aloof from doing. In his laboratory school Dewey used such occupations as carpentry and cookery as ways of providing active insights 'into natural materials and processes, points of departure when children shall be led into a realization of the historic development of man'. In *Democracy and Education* he explains by reference to gardening that children can be helped to understand the place that farming and horticulture have had in the history of man and the place which they occupy in present social organisation. 'Carried on in an environment educationally controlled, they are a means for making a study of the facts of growth, the chemistry of soil, the role of light, air and moisture, injurious and helpful animal life etc'[5]. Applied to CDT we can see how certain materials, arts or techniques can be studied as a centre of interest with the raising of related historical, moral, scientific, aesthetic and social questions. It is to be noted that this approach involves some degree of curriculum integration, team-teaching and project work and is far from the efficient achieving of specified ends by problem-solving. It involves an introduction through practical activities to a liberal education. Dewey's much cited account of the stages of problem-solving has its direct influence in many versions of the stages of designing in education, and his influence through Kilpatrick on the project method can be seen in the integrated movement of project technology. For these reasons I might be justified in relating Dewey's theories directly to problem-solving in CDT. However in what follows I will concentrate on some more general logical points about the conditions of problem-solving and the implications for CDT. I will even offer a modification of Dewey's five stages[6]. I do this because I want to make my concern more

specifically problem-solving than an academic interpretation of Dewey. Nevertheless many of the points that I make will have its origin in the debate that is centred on Dewey's advocacy of this method.

### 3. The Nature of Problem-Solving

As Dewey was keen to point out, problem-solving occurs in many aspects of everyday life, when tradition or stereotyped habits of thinking and acting, or the replication of previous experience can provide no answer to a difficulty one encounters and one has to use one's intelligence and imagination to overcome the problem and adapt to the environment. In saying this I have tried to show that problem-solving is related to biological and evolutionary processes and that as a concept it overlaps with other concepts. Writers on the sociology of scientific ideas have suggested that there are two levels at least of problem-solving, that in which a revolution of thought occurs and a new model or paradigm of science is offered (exemplified by Einstein), and that in which an everyday scientist who presupposes such a paradigm of science fits his own research into the model like pieces of a jig-saw[7]. The genius of the model-maker lies in finding problems where others do not. The everyday scientist is seen to be operating in a more determinate situation. With a determinate problem the issue can be clearly defined, the mode of tackling it can be known and what would count as a perfect solution can be judged beforehand. In the case of creative work, such as aesthetic expression and production or the problem-finding of the model maker, as with many everyday problems, the goal-states and the methods of achieving them are not so clearly defined, so that what is originally regarded as a possible solution may be changed. In short, problems vary in their degree of openness and complexity, as well as in their type of objective. One question that arises from this is the extent to which the use of problem-solving methods in the learning situation will enable one to develop a general capacity to solve problems. The answer to this should become more evident from an analysis of the logically necessary stages of problem-solving.

Writers have suggested something like four stages: a) perplexity, b) problem-identification, c) plan-construction, and d) evaluation.

a) *Perplexity* Logically a problem must be a difficulty, an obstacle or a state of confusion or uncertainty for someone. It is the individual or group who defines what is to count as a problem. What is a problem for you is not necessary a problem for me. This means that for the person who regards something as a problem some degree of tension is experienced, some impetus is felt to reach the goal. It is for this reason that problem-solving can be seen as an ideal form of active learning, though it differs from learning itself in its goals and in the predetermined nature of its material.

b) *Problem-Identification* A problem is not a problem until one can specify and identify the actual perplexity. One requires the appropriate knowledge, experience of conceptual framework to categorize the problem and to realise what might count as a solution. Problems are not just problems; they are particular kinds of problems, and one needs to be initiated into the relevant way of thinking in order to correctly analyse the situation. Even the problem-finder standing at the frontiers of knowledge does not stand in a position of discontinuity with tradition. Consequent upon identification is the consideration of alternative hypotheses and the planning of a possible solution.

c) *Plan-Construction* The problem may be tackled in two ways' symbolically and abstractly at first and then by a more demonstrable working out of a solution. For the first stage a number of different strategies can be employed. A frequently made distinction is between the algorithic strategy (which involves the extensive and systematic working out of every combination and alternative) and the heuristic strategy (which involves working by hunch, intuition or insight). Using the algorithic method may involve too long and complex a search and may not apply to all kinds of problem-solving (especially those which are ill-defined or involve creative work), while using the heuristic method does not in itself provide a mechanism for selecting suitable solutions so that after the first few attempts one may be forced to adopt an unsystematic trial-and-error approach. While previous knowledge may be of direct or analogous help in situations sufficiently similar to previous experiences, it can also act as an inhibiting factor in situations where a totally new answer is required. One needs somehow to see the problem from a different perspective. In order to translate the hypothesis into action one requires the necessary skills and know-how. Indeed

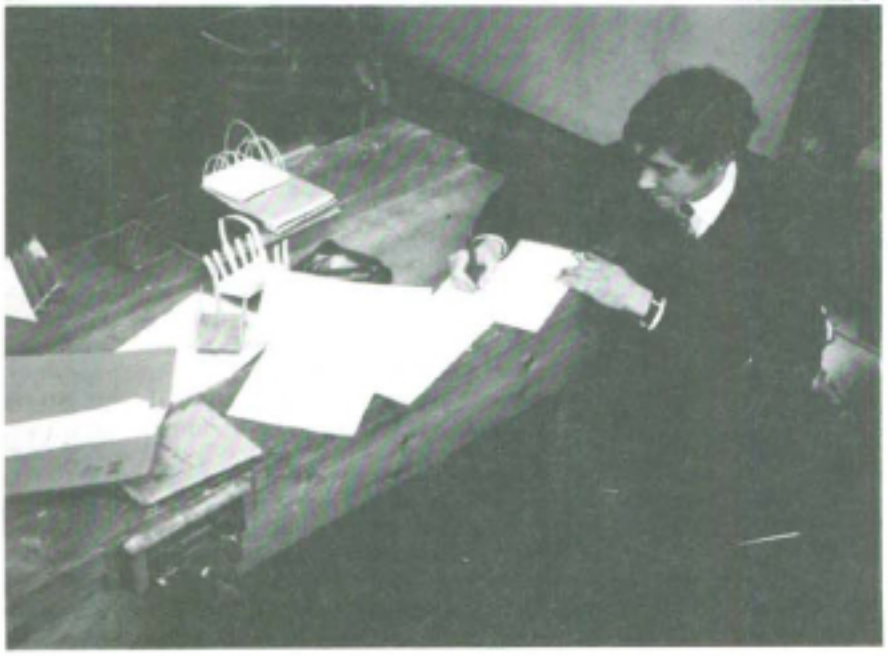
*Below: Is problem-solving only for the capable? Two winners of the Schools Design Prize 1981*

one of the conditions for a suitable solution is that it must take into account the practical problems involved in its realization.
d) *Evaluation* Just as a problem is a problem for someone so what counts as a possible and satisfactory solution must be acceptable to the originator of the problem. We often have occasion to question what someone else has accepted as a solution to their problem. We fail to grasp what their intentions are or how their original goals have become re-defined.

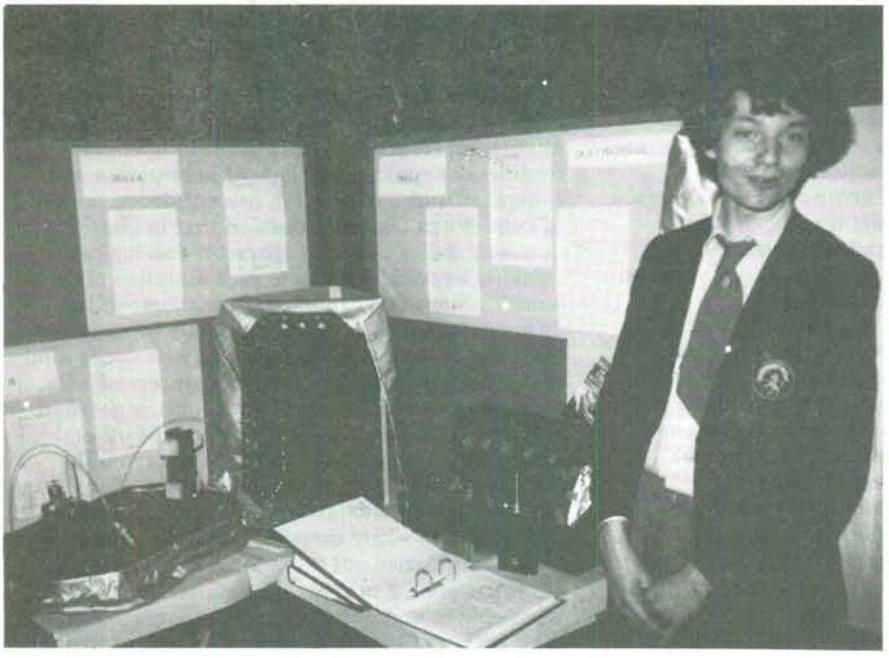
**4. Claims for Problem-Solving Examined**

Among the claims that have been made on behalf of problem-solving are the following four: a) a supposed motivational superiority, b) a supposed superiority of learning from experience, c) its openness and democratic view of authority, and d) its contribution to a general capacity to solve problems[8].
a) *Motivation* Dewey himself made it clear that the motivational impetus with problem-solving could be seen when the pupil has a problem and with it a tension and psychological need to solve the problem. In other words when the problem is our own rather than one imposed upon us we have a basic desire to solve it. But in so far as the problems offered within school are artificial then as Ausubel noted 'problem-solving can be just as deadening, just as formalistic, just as mechanical, just as rote as the worst form of verbal exposition'[9]. The teacher is more important than the method and a stimulating teacher can make what might seem to be a weak method come alive so that the children become excited and acquire new interests. The question we need to ask with respect to this in CDT is whether we need to introduce this method for *motivational* reasons. As many reports have indicated, for the majority of pupils the craft subjects seemed enjoyable because they were practical and relevant[10]. It may not always be this way if less and less time is spent in making things and more and more time is spent on design work or technological theory. Of course for some of the brighter pupils, who have opportunities not previously available to them to explore some personal interest into whatever material or medium they require, into fascinating areas of electronics for example, the workshop has come to offer something significant. Obviously the more tailor-made a subject can be to everyone's individual's requirements the more pleased everyone can be. But there is a need to ask upon what aspect of the subject and for what purpose teachers should spend their major effort.
b) *Learning from Experience* One main reason why child-centredness stressed problem-solving as opposed to transmission models of teaching is because they believe that learning from experience is a more active and valid way of learning. But it was Rousseau who offered the objection to this view: 'To acquire knowledge it is not enough to travel hastily through a country. There are plenty of people who learn no more from their travels than from their books, because they do not know how to think because their mind is at least under the guidance of the author, and in their travels they do not know how to see for themselves'[11]. It is part of the art of teaching to know what kind of structuring and preparation to offer for any form of learning, when pupils are learning from their own mistakes, and when there ought to be intervention. We learn both from experience and guidance from teachers. In many ways the traditional teaching of craft skills can be seen as employing a form of transmission model. The teacher demonstrates, instructs, corrects, warns or encourages; the pupil models himself on the teacher, learns something of the theory of skills and tools, and practises and applies the skills that have been demonstrated. As Warnock put it in respect of the music teacher: 'He will show me, help me to practise, give me tips (along with some theory, no doubt) and the hoped-for result will be that I shall discover how to play'.[12] The point is that discovery learning, learning by experience in the sense of learning by trying out or by attempting to act[13] is an essential feature of acquiring and practising skills. So the traditional teaching of skills by demonstration and pupil practice involves both transmission and discovery methods. Where problem-solving in CDT differs from the acquisition of craft skills is not that one involves learning from experience and the other does not, but that what is learned through the two methods is different. CDT is concerned with the rationale of designing, the understanding of aspects of technology and the development of an awareness of different kinds of material. The concern of traditional craft education is towards competence in certain limited skills on a restricted range of materials.

*Below: Is problem-solving too theoretical? One boy designing a toast rack.*



*Below: Is learning by instruction becoming outmoded? Two boys at a forge following instructions and one boy with his examination work on hovercraft skirts.*



c) *The Democratisation of Authority* One reason that radical educators prefer the problem-solving model to the transmission model of teaching is that they regard it as less dogmatic and authoritarian, paying more respect to the student's individual viewpoint. There are two claims that are being made: *i* about knowledge, and *ii* about the position of the teacher. *i* With regard to knowledge, it is maintained that while doubts can be cast on absolute claims to truth, since all that we know is socially constructed or based within a form of life that is immune to outside criticism, then ultimately instruction must be based on unjustifiable assertion. In such a situation indoctrination can be avoided only by open discussion, problem-solving and a cooperative teacher-pupil construction of reality.[14] Against this argument I want to make two points, one a general logical point, and the other a specific point about practical or craft activities. There is something logically odd about the argument, for if there can be, in principle, no agreement about what counts as truth or evidence, problem-solving and the child's construction of reality cannot produce a greater insight into truth: they can only create a greater psychological satisfaction. More specifically, since craft and technology assume the pragmatic principle that knowledge is what works, practical instruction in their skills could not be regarded as exemplifying epistemological dogmatism. As the Newsom Report pointed out, practical subjects lead to something which can be seen or handled and to a success which is easily recognised.[15] *ii* By teacher's 'authority' we mean something like his competence and right to make statements and to demonstrate know-how which reflect the methods and conclusions of the discipline and the academic community to which he belongs and which he mediates for his pupils. As such, authoritative statements can be checked against the findings of current research. In life we accept many statements on someone's authority and it is, in principle, not irrational to do so, for we cannot critically examine for ourselves the truth of everything we hear or read; nor are we capable of doing so. However we can compare the statements of different authorities and we distinguish 'authority' from 'authoritarian' in that the latter implies a dogmatic manner of assertion or a refusal to submit one's opinion to the impersonal tests of the appropriate discipline. Therefore we can recognize that while there may be teachers of the transmission model who are authoritarian there is no necessary connection between transmission or instruction and authoritarianism. It is also perfectly possible to exercise authority and yet to respect pupils as persons and to encourage them to think for themselves. Indeed it may be argued that the more open the situation the more important a model for imitation and the more powerful a socializing agent the teacher becomes, because of the premium placed on social trust[16]. Nevertheless there is one major difference between the position of the teacher in the transmission and the problem-solving models. In the latter case, when the problem is allowed to go beyond the teacher's present knowledge and skills, he has to use resource material and to find out information or to practise new skills. There is a sense, therefore, in which he is placed in a more vulnerable position, his knowledge no longer being superior to his students. In this situation he needs a more general knowledge than the average subject teacher and he has to be willing to expose his ignorance and to learn occasionally

from his students. It is this aspect of the change in authority that may be most worrying to the teacher of traditional craft, whose expertise was made obvious through the demonstration and by a control of the products to be made. In the new circumstances the behavioural outcomes are not always predictable. Yet it can be said that the view of authority that this assumes is one of the rational authoritative teacher, whose aim is always to point beyond himself to an evolving tradition of knowledge.

d) *Problem-Solving as a General Thinking Capacity*

It is sometimes argued that problem-solving is a general capacity to think reflectively, consisting of a set of general skills which can be regarded as independent of particular knowledge or context. On this view anyone who has ever solved a problem has employed these skills. Mere information is insufficient in itself to develop them, though one can be trained or taught to become more efficient in their operation. In particular, practice in problem-solving methods is one of the best ways of developing this general capacity, and it ought to be the aim of education to develop it. Dewey and others since have stressed as the aim of education the development of such related capacities as reflective thinking, effective thinking, intelligence and creativity, often used synonymously for problem-solving. Part of what is being said through such statements is that in such a society as that in which we live, education cannot concern itself mainly with the storing of facts and the separation of theory from practice, or on an undue reliance on authorities. We need to educate pupils to think for themselves, to possess the skills necessary to find things out and to cope with the changing nature of society and the many problems that emerge. As a corrective to existing practice such aims may be useful, but as Dewey himself discovered they can be so mis-used as to underplay the value of authority and tradition. They also overstress the importance of the intellect and individual. Schools rightly regard, as Dewey himself recognized, other factors as important – the social and community life, as well as physical, practical and aesthetic activities. Education must involve the whole person so that not only the intellect is expanded, but also a person's wants, attitudes, dispositions and emotions – indeed his whole awareness – must be extended, regulated and sensitivized.[17]

But this is only part of the difficulty with a problem-solving aim. It assumes that problem-solving and the acquisition of knowledge can be regarded as logically equivalent, and as I have already indicated, it regards problem-solving as a general set of skills acquired independent of context. The first assumption leads to an instrumental view of knowledge so that what is studied is not so much for intrinsic value or enjoyment but for the sake of the solutions found to present problems. Consider the way that history, music or literature can be distorted when pursued with these motives solely. Against the other assumption I have already argued that problem-solving is a specific set of achievements that needs to be informed, both in the identification of the problems and in the method of working on the problem, by previous experience as well as relevant skills and knowledge: it is therefore context-bound. People cannot be taught to think without some particular content to think about and without some awareness of the logic and methodology of the appropriate discipline. What counts as effective thinking in one discipline will not necessarily be transferable to another discipline. Ausubel makes the point that empirical researchers have failed to establish 'any impressive degree of transfer to problem-solving situations in other contexts, disciplines or sub-disciplines. Their efforts foundered on the improbably thesis that there is a general heuristics of discovery'[18].

Most everyday problems are solved by the replication of skills or the application of knowledge. Insights can also occur, as Koestler was keen to show, through the use of analogy, the relationship of cabbages and kings[19]. Even in this latter case where the transfer is extraordinary, the research is prepared and even searching for ways of formulating the problem or solution upon which he is working. If problems are, as I have argued, context-dependent then transfer must be generally within contexts rather than between them. As Toulmin puts it 'If we ask about the validity, necessity, rigour or impossibility of arguments or conclusions, we must ask these questions within the limits of a given field, and avoid, as it were, condemning an ape for not being a man'. However Kilpatrick long ago pointed out that schools can improve thinking by engendering certain attitudes and habits, such as the habit of stopping to think before rushing into a possible solution and the concern about appropriate evidence, relevant data and consistency as well as care about the planning of details for any complex matter[20].

While each discipline tends to have its own logic, skills or conceptual framework which constrain the uninitiated from solving problems in it, some freshness of approach or lack of habituation and general attitudes of concern or confidence can be of help. When Glenister claimed that in craft practical ability develops character and logical thinking he could only have such a limited claim in mind[21]. Since one cannot learn the logic of the different form of knowledge without being taught them and since this is unlikely to occur in the kind of craft lesson that Glenister was concerned with, it would be impossible for craft students engaged in practical activities to master the logic of other disciplines, though they might acquire from the teacher an awareness of the importance of analysing any problem by whatever means are relevant. In a CDT situation where there might be inter-disciplinary work being carried out there could be a development of understanding in other disciplines. In any case it is possible to argue that where students are put in the position of having to generate much of their

own learning they may ultimately become more self-reliant. But this is an empirical point that would require further investigation.

## Conclusion

The last decade has brought about a number of major changes in the CDT area. It is against such a background as well as considerations about the future of society that the nature of this subject must be debated. We have seen the movement of equal opportunities for girls, an increased social pressure for technological competence and curriculum concern with inter-disciplinary studies. There has been some desire to up-grade this practical area and to encourage pupils to choose the more technological areas. There has also been increased unemployment and a reduction of educational resources. Problem-solving has been one way of encouraging the development of individual interest, though perhaps at the expense of the coherence of the subject and the teaching of the older craft skills. It offers an awkward compromise between those who see technology as applied science with a strong theoretical element and those who want to retain the old craft skills in modern terms that take account of advances in material technology or perhaps even those who want to equip us all for the practical D.I.Y. tasks we encounter in the home. I am uneasy about some of the claims made for problem-solving as I have indicated in this paper, but I am also most uneasy about attempts to increase the subject's status by turning competent teachers of practical skills into teachers of scientific and technological theory – as illustrated by some moves, for example in teacher education. Is problem-solving a way of teaching mixed-abilities a variety of things? In designing through problem-solving are we aiming at producing competent designers or a more general design awareness? It seems to me that in the end my problem and the problem I find in this area is a lack of clarity about aims. Can others help?

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