RAISING THE EDUCATIONAL STANDARDS THROUGH ENHANCING CHILDREN'S THINKING: IMPLICATIONS FOR TEACHER EDUCATION

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ABSTRACT

In this study, the main aim is to raise a fundamental question of whether there is any possible way of raising the educational standards in order to meet the demands of society. In this respect, firstly, the changing function of education and the significance of teaching children how to think and learn will be emphasised, and the importance of science education in children's learning processes and the gradual improvement of science education will be examined. Secondly, in the light of learning theories, the changing notion of the learning process will be indicated, and the cognitive acceleration intervention programme of the CASE (Cognitive Acceleration through Science Education) project will be examined briefly. The necessity of instruction and intervention will be emphasised. Then, the programme and the findings of CASE will be debated. Finally, some suggestions for teacher education will be made.

Key words: *Educational standards, science education, learning theories, Cognitive Acceleration through Science Education project, teacher education.*

EĞİTİMDEKİ STANDARTLARI ÇOCUKLARIN DÜŞÜNME BECERİLERİNİ GELİŞTİRME YOLUYLA YÜKSELTME: ÖĞRETMEN EĞİTİMİ AÇISINDAN BAZI ÖNERİLER

ÖZET

Bu çalışmanın ana amacı, toplumun ihtiyaçlarını karşılayabilmek amacıyla eğitimde standartları yükseltmenin olası yolunun olup olmadığı sorusunu tartışmaktır. Bu nedenle, ilk olarak, eğitimin değişen fonksiyonu ve çocuklara nasıl düşüneceklerini ve nasıl öğreneceklerini öğretmenin önemi vurgulanacak, öğrenme sürecinde fen eğitiminin önemi ve fen eğitiminin sürekli gelişimi incelenecektir. Ikinci olarak, öğrenme teorilerinin ışığında, değişen ve değişmekte olan öğrenme süreci kavramına işaret edilecek ve İngiltere'de halen uygulanan bilişsel hızlandırma programı olan CASE (Fen eğitimi yoluyla Bilişsel hızlandırma) projesi kısaca incelenecektir. Öğretimin ve öğretimde bilişsel hızlandırma programının gerekliliği belirtilecektir. Daha sonra, bilişsel hızlandırma programı ve CASE projesinin bulguları tartışılacaktır. Son olarak, öğretmen eğitimi açısından bazı önerilerde bulunulacaktır.

Anahtar kelimeler: *Eğitimde standartlar, fen eğitimi, öğrenme teorileri, CASE projesi, öğretmen eğitimi.*

1. INTRODUCTION

'You can raise standards substantially only by improving the quality of thinking. ' (Adey and Shayer, 1994: 182).

In the post-modern world, raising the educational standards is of great concern to many nations. In contrast to the assumption that the ability of children and their intelligence are a fixed quantity, today it is known and accepted by educators that every child has a different capacity to learn and think (Light, *et. al.*, 1991; Wood, 1998; Woolfolk, 1998). However, current educational systems seem to assume to the detriment of the students, that all schools and students have similar characteristics.

The research of Adey and Shayer (1994) highlights such a position in the British education system, and corroborates it with the research evidence derived from their project called 'Cognitive Acceleration through Science Education' (CASE). According to the CASE project, there is a significant mismatch between the levels of attainment targets and the ability of children. As Adey and Shayer assert children cannot be expected to reach high standards with today's instruction methods, because, today's education systems and instruction methods are still dominated by traditional referred assumptions regarding the learning process. There is so much emphasis on the content and theory of teaching, and learners and their characteristics are being neglected.

There are some government-inspired and imposed systemic reforms, now in favour, which aim to raise the educational standards; in curriculum content, in subject matter teaching, in assessment systems, inspections, and in the changing duration and content of teacher education programmes. These externally imposed reforms make little impact on the quality of teaching, and learning (Hopkins, *et. al.*, 1996), and, Adey and Shayer, suggest that 'to make real changes in a system one needs to understand its inner workings' (1994: 164). Making any attempts to raise the educational standards crucially depends on the understanding of the nature of the learning process and its characteristics.

On the other hand, there is a great expansion of information as well as the increase in population around the world. Changes in society, and in science and technology require people to adapt, manage the change and change their thinking. In this sense, education as being a vital part of our life must reflect the changes in society. Therefore, I suggest that the purpose of education, taking in consideration the nature of learning and thinking, and awareness of the scientific and technological growth must be re-considered before taking some decisions regarding educational problems. Changes in society also require new roles for teachers and schools. In this respect, the quality of teacher education and professional development of teachers seems crucial.

In this study, it is intended to raise a fundamental question of whether there is any possible way of raising the educational standards in order to meet the demands of society. In this respect, firstly, the changing function of education and the significance of

teaching children how to think and learn will be emphasised, and the importance of science education in children's learning processes and the gradual improvement of science education will be examined. Secondly, in the light of learning theories, the changing notion of the learning process will be indicated, and the cognitive acceleration intervention programme of the CASE project will be examined briefly. The necessity of instruction and intervention will be emphasised. Then, the programme and the findings of CASE will be debated. Finally, some suggestions for teacher education will be made.

2. THE CHANGING FUNCTION OF EDUCATION IN THE POST-MODERN WORLD

'*If you always do what you have always done, you will always get what you have always got… As educators we must try to ensure that reform efforts are consistent with our best knowledge about teaching and learning and our best insights into our pupils' needs in a post-modern age'* (Stoll and Fink, 1996: 118).

Continuing changes in science and technology require that functions and responsibilities of schools and teachers should be changed for the betterment of children for their future. From this point of view, the meaning of education needs to be made clear that simply preparing children for numeracy and literacy for their future is inadequate. Because, there are tremendous developments in Science and Technology; and also Information Communication Technology (ICT) facilities have undeniable importance in our lives. There is enormous expansion of information around the world, as Dr. James Appleberry, the President of the American Association of State Colleges and Universities, informs us: 'The sum total of humankind's knowledge has doubled at least every five years since [1965]. … It is further projected that by the year 2020, knowledge or information will double every 73 days' (as cited by Bowring-Carr and West-Burnham, 1997: 66).

At this moment, it is necessary to distinguish the terms; 'knowledge' and 'information' that are generally confused in the education process and used in terms of each other. Knowledge is traditionally presumed to be transmitted by teachers. However, the consideration of children's minds as 'tabula rasa' is no longer acceptable. Children's minds cannot be thought of as sponges that absorb whatever is transmitted. Rather, information given by teachers is adapted to the schemata that is already in children's minds or is rejected if it does not fit. Knowledge is not transmitted but it is created through the process in which information given is constructed, assimilated and accommodated.

One of the most important assumptions about learning pointed out by Black and Atkin, (1996: 62) is 'knowing that' must come before 'knowing how'. When the job of education is just presumed to be transmitting information from teachers to children, the bombardment of information seems to be a problem for education systems that rather incline to make children information carriers. Stoll and Fink (1996: 122) mention this issue more clearly: 'if teachers taught everything that experts and special interest groups recommended, school systems would have to

have a retirement plan for pupils'. In this case, it seems that, not only the education of children but also the education of teachers would be problematic, because, how could we claim that teachers know everything that we recommend them to teach? Indeed, if scientific and technological growth and current teacher education programmes are continue, I do believe that it will no longer be possible for teachers to be 'life-long experts' of their subject domain. Because *transmission of information* is still the core idea in those teacher education institutions and teacher trainees are not being educated to meet the demands of the post-modern world.

Correspondingly, how much and what kind of information do children need to control over their lives in the future? Erasmus (quoted in Cullingford, 1995: xi) emphasises this by stating that 'The important thing is not how much you know but the quality of what you know'. I do believe that information given in schools today is not satisfactory for the future. In this respect, the emphasis of education systems should be on the quality rather than its content.

Another important concern is about the decision-makers who will select the subject contents to be taught in schools. It is argued whether governments, schools, teachers, parents, or individual students should have responsibility and participation in the decision making process. However, this decision is generally taken by the governments. As Bowring-Carr and West-Burnham (1997) indicate, in such educational systems, the same learning and teaching strategies are employed and only verbal and logico-scientific intelligences are emphasised. However, these kinds of education systems do not help children to become more effective learners and thinkers, because, they do not consider children as unique learners with different abilities.

The UNESCO report (cited in Fisher, 1990: 253) on education asserts that 'the human brain has a very large unused potential which some authorities – more or less arbitrarily – have assessed at 90%'. Fisher continues by saying that 'the job of education is to realise this potential'. He suggests that it is possible to teach children also to be more effective thinkers and to be more intelligent. Therefore, we might refer the function of education as 'to teach how to use our brains effectively'.

Schools, in any education system need to provide a stimulating learning environment in which both teacher and children are learners from different perspectives. This is possible with maximum communication between teachers and students, so that, children can have the opportunity to have control over and awareness of their learning. In such an education system, as Bowring-Carr and West-Burnham (1997) suggest, learning, coaching, mentoring, and teaching needs to be designed to guarantee that every child really learns something, and then, chooses the appropriate way and time to demonstrate that learning. They (*op. cit.*: 25) state that 'the major end purpose of education as being concerned with enabling people to change, to construct their own reality through being able thoroughly to analyse the evidence they encounter, and

thereby be able to make informed choices based on a clear ethical base'.

To conclude, it must be considered that the function of education and teachers is not simply preparing children for numeracy and literacy. What is needed in schools should be as Rogers (1983: 1) asserts: 'the only way we can be assured of that help is to assist our youth to *learn*, deeply and broadly, and above all, to learn *how* to learn'. In other words, I suggest that, teaching children the skills of how to think, to be aware of their learning, the reason why they are learning, and the development of the mind through enhancing thinking, need to be the primary purposes of education. In that case, we can be sure that children are confident in facing their future. I do believe that science, including mathematics, logic and all forms of thinking, seems to be a powerful tool in serving this purpose.

2.1. The Importance of Science Education in Enhancing Children's Thinking

In the past, there was a recognition of two types of intelligence; linguistic intelligence (verbal) and mathematical, scientific or logical intelligence (logico-scientific). Traditionally, the curriculum has been divided into two groups: arts -that are regarded as creative and humanistic, and sciences -that are regarded as logico-technical and abstract. In order to develop ability in learning and effective thinking, Latin and Mathematics have been taught, yet, they were not successful in transferring such skills into higher levels of thinking in other subject areas (Fisher, 1995). Although, the human mind cannot be restricted to these two types of intelligence, it has different capacities for various forms of intelligence.

Fisher (1990) claims that today there is a greater emphasis on the process of learning, investigation and problem solving, reading for meaning, the use of reasoning in writing, study skills and developing autonomous ways of learning rather than simpler forms of learning. However, in his point of view, transferable skills and expertise are lacking in the curriculum. All forms of thinking skills: critical thinking, creative thinking, problem solving and reasoning are essential for the curriculum in which theoretical and practical aspects of subjects should be linked. Fisher (*op. cit*.) comments that 'what is needed is a combination of 'knowing that' and 'knowing how' which together form the elements of 'knowing why''.

Science as –one of the school subjects- itself includes mathematics, logic and all forms of thinking. Scientific and technological growth requires people to transfer skills and apply them into their real life situations in order to solve their everyday problems. However, school science is not related to real life and there is a great gap between what is taught in schools and what is going on in real life.

In science lessons, explaining events, objects, ideas, theories or phenomena is not as easy as expected, because appropriate explanations are required in accordance with the level of the students. In order to explain different perspectives of the phenomena, different models that are the representations of an object, event or idea, are needed.

Models can be accepted as a major teaching and learning tool. It is a major teaching tool because understanding abstractions of theories is very difficult, but through using models theories can become easier to grasp. It is a major learning tool, because students form their own models in order to understand theories and concepts and by determining their own models students can contribute to their own learning. However, this also introduces the problem that children may not perceive models as 'only one of the possible representations of that scientific phenomena'. So that, children may have a conflict when they witness the phenomena in the real life situation. That is why children generally have difficulty in transferring school science into their real life (Godek, 1997).

Thus, children can be taught to link theory and practice by using appropriate models and teaching them how to think. Unfortunately, the history of science education shows that in spite of including all forms of thinking skills, science education has not being taught to link theory and practice, and did not assist children to learn how to think.

2.2. A Brief view of Science Education and the National Curriculum in the UK

Science education is of growing concern for many nations in the world. Since Aristotle, through Greek Philosophers, Copernicus, Galileo, Kepler, Newton, science education shows a gradual influence and improvement (Turner, 1927). In the past, in the UK, the teaching of science is claimed to have served to improve the elite class rather than the whole social system (Turner, *op. cit.*; Shayer and Adey, 1981). In contrast to previous improvements in the education system, the principle of 'The Education for all' regardless of children's intellectual ability, social class or gender differences, is one of the aims of the education system in the UK. At present, the National Curriculum is being used; yet, it has a standardised approach to children's learning.

With the National Curriculum, all children are expected to achieve different level of attainment targets in different subjects. The stages of science teaching have been prepared to match with the chronological age of children rather than their present intellectual level. The child's achievement is obtained through the criterion referencing system in which the child is compared only with the predetermined criteria, and the government expects that all children should reach the average level for that age. Thus, the main structure and the demands of the National Curriculum appear to consider that every child is as same as each other and they can learn and think in the same way.

Shayer and Adey (1981) point out that the *matching* idea that stems from Piaget who describes the population distribution of the stages with chronological age. Based on their research evidence that comes from Cognitive Acceleration through Science Education Project (CASE), Shayer and Adey (*op. cit.*) declare the mismatch between institutionalised courses, textbooks, examinations, science curricula and the ability of children to assimilate the experiences given in secondary schools. The belief that the 'intellectual demand of the curriculum' has to be matched to the 'current

stage of development of the learner' is also criticised by Bowring-Carr and West-Burnham (1997: 93). They believe that the cognitive aspect of learning is one of the most misunderstood and neglected aspects of the curriculum. Unfortunately, this often causes children to be blamed for their failure by their peers, parents and teachers, and schools are also blamed as being unsuccessful. I feel that, if the cognitive development of children is considered, matching idea seems to be unrealistic.

The National Curriculum Report on Science (August 1988) (cited by Fisher, 1990: viii) refers to important attitudes at all stages of education as follows; curiosity; respect for evidence; willingness to tolerate uncertainty; critical reflection; perseverance; creativity and inventiveness; open-mindedness; sensitivity to the living and non-living environment; co-operation with others. These attitudes are presumed to be developed through activities in the various subject areas without children being taught to be critical, creative, independent and capable of rational thought.

Adey and Shayer (1994) believe that since the 1970s, science education courses have provided lots of activities, most 'recipe following' but which did not have any cognitive demand. Kutnick (cited in Adey, et. al., 1989) criticises curriculum planners as having not fully understand cognitive theory. It is also mentioned that curriculum planning and learning processes have always been divided, although, cognitive development theory involves the learning process as part of what is learnt. I do believe that without a good understanding of the nature of the learning and thinking process, the efforts to change curriculum and assessment systems, and teaching methods in order to enhance the quality of children's achievement and improve the quality of education, will remain ineffective. In Adey and Shayer's words 'No serious progress can be made in improving educational standards without a well-articulated theory which can be tested and described in enough detail to enable replication' (1994: xi).

THE CHANGING NOTION OF TEACHING AND LEARNING: DEVELOPMENT AND LEARNING PROCESS

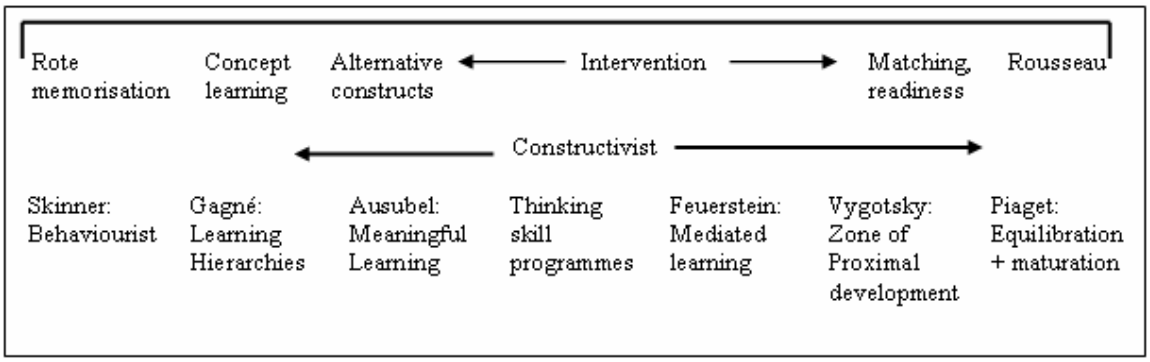

Figure 1. A learning- development spectrum (source: Tanner (1978) in Adey and Shayer, 1994: 5)

A learning- development spectrum (Figure 1. adapted from Adey and Shayer, 1994) shows that there is a shift from the theories of 'instruction' in which the effective presentation of material is considered, to the left of pure 'leave it to nature' developmental models. The 'intervention' theories and programmes are in the centre-right region of the learning- development spectrum.

Behaviourism

On the left side of spectrum 'Behaviourism' and 'rote memorisation' whose roots go back to the American Psychologist B. F. Skinner, who believed that effective teaching, in his terms 'shaping behaviour', involves the only intermittent schedule of reinforcement (Wood, 1998). In the Behaviourist approach, learning is perceived as a change in behaviour. It emphasises the passivity of student's minds, and there is no connection between what is learned and knowledge already held. The environment provides an input whose information is directly transmitted and accumulated by the learner. As a consequence from this procedure, 'output', the behaviour of the learner, is intended to be changed.

Gilbert, Osborne and Fensham (1982) point out that the assumptions that the behaviourist approach held, are referred to as 'black box', 'black minded' or 'tabula rasa' in which it is believed that the learner has no knowledge of a specific topic before formal teaching. The second assumption is ascribed as 'teacher dominance' that regards learners as being passive in the process of learning and their views have little importance for learning and can be easily replaced. This approach simply put the learner in a passive state and the learner's different responses to a question are believed to be entirely his/her responsibility. In this case, however, the 'wrong' answer is assumed to be the fault of the learner who did not try, study enough or did not pay attention during the formal teaching.

Constructivism

On the other hand, the 'Constructivist' view is a totally different approach in which the core idea is 'learners', because they are not accepted as 'black minded', rather they interact with the new information and construct their own knowledge. The Swiss psychologist Piaget is considered to be the first educator who had a constructivist view of learning in which the learner has an active role. He believed that children learn through a process of adaptation, named by him 'equilibration', which takes place when they assimilate an experience by adjusting or accommodating their knowledge structure to it. The importance of the active role of learners with the aim of the construction of meaning is stated by Osborne and Wittrock (1983: 492) that;

> *'The brain is not a passive consumer of information. Instead it actively constructs its own interpretations of information, and draws inferences from them. The brain ignores some information and selectively attends to other information. In other words, although the brain often responds reflexively to incoming stimulation, it is much more than a 'blank state' that passively learns and records incoming information'.*

Piaget considered learning as an activity with different stages of development biologically programmed and which cannot be changed (Fisher, 1990). The idea of stages of cognitive development considers that every child thinks, learns and develops through distinct stages. However, Fisher (*op. cit.*: 8) criticises that 'there is no pattern of cognitive growth, which all children pass through. The pattern of development for each individual child is unique, and research shows that the way children are taught can have a profound effect on their progresses'.

The stages of cognitive development seem to be convenient for curriculum makers in structuring the curriculum, for example in the UK. However, Piaget's stages of cognitive development might be criticised in two ways: firstly, it seems to assume that every child has the same knowledge, beliefs, expectations and environment at the same age. Secondly, it gives credence to the 'matching idea' in which learning material should not be prepared higher than the current level of thinking of the learner. This meant that the learner at a particular level did not have the capacity to achieve higher levels. Therefore, the learner needs to wait until his/her cognitive ability develops as he/she biologically develops, and then, the material is taught. However, this is not the case. I believe that children vary in their knowledge and beliefs, and in their social environment, and they do have a capacity and potential to learn -if there is an adequate consideration of their existing knowledge.

The ideas of structuring learning material of Gagné and Ausubel are accepted as valuable guides for teachers and for curriculum designers. 'The Instructional Events Model' proposed by Gagné, is concerned about the quality, permanence, and usefulness of learning rather than the ways of learning such as by discovery or by reception (Woolfolk, 1998). In this model, he introduces 'learning hierarchies' in which the first step for the teacher is to gain the learner's attention. On the other hand, Ausubel suggests 'The model of meaningful learning', where he suggests that if a new concept can be integrated or subsumed into a previous cognitive structure, it is more likely to be accepted by the learner. He points out the main principle of educational psychology as 'the most important single factor influencing learning is what the learner already knows' (Ausubel, Novac and Hanesian, 1978: iv). The idea of 'learning hierarchies' by Gagné and the plea of 'to start from what the learner already knows' by Ausubel, concern the learners as individuals. However, these considerations contrast with the behaviourist approach, which simply focuses on the material to be learned (Adey and Shayer, 1994: 5). I accept that it is reasonable to describe and measure what the learner already knows and what processing skills the student has to cope with new material. It must be the starting point for teachers to reveal students' existing ideas in order to understand the individual differences and learning difficulties.

To turn to Piaget; his stages of cognitive development theory seems to overlook the cognitive abilities of children because it does not explain how young children can perform at an advanced level in certain areas. His

theory also seems to underestimate the cultural and social differences among children. However, Russian psychologist Vygotsky 'socio-cultural theory' suggests that 'cognitive development depends mainly on interactions with the *people* in the child's world and the *tools* that the culture provides to support thinking' (Woolfolk, 1998). By the interaction with others, children's knowledge, beliefs, attitudes, and values develop.

Vygotsky believed that all children have the potential called the 'Zone of Proximal Development' (ZPD). For him, traditional attainment and intelligence tests did not assess what a child might achieve. If the right help and support are given by parent, teachers, peers and by the others, all children have potential to develop their thinking. In collaborative or co-operative situations, children are able to function at intellectually higher levels (Fisher, 1990; Strang and Shayer, 1993; Woolfolk, *op. cit.*).

The main distinction between Piaget and Vygotsky is that for Piaget the child's development is driven by the interaction of the child with events in his/her environment. However, Vygotsky emphasises the role of 'mediation' or 'mutual interaction' between a child and people who are around. On the other hand, Adey (1994: 55) asserts that 'the development of thinking is more than the accumulation of knowledge. Thinking develops qualitatively as well as quantitatively, and the drivers of this development are genetics, maturation and stimulus'.

To put it all together; genetics, maturation, stimulus, environment, social and cultural interaction, social experience, mutual interactions between adult, peers, and child and the use of language all of them are substantial factors in a child's learning and thinking and cognitive development is conceivable with proper assistance.

Thinking skills programmes

On the other hand, the work of the Israeli psychologist Reuven Feuerstein (in Fisher, 1990; Shayer, 1991; Strang and Shayer, 1993; Adey and Shayer, *op. cit.*) in Jerusalem on social disadvantaged students confirms that children are helped in developing the level of performance and potential by 'Instrumental Enrichment' (IE) programme. As Vygotsky believed, Feuerstein's work shows and I agree, that the traditional IQ tests, the levels of attainment and mark grades are not the indicators of the child's level of possible development. Feuerstein's IE programme is called a 'meta-learning intervention programme' by which children are taught how to learn (Adey and Shayer, *op. cit.*). The IE programme contains fifteen units, emphasises the necessity of allowing children time for thinking. IE intends helping students to become active, self-motivated and independent thinkers through 'bridging' knowledge that has been gained from new material. Relatively free from traditional school curriculum content, IE materials helped to focus on the process of thinking, not on the products. Having intellectual puzzles, they were quite similar to the traditional IQ tests, and supported children to develop their cognitive abilities.

Correspondingly, Somerset Thinking Skills Course and The Oxfordshire Skills

Programme are well-known successful programmes of IE. They indicate that the principles of IE can be adapted to a wider range of children. According to Bowring-Carr and West-Burnham (1997: 95), the modules in the Somerset Thinking Skills course provide a most useful starting point for any cognitive development programme. IE is suitable for improving basic geometrical, numerical and logical structures, hence, this programme successfully serves to develop logico-mathematical domains of intelligence. However, Fisher (1990) approaches it critically that IE ignores other forms of intelligence such as; linguistic, inter-personal, bodily/kinaesthetic, visual/spatial.

In schools, the transmission 'chalk-and talk' teaching method, which is called differently by different authors; the 'Jug and mug model' (Rogers, 1983); simply 'pour' the knowledge into children's mind; 'vessels to be filled' (the transmission model) model of teaching, or 'fires to be lit' (the discovery model) (Fisher, 1990: 184) are still being used. It is considered that children need to be exposed to the right ideas that are in the teacher's mind to gain understanding, although, the learning process is not as simple as it is thought. The transmission model of teaching acts as a catalyst for new understanding, but just requires children to absorb and retain information, therefore, Fisher calls it as a *reproductive mode*. On the other hand, the *discovery model* is *a productive mode of learning*, yet it cannot guarantee any qualitative difference in children's thinking. The *teaching for thinking model* is considered as a *transformational mode of learning* that focuses on a thinking approach rather than just a telling or doing approach. In this transformational mode of learning, knowledge is constructed by transforming, organising, and of reorganising previous knowledge. Knowledge could not assumed to be a mirror to the external world, because the learner who has active role, constructs his/her own knowledge through transforming and reorganising the existing structures of knowledge to a more co-ordinated and useful one rather than simply accumulating.

Both 'Cognitive developmentalists' and 'Constructivists' agree that people's perceptions are affected by their existing ideas, beliefs and expectations, and how people themselves actively construct their knowledge depends on their own experiences (Driver, 1983).

Constructivism determines children's ideas about phenomena. It regards students' prior ideas as important factors in the development of children's learning and science teaching. The ideas of children regarding scientific phenomena are variously called: *ideas, beliefs*, *understandings*, *preconceptions*, *viewpoints*, *prior knowledge*, *alternate conceptions*, *alternative frameworks*, *conceptual ecologies*, *conceptual frameworks*, *cosmographies*, *mixed conceptions*, *personal constructs*, *gut science*, *children's science*, *misconceptions*, *intuitions*, *naive theories*, or *children's conceptions* (Shapiro, 1994). In order that teachers or adults can help a child in constructing knowledge, it is logical to start from what the child already knows. Because it is obvious that teaching is not just ordering learning

material in a logical manner, rather teachers need to the nature of learning difficulties. According to this movement as Driver (cited in Adey *et al.,* 1989) states knowledge is personally and socially constructed and learners are responsible for their own learning, since they cannot be viewed as passive recipients of an instructional programme. Learning can be developed through previous experiences, in school or out.

The Children's Learning in Science Project (CLISP) based on Constructivism is criticised by Adey and Shayer (1994) because defining the students' prior ideas is just instructional and a relatively short-term aim rather than a way to develop formal operations and to have long-term effects. However, I think that learning about the children's prior knowledge is helpful for teachers in deciding appropriate teaching strategies not only to develop formal operations but also at all levels.

In contrast to the transmission model of teaching, Cognitive Acceleration through Science Education (CASE) project aims to devise ways of making children construct their own knowledge through not only just encouraging children to construct knowledge of science concepts, but also by putting them in a position where they must construct the reasoning patterns of formal operations.

4. COGNITIVE ACCELERATION THROUGH SCIENCE EDUCATION (CASE) PROJECT

Cognitive Acceleration through Science Education (CASE) project is the first project in the UK in assessing a large representative sample of the school population of a whole country. The CASE project emphasises the maximisation of every child's potential intellectual power through social interaction in the classroom (Adey and Shayer, 1994).

Piagetian psychology, Vygotsky's notion of the importance of social environment on a child's thinking and the Zone of Proximal Development (ZPD), and Feuerstein's Vygotsky-derived model of intervention programme, altogether provide a theoretical ground for CASE. However, the Piagetian staged development model is regarded as a guide rather than a direction for the CASE project. According to Shayer and Adey (1981), the quality of thinking that develops through stages depends on the child, but not by the chronological age as Piaget believed. Shayer and Adey (*op. cit.*) assert that cognitive development is affected by genetic make-up, by age, and by experience. These features create main differences in intellectual levels of children.

The theory on which the CASE project is based considers that learning and understanding of psychological theory of children's development are important and helpful to be a good teacher. The understanding of psychological theories of children's development will help teachers to change their practice. This understanding will provide them some theoretical justification in following new teaching methods. Adey (1994: 55) claims that 'more effective learning demanded by society can only be delivered on the back of a better theoretical understanding of the learning process'. On the other hand, Constable, *et al.,* (1994) argue

that in order to achieve higher levels of thinking by students, teachers need to have a good understanding of the nature of formal operational thinking. Otherwise, teachers are not able to respond flexibly and intelligently to the day-to-day instances.

The main aim of CASE is to investigate possible conditions in which formal operational thinking is brought forward. According to Adey, *et al.,* (1989: 247) teachers' beliefs regarding general intelligence are important factors in achieving their project. Therefore, investigating the teacher variables that are willing to promote cognitive development is necessary in implementing the CASE project.

One of the criticisms made by Adey and Shayer (1994) of Piaget's work is its unrepresentativeness of the samples chosen, but the Piagetian model was still attractive for measuring the level of development of pupils' mental schemas and determining the level of cognitive complexity of curriculum material. In the Concepts in Secondary Mathematics and Science (CSMS) programme a Piagetian model of cognitive development was applied to the practice of science teaching, in order to build a model to investigate children's difficulties, success, failure in science, the level of development of children's mental schemas and to find out the limitations and the level of complexity of the curriculum material, so that the correct 'child-material' match is made. From Adey and Shayer's research, the children's stages of cognitive development and enormous variation between the stages of cognitive development of children in different schools have been determined.

The second consideration of Shayer and Adey (1981) was to analyse the science curricula for levels of demand. However, the levels of the Nuffield 'O' level Science courses were generally out of reach of the average population throughout, even for the first year children of selective schools. Shayer and Adey (*op. cit.*) argue that the Nuffield 'O' level courses were not adapted to the whole population of children and the levels of these courses were not well matched to the teachers and children. Shayer and Adey criticise the Nuffield O level Course designers as influenced by the Piagetian idea of the distribution of the stages with the child's age.

Research conducted by Shayer and Adey shows that:

- According to CSMS data, there was a 'Twelve-year-gap' in Mathematics among 12 year-old children; the range of levels of thinking between the most able (operating at the level of average 18 year-olds) and the least able (operating at the level of average 6 year-olds) among children in the first year of ordinary mixed-ability high schools (Adey and Shayer, 1994).

- The Curriculum Analysis Taxonomy (CAT) has been used to find out the interaction between the cognitive levels of the children and the level of thinking required for activities in the original Nuffield O-level science courses, shows that 14 year-old children are expected to

have formal operational thinking. However, it was not the case. In fact, the science curriculum was shown to have for the selective grammar school populations (Adey and Shayer, *op. cit.*).

- CAT also has been applied to the 1991 National Curriculum for Science and the gap between the cognitive demand of attainments and the levels of thinking of 14-year-old and 16-year-old children has been found. Shayer (1991) claims that the Levels of Attainment in Science in the National Curriculum is achieved by the top 20 per cent of 14 and 16 year olds rather than 50 per cent as planned. Adey and Shayer (1994) pointed out that the demand of the curriculum is that approximately 50 per cent of all children should be at the 5/6 level boundary by the age of 14. However, in reality only 14 per cent of children achieve level 6 or above. Though, science is thought to be suitable and desirable for all children, it was the proof that there is a tendency to think of children as much the same everywhere.

- Fewer than 30% of 16 year-old children show the use of early formal operations. It means that the majority of the population leave school using only concrete operations.

- 70 per cent of adolescents do not achieve the final formal operational stage of development (Adey and Shayer, 1994).

Any curriculum is prepared for the purpose of achieving higher levels of student attainment. Likewise, in the UK, National Curriculum designers aim is for children to have formal operational thinking at the age of 16, although, above research findings show that in today's education system not all children seem to be able to meet this demand. In my opinion, this problem is mainly due to the quality of education in schools because it is not complementary with the expectations of the curriculum designers. Children are being asked to learn and think in the same way and they are not being taught to construct their knowledge.

Adey and Shayer (1994) define the characteristics associated with cognitive development as unconsciousness, unidirectionality and orientation towards natural goals. Everyday, in a classroom or social environment children are unconsciously open to learn in any direction. Learning is a lifelong process; its ends or limits could not even be conceived. However, in education systems, schools offer some information to the some extent that is defined by course syllabuses and curricula. If children are expected to prepare for the future, it should be schools' and educators' objective to provide a stimulating environment for children to learn the ways of learning and thinking.

Current education systems ignore the demand of teaching children to think and learn. Rather, they only focus on the teaching of the basic skills: reading, writing and arithmetic. Fisher (1990: ix) argues that thinking or reasoning skill is the 'foundation skill of all learning and fundamental to the development of all the other skills'. The thinking skills that promote intellectual development for children have been identified

by Fisher (1990) and summed by Bowring-Carr and West-Burnham (1997: 94) as; creative thinking; critical thinking; problem-solving; reasoning. Teaching to think critically assists children to learn how to question, when to question, what question to ask, how to reason, when to use reasoning and what reasoning methods to use. Teaching children to think creatively assists children to rearrange the knowledge that is already held and use it to find out what they do not know. By supplying this, they are able to achieve the context of discovery and the generation of hypotheses. Creative thinking develops with confidence and capability and through working effectively with others (collaboration). Critical and creative thinking as forms of investigative thinking should be applied for the purpose of problem solving (Fisher, 1990). If the teachers' aim is for children to have high levels of learning and thinking ability, they initially need to learn these processes, and then, they need to give children opportunities to be taught the reasoning patterns (formal operational thinking).

The other point is the transition from the concrete level to formal operational level. It is easier for a child to understand concrete explanations and models than it is to understand abstract ones. At formal operational level, children are expected to construct formal models. However, it does not happen spontaneously, rather, it is a process gained by using formal operational reasoning patterns. According to the CASE project, formal operational thinking can be taught by practical activities in which demonstrations are carried out by teachers or experiments are carried by individuals or groups of children. While doing or observing the experiments, children are requested to apply the reasoning patterns. These experiments are chosen with the aim of accommodating these reasoning patterns in children's mind. As the CASE project suggested and as I also believe, that once people are taught the learning or thinking process, they do not need to be assisted. In other words, if fishing is vital for a person who does not know how to fish, giving a fish to him will not be helpful, but teaching him how to fish will save his life.

Shayer (1991) states that when teachers present the information required more efficiently, get children involved in more active learning, or even know their subjects better, it may improve the achievement of the top 25 per cent of children. In order that children are able to achieve the attainment level expected, repeating the work a year later is not helpful. However, he suggests that by professional skills and artistry, teachers can intervene in children's development in the first two or three years of secondary education, so that they will bring children to the expected Attainment Target levels.

4.1. Instruction or intervention?

The provision of knowledge and understanding through appropriate activities is known as instruction. Instead of just suggesting instruction, the CASE project mostly emphasises the intervention method that is known as the manipulation of the environment and experiences specifically aimed at maximising cognitive developmental potential. Shayer (1991)

informs us that the CASE project had long-term effects on child achievement by intervention delivered within the context of science to 11-14 year-old students over a two-year period after that children benefited from good instruction.

Vygotsky states that 'instruction is good only when it proceed ahead of development, when it awakens and rouses to life those functions that are in the process of maturing or in the zone of proximal development' (quoted by Shayer, 1991: 22). So that, Adey and Shayer (1994) consider both instruction and intervention are necessary for an effective educational system and claim that intervention has been neglected by concentrating on improved instructional methods for 40 years. However, intervention provides the route for the raising standards in education.

Adey and Shayer (*op. cit.*) state that by the use of an intervention programme involving time taken out from the instruction in the early secondary years, higher level thinking skills will significantly increase and then by continuing effective instruction methods there will be an automatically increase in the achievement of children.

According to Adey and Shayer (1994) (Figure 2.) cognitive intervention programme includes phases of duration and density, concrete preparation, cognitive conflict, construction, metacognition, and bridging. For effective intervention to make a permanent difference in children's cognitive development, a two-year period is needed. In concrete preparation, the aim is for children to become familiar with the technical vocabulary, apparatus and framework and to give children practice in using the terminology, which consists of terms such as variables, values of variables, and relationships between variables. Intervention lessons include control and exclusion of variables, ratio and proportionality, equilibrium, compensation, combinatorial thinking, correlation, probability, compound variables, and conservation involving formal modelling. However, children are just required to operate on a concrete level, and they are put in a position in which cognitive conflict and construction takes place. In the metacognition phase, children themselves become conscious of their own thinking processes and then they can accommodate their conceptual framework to the new type of thinking. In the intervention lessons, examples are chosen from the science curriculum to assist children 'bridging' it into other lessons and into everyday life.

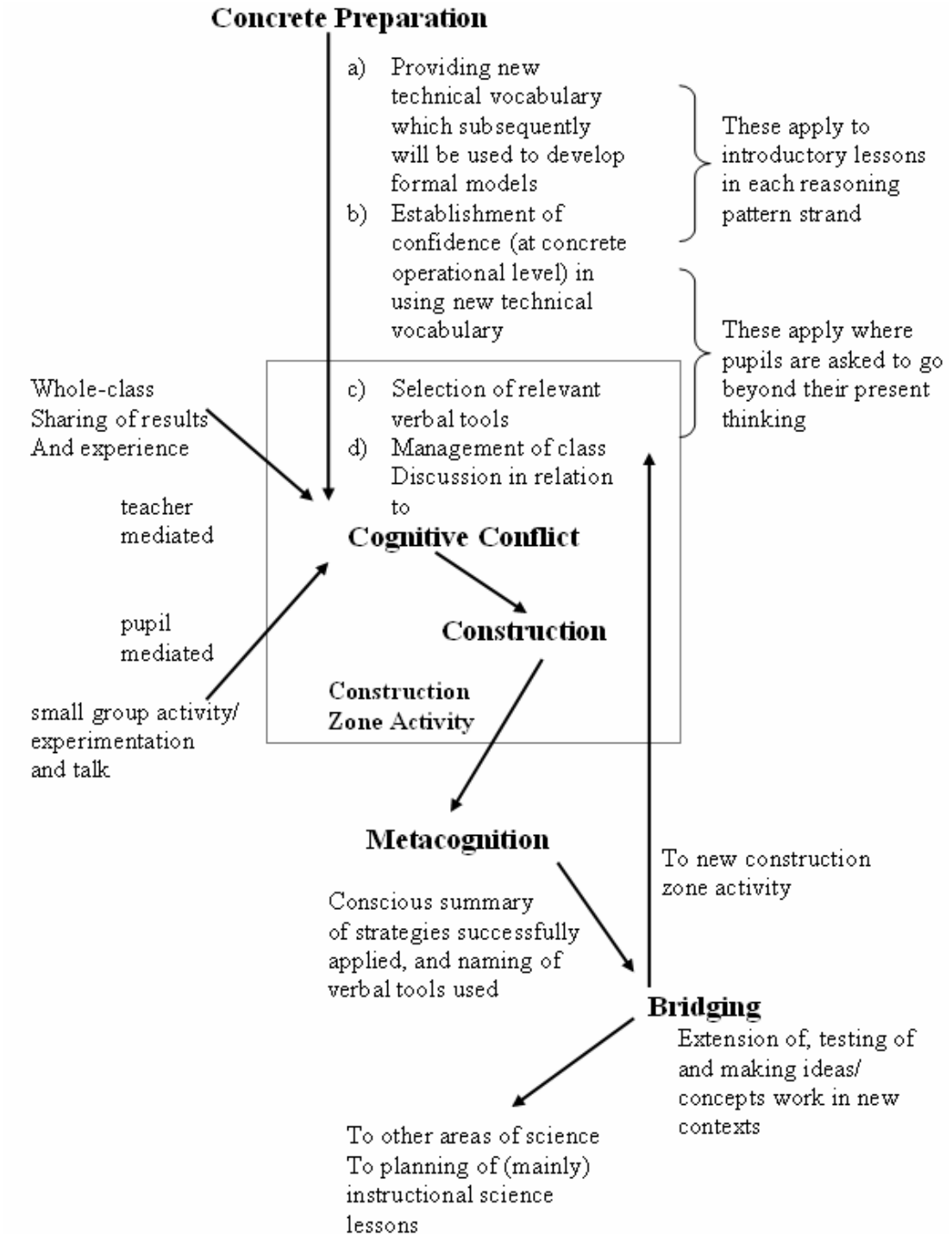

Figure 2. Summary of the features of a cognitive acceleration programme (adapted from Adey and Shayer, 1994: 76)

4.2. A critical perspective of the CASE project

The quick-fix solutions to educational problems are being criticised as having no consideration of the individual school settings (Hopkins, et. al. 1997). I do believe that, in any school, before adopting a new strategy, support mechanisms, collegiality, joint planning, leadership, motivation of staff and children, involvement, empowerment, co-ordination, collaboration, participation and ownership and in-service training of all the staff should be considered. The CASE project does not suggest adopting it without creating the right internal conditions in the schools. The research evidence about the CASE project of Jones and Gott (1998) points out that the success of different schools that have different structures, management, and support mechanisms are varied. In the school whose staff have a commitment to change their practices, and enthusiasm, and has also been given extra in-class support by the other members of the department or the school, the CASE pupils had greater success than the non-CASE pupils. Therefore, before implementing the new programme, the internal conditions of the school need to be strengthened, otherwise, these new programmes will be unsuccessful or in Hopkins' words 'without an equal focus on conditions, even development priorities that directly affect classroom practice quickly become marginalized' (Hopkins, et. al. 1997: 263).

In my opinion, the claimed success of the CASE project mainly depends on keeping the balance between the top-down and bottom-up change strategies. The top-down change strategies or in Hopkins's et. al. (1994: 17) words 'centrally imposed change', focuses on the formal organisation of the school and curriculum without participation of the individual teachers. Top-down change models fail in the implementation phase because the imposed change attempts are not well understood by teachers. Teachers need some new knowledge and skills to implement new strategies. As opposed to the top-down approach, the bottom-up approach aims to change educational processes, rather than school management or organisational features. The bottom-up approach is governed or owned by the individual school with the participation of all staff, outside school consultants, and experts. The practitioners of the school can argue about the goals and outcomes of school improvement programmes (Reynolds: 1997). In my opinion, if this project was not chosen by the individual schools, but imposed by the central government, it would not be possible to talk about the success of the CASE project. The autonomy of the schools and the teachers, the participation of all staff, the collaborative, communicative and supportive environment within the school by the teaching staff and the project team are important factors in keeping the balance between top-down and bottom-up change strategies.

According to Adey and Shayer (1994), in the early phase of the project in those schools in which two or three teachers from each school were introduced the project, teachers who applied the CASE project have been promoted and moved to other schools, but other teachers, with the withdrawal of support

by the CASE team, felt isolated within their departments. For this reason, the CASE project aims to work with whole departments, but not with individual teachers. Adey and Shayer (*op. cit.*: 160) assert that 'the key to implanting a new methodology lies at departmental level'. In this supportive and communicative environment, the individual teachers have an opportunity to develop and share their experiences. In this way, an implementation and management strategy can more easily be transferred to other departments and become part of a whole-school policy. It must be emphasised that working with whole departments and schools is important in implementing the particular project. However, it is also necessary to convince and train all the teachers in the school. For this reason, in the schools who apply the CASE project, teaching staff are supported through in-service training by Kings College, and the external support is also provided by the project team inside the classrooms.

It is undeniable that teachers are the key factors as persons who have the most influence on children's achievement, by having different life experiences, perceptions, beliefs, and professionalism in the education process. The value given to teachers in the form of salary or status is insufficient in many countries and teachers are the foremost people who are blamed for inefficient schooling. Yet, Goble and Porter (1977) assert that 'no reform, then, can be expected to succeed unless it is fully understood, fully embraced, and effectively implemented by teachers'. Teachers who are willing to change themselves in terms of their vision, beliefs, thinking, and their teaching styles, are able to create the conditions inside the classroom, the department and the school level in order to raise educational standards. Owing to successful school improvement, teachers are regarded as change agents and 'catalysts' (Goble and Porter, *op. cit.*). Therefore, the CASE project sees teachers as a crucial factor in improving the quality of education.

For the CASE project, the understanding of underlying learning theory is necessary for teachers to understand the reason why they are doing the things that are expected by the project team (Constable, *et. al.*, 1994). Without this knowledge, the teachers would be put in the role of technicians who are instructed to follow set procedures to produce certain results. However, the CASE project recognises teachers as professionals. According to Adey and Shayer (1994: 182) 'A professional is not only a good practitioner but is one who has an internalised theory which allows him or her to modify practice in the light of feedback'. Carter and Halsall (1998) state, and I strongly agree, that teachers are 'not technicians who merely apply initiatives handed to them by others, but definers of their own reality through being able to investigate and reflect on self-chosen practices, and then modify these on the basis of professional judgement which engagement in the research process has itself informed. The matter of making 'judgements as to what is worthwhile and decisions as to what to do' (Bassey, 1995: 39, as cited in Carter and Halsall (1998: 71) is at the heart of professionalism' (Carter and Halsall, *op. cit.*: 71).

The teaching process is twofold; it is not a one-way process, but it is a multidimensional process in which both learners and teachers gain some knowledge. As Hopkins and Stern (1996) and Hopkins, et. al., (1994: 54) state 'models of teaching are also models of learning; the way children are taught has an impact on the way in which they educate themselves'. Teachers help students acquire information, ideas, skills, values, ways of thinking and means of expressing themselves, they are also teaching them how to learn. In order for teachers to teach their students how to make productive use of their knowledge, they require deep understanding of how students learn and think. That is also the main theme of the CASE project. To me, teachers, who have knowledge about underlying theory, an efficient subject matter knowledge, pedagogical knowledge, and pedagogical content knowledge, can easily apply different teaching strategies and models in their classrooms, and this is also crucial for them to develop their professionalism.

If we look at the way the CASE project has been implemented in classrooms, it is seen that teachers are expected to apply different teaching strategies and models. The role of the teacher, an authentic relationship with her/his students, making a start, handling questions, encouraging children to make some kind of record of their work, helping them to raise questions, to observe, to plan investigations, and taking into account children's own ideas are very demanding factors in constructive learning. Implementing new models really requires knowledge of the learner characteristics, the learning theories, and skills to implement them. The in-service teacher-training phase of the CASE project gives emphasis to these issues.

One of the criticisms made of CASE is, as Leo and Galloway (1996) claim, CASE is successful only on mastery-oriented pupils but not on pupils who possess 'learned helpless' and 'self-worth motivation'. Jones and Gott (1998) also comment that the cognitive acceleration programme of CASE might become a deceleration for those pupils. Leo and Galloway, and Jones and Gott point out the importance of being aware of learner characteristics. They suggest that self-esteem and motivation of learners are affective in the learning process, and teachers need to be aware of the individual learner differences within their classrooms before implementing CASE. In my opinion, teachers who have an efficient knowledge of pedagogy can achieve success in their classrooms, and that, learners' motivational style and self-esteem need to be considered before implementing any teaching strategy.

On the other hand, as Hopkins, et. al., (1994: 55) point out 'teaching models need not adopt a prescriptive from to be followed in a step-by-step manner' and to improve student learning the models and strategies need to be combined. The combination of the models and strategies depends on the teacher's '-artistry-' that is, the level of creativity a teacher has in using a repertoire of responses. The CASE project also aims to transfer the ownership of the methodology from the researcher to the teacher. In Adey and Shayer's (1994: 157) words, 'this is a constructivism for teachers'. Therefore,

teachers are expected to construct the methods of cognitive intervention for themselves. This transfer of ownership also helps teachers to be creative in their models of teaching. In this sense, I believe that the CASE project also seems to be supportive in the development of teachers' professionalism.

As discussed earlier, the development of the mind through enhancing thinking, needs to be the primary purpose of education. From this viewpoint, the quality of teacher education needs to be considered more carefully. However, the changes in the teacher education systems are restricted by just their content and there is still a remarkable gap between theory and practice. In my opinion, the CASE project, while aiming to accelerate children's thinking and learning in ordinary school settings, also helps to minimise the gap between the theory and practice of teachers. It trains teachers as professionals who can develop their own philosophies of teaching and learning, and who can employ different types of teaching models and strategies. For this reason, the main features of the CASE project seem to be essential for pre-service teacher education institutions.

5. IMPLICATIONS FOR TEACHER EDUCATION

It is demanded from teachers they to teach their subject domain more effectively, and prepare their children for their future's unpredictable world. However, the education of teachers is also questionable. Do the teacher education institutions prepare teachers to cope with the demands of an ever-changing world? I believe that the key factor in raising the educational standards is dependent on the quality of the teachers or in Southworth's words 'there can be no curriculum development without teacher development' (Southworth, 1994: 52 as cited in Lumby, 1997: 33). Therefore, teacher education is also crucial in raising the educational standards.

The rapidly changing educational demands require more skilful teaching and more responsive schools than the present educational systems have. However, teaching is commonly presumed as a matter of ordering learning material in a logical manner and therefore, the nature of cognitive development and learning difficulties are neglected. Adey and Shayer, and Grimmett (1995) believe, and I strongly agree, that 'one of the most important things that teachers in training need to re-learn is the nature of difficulties that children have in understanding' (Adey and Shayer, 1994: 3). Since teaching means much more than conveying subject matter to passive receivers, effective teaching requires knowledge of learners, their experiences and the ways in which they learn and think. Teachers should also be educated to have knowledge about the purpose of education, and the role of educational theories in improving standards.

As mentioned earlier, there is a remarkable gap between the subjects taught in schools and real life. If schools cannot serve to prepare children for the demands of real life, why do we need schools? In this sense, teachers should be accepted as *bridging factors* who create bridges between challenging curriculum goals and individual

learners' experiences and needs. In order to do this, teachers must have an understanding of child development and pedagogy, as well as their subject matter. However, this is not the solution we have now, because, in teacher educational institutions, teacher trainees are taught theory and practice separately. This is again, a fundamental problem for teacher trainees to connect theory and practice. I believe that teachers must also have knowledge about pedagogical content knowledge. That is, the ways of representing and formulating the subject that make it comprehensive to learners (Bennett and Carré, 1993: 84).

One of the most important tasks of a classroom teacher is to ensure that all the children are learning. This can only be achieved in a stimulating learning environment, which is described by Stoll and Fink (1996: 127) as; effective lesson planning, grouping students according to academic and affective needs, the efficient use of time, smooth, efficient classroom routines, higher-order questioning to encourage thinking and reasoning, explicit, consistent and equitable standards for classroom behaviour, focused lessons, high expectations for student learning, maximum interaction between the students and the teacher, and a work-centred environment. In this stimulating learning environment, teachers attend to pupils' self concepts; address the basics of classroom management and teaching skills; employ a variety of teaching and learning strategies to engage multiple minds (Stoll and Fink, *op. cit.*: 126-128).

Assessment and feedback are important parts of learning as well. Teachers should have knowledge of assessing children's understandings both qualitatively and quantitatively. Teachers should know the techniques of probing understanding; such as; essays, concept mapping, multiple choice tests, concept maps, prediction, observation, explanation, interviews, drawings, and relational diagrams (White and Gunstone, 1992) in order to reveal the children's learning difficulties.

There is no doubt that there will be various reforms or imposed changes during the life careers of teachers. Fullan (1991) asserts that 'Reform is not putting into place the latest policy. It means changing the cultures of the classrooms, the schools, the districts, the universities, and so on'. It goes without saying that the nature of teaching and the lives and ideologies of the teachers are also affected by imposed change mechanism (Sikes, 1992: 38). Moreover, Hargreaves (1988, quoted by Sikes, *op. cit.*) states that 'changing the teacher … involves changing the person … (and, therefore) changing the life'. For this reason, we need teachers to cope, adjust, and have the potential to change.

As already mentioned, the professionalism of teachers depends on the degree of their "artistry" (Hopkins, *et. al.,* 1994; Figure 3). As Joyce, *et. al.*, (1989) suggest the consistent and strategic use of specific teaching models can enhance student achievement. Therefore, teachers need to utilise various teaching models and strategies in relation to the learners' capabilities. This again, could mainly be sustained by subject-

matter knowledge, pedagogy and pedagogical content knowledge. On the other hand, individual schools and external policies are also affective in teachers' quality. As Hopkins and Stern (1996) suggest '…there are three sources of teacher quality –the individual teacher, the individual school, and the external policy environment'. Staff development is an essential activity for ensuring high levels of teacher quality in schools. Therefore, there is a need for opportunities for teachers to learn from each other, to evaluate of the outcomes of their work, and this inevitably is achieved by the activities in the schools through peer coaching, partnership teaching, collaborative classroom research, and reflection.

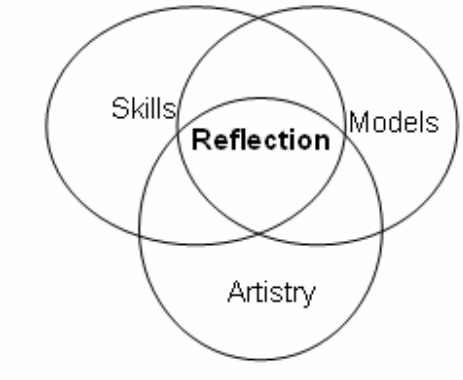

Figure 3: Three ways of thinking about teaching (Hopkins, *et. al.,* 1994; Hopkins, 1996).

As part of teachers' professionalism, teachers should become *life-long learners*. I would agree that life-long learning is based on three interwoven characteristics that are 'teaching', 'learning', and 'researching'. This is achieved through 'reflective practice', which is defined by Day (1995: 112) as 'continuing conscious and systematic review of the purposes, plans, action, and evaluation of teaching in order to reinforce effectiveness and, where appropriate, prompt change'. To me, reflection is vital to the improvement of teachers' professionalism.

I would argue that the role of teachers should not be assumed to be transmitters of the knowledge, or in other words, as technicians who just deliver things. The new changes in society, science and technology require teachers to be facilitators and mediators of information, and knowledge counsellors. Teachers also need to be 'leaders of life-long learning'. There must be a shift from the transmission of knowledge to the organisation of pupil's learning. They should have more responsibility for the organisation of the content of learning and teaching. Teachers should have knowledge of the use of modern educational technology. They should work in co-operation with other teachers in schools, and with the parents and other people in the community.

There is a traditional acceptance that teacher's duty is just to teach and take care of children, so that their role in education is restricted at the classroom level. However, the conceptions of teaching have changed from the view of 'teachers as the recipients and consumers of research to the view of teachers as producers and mediators of knowledge' (Richardson, 1994). Recently, there has been an increasing demand for teachers to conduct research that addresses basic issues such as curriculum development, although the number of teachers who contribute to educational research with their

professional knowledge and invaluable experiences within their classrooms and their schools is unsatisfactorily low.

There is a need to have active collaboration between researchers and teachers to support each other. Above all, there should be the recognition of teacher participation in educational research, in change strategies and in the decision-making process. This should be seen as a right and a duty of their profession.

6. CONCLUSION

> *'You can raise standards substantially only by improving quality of thinking. This can be done, and we have seen how raised levels of thinking open up opportunities to all children to benefit anew from good instructional practice. All that is required now is the professional and political will to make it happen'* (Adey and Shayer, 1994: 182).

This study has tried to answer the fundamental question of whether there is any possible way of raising the educational standards to meet the demands of society. As mentioned earlier, due to scientific and technological developments, the changes in society require education systems to reflect those changes and prepare people to be confident in facing the future. Therefore, people are required to be self-directed and independent learners who have creative, critical, and rational thought. I think that current education systems are far away from serving these changing demands, because, they prepare people who are dependent on teachers who are used as a knowledge resource. There is no doubt that this assumption has to be changed.

In current education systems, there are many attempts to raise the educational standards through changing the curriculum, assessment systems and teaching methods. In my belief, these attempts will remain ineffective unless there is a consideration of the issues below;

- The changing function of the education;
- The great expansion of information as well as the increase in population;
- The changing notion of teaching and learning.

As I indicated earlier, intelligence is still being assumed to be a fixed potential. The National Curriculum in the UK shows that all children are expected to achieve average levels of attainment targets at distinct ages, regardless of individual differences. Shayer and Adey (1981) describe the existing problem in current education systems very clearly;

> *'If a style of curriculum adapted to the cognitive development of selected students (selected, that is, on the basis of parental income, social standing and stringent entrance exams; or electively by criteria rather comparable) is produced, then it will produce another social effect: that of exclusion of the rest of the student population. This will produce an effect on the teachers of which they will be unconscious: their teaching style will be conditioned so as to sort the sheep from goats'.*

In this respect, this selection will be an advantage for the students who achieve the

expected levels, but what about the rest of student population? I would agree that standardised tests are unavoidable for central governments and it is unrealistic to demand lowering the educational standards, but what should be the solution?

As it is suggested in this study, the possible solutions are:

- Deliberate thinking and good understanding about the nature of learning and thinking processes and individual differences,
- Connecting theory and practice,
- Enhancing children's thinking through teaching children skills of how to think and learn, the awareness of their learning, and the reasons why they are learning.

The CASE project gives impressive evidence that children are brought to the expected levels at distinct ages through teaching them thinking processes. The development of thinking in average secondary school children can be accelerated through science education that includes thinking skills, and general intelligence can be raised even in ordinary school settings (Adey and Shayer, 1994). This requires teachers to employ thinking skills and a variety of teaching strategies and methods in accordance with the varying capacities of children. However, the quality of teacher education and professional development of teachers needs to be re-considered more carefully.

The CASE project also seems to offer new insights for pre-service teacher education institutions and the professional development of teachers. The main features of the cognitive intervention programme of CASE should be included in teacher education programmes, because it trains teachers as professionals who can develop their own philosophies of teaching and learning, and employ different types of teaching models and strategies.

I conclude with the suggestion that overall changes never occur spontaneously. What we need mainly depends on the quality of teacher education institutions that fulfil teachers as professionals who are confident in connecting theory and practice. In my belief, this can be achieved through educating them with efficient pedagogical content knowledge, as well as subject- matter and pedagogical knowledge. After that, willingness by teachers to learn, openness to criticism and reflection are crucial factors for them, so that they develop themselves as professionals who employ different types of teaching models and strategies, take new roles in education; co-operate and collaborate with the other members of community and researchers, and contribute to educational research, change strategies and decision-making mechanisms with their invaluable experiences.

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