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COGNITIVE REVOLUTION AND THE KNOWLEDGE-BASED SOCIETY: EDUCATIONAL IMPLICATIONS

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Abstract: The advent of the knowledge-based economy calls for new paradigms in education. There has increasingly been a search for educational methodologies that emphasise areas such as real world challenges, higher-order thinking skills, multi-disciplinary learning, independent learning and entrepreneurship. According to Feuerstein these challenges relate primarily to the ability to adapt and confront change. How can educational psychology and cognitive theories contribute to these endeavours?

This paper posits that the cognitive revolution anchored in the theories of Piaget, Vygotsky and Feuerstein provides the theoretical basis for many of the educational challenges today. Piaget's work addressed the internal world of the individual in relation to intelligence and questions pertaining to the structures of the mind. Vygotsky and Feuerstein considered the environment and social processes in developing internalization based on their respective theories of the Zone of Proximal Development and Mediated Learning Experience. The insights and educational implications are discussed.

Introduction

The knowledge-based era has also been described as the “intelligence era”. Most researchers in the field of intelligence now agree that intelligence is learnable and pertains to the capacity to learn and to solve problems. The great cognitive psychologists Piaget, Vygotsky and Feuerstein provided valuable insights for education today. Their theories of learning and intelligence reveal the importance of emphasis on cognition, contextualization and mediation.

Contribution of Piaget

Piaget's (1959, 1969) work addressed the internal world of the individual in relation to intelligence and questions pertaining to the structures of the mind. His work was influenced by his background in biology and philosophy, hence his genetic epistemology. Interestingly, the 21st century will be an era with much emphasis on biology, biotechnology, information processing and knowledge management. Perhaps new relevance and insights may be gained by an examination of Piaget's ideas. In today's era knowledge is multi-disciplinary and multi-faceted. Knowledge is also viewed from the perspectives of networks and maps rather than sequential information or content. Sternberg (1990) noted that Piaget's theory is a theory of competence rather than performance. The 21st century workplace and education is similarly about competence (cognitive capabilities) rather than job descriptions and behaviours. It can be argued that the cognitive revolution has a new place in the knowledge-based society.

Piaget's work in intelligence grew partly as a result of his interest in the bases of children's wrong answers in response to the Binet-Simon Intelligence Scale while working at Binet's laboratory. Piaget's investigation brought him to consider the way a person acts on the environment and why the person performs as he/she does, taking into account the cognitive structures underlying the individual's action. Piaget's view was based on three interrelated conceptions: (i) the relation between action and thought, (ii) the construction of cognitive structure, and (iii) the role of self-regulation (i.e. equilibration in the development of thought).

According to Piaget (1959, 1969), logical thinking and reasoning about complex situations represents the highest form of cognitive development. He expounded a stage theory of cognitive development in terms of different ways of thinking (e.g. concrete operation to formal operations) from infancy to adulthood and described the processes by which complex cognitive structures are developed through assimilation, accommodation and equilibration (Piaget & Inhelder, 1969; Piaget, 1980). Piaget's investigations centred round the child's manipulation of and interaction with his/her environment i.e. the S-O-R model. Sternberg (1990) noted that Piaget dealt primarily with the relationship of intelligence to the internal world of the individual and that Piaget believed intelligence essentially matured from the inside and directed itself outward.

The implications of Piaget's work in the context of the knowledge-based education are: the importance of cognition, the need to understand and emphasise cognitive processes, the inside-out approach to the development of intelligence in the light of today's information-rich environments.

Piaget's Missing Links

Despite its contributions to cognitive psychology Piaget's work is incomplete and has many limitations. Sternberg (1990, p.13) observed that Piaget's theory "needs supplementation by other theories." In particular Piaget's stage theory of intellectual development failed to address some issues. According to Feuerstein (1990), Piaget in his S-O-R (stimulus-organism-response) theory gave little consideration to the great differences among individuals in the development of those cognitive processes that were considered to be universal outcomes of the maturation-environment interaction. Feuerstein's argument was: How many of those who attained the age of formal operations also attained the operations themselves? Feuerstein (1990) argued that he "confronted Piaget with the data that proved that groups of north African children and young adults functioned on the level of five- to six-year olds in Geneva in operational areas" (p. 77). Feuerstein's argument was that the differential development has to be explained by another modality of human-environment interaction, hence the S-H-O-H-R model to account for Piaget's missing link where "H" represents the human mediation.'

Contributions of Vygotsky

Vygotsky (1978), in contrast to Piaget, believed that intelligence began in the social environment and directed itself inwards. According to Vygotsky, all psychological

processes are in genesis essentially social processes, initially shared between people, particularly between children and adults.

Vygotsky (1978, 1986) posited that higher mental processes are functions of mediated activity. Kozulin (1990) noted that Vygotsky suggested three major classes of mediators, namely, material tools, "psychological tools" and other human beings. Material tools have only an indirect influence on psychological processes as they are directed at processes in nature. Psychological tools mediate the human's own psychological processes. Kozulin (1998) explained that psychological tools are those symbolic artifacts (e.g. signs, symbols, formulae and graphic-symbolic devices) that help individuals master their own "natural" psychological functions such as perception, memory and attention.

According to Kozulin (1998), psychological tools "serve as a bridge between individual acts of cognition and the symbolic sociocultural prerequisites of these acts" (p.1). Kozulin and Lurie (1994) observed that previous research pointed to the fact that psychological tools such as written language and numerical systems in the context of formal schooling have decisive influence on the type of reasoning used by the individual.

With regards to human mediation, Kozulin (1998) noted that French psychologist Pierre Janet's statement that "a psychological function appears twice in the life of the individual: first as an interpersonal function and then as an intrapersonal function" (p.12), has often been cited by Vygotsky.

Vygotsky (1978) wrote:

Every function in the child's cultural development environment appears twice: first, on the social level, and later on the individual level, first between people (interpsychological), and then inside the child (intrapsychological) (p. 57).

Vygotsky contributed significantly to the understanding of intelligence in the theory of internalization, the theory of the convergence of speech and practical activity, and the zone of proximal development (Vygotsky, 1978). In the case of a classroom example, an expert teacher may model many approaches of a problem solving process for the students. The students will need to internalize these processes as their own problem-solving activities if they are to develop effective self-regulation and metacognitive abilities. Within the context of the gradual internalization of cognitive activities through interaction, Vygotsky (1978) defined the zone of proximal development as "the distance between the actual developmental level as determined by individual problem solving and the level of potential development as determined through problem solving under an adult guidance or in collaboration with more capable peers" (p. 86). In Vygotsky's view, logical memory, voluntary attention, categorical perception and self-regulation of behaviour represent the highest forms of psychological functioning.

Referring to the Vygotskian theory, Feuerstein (1990) observed that whilst Vygotsky conceived "the impact of social mediation as facilitating the passage from the current

level of functioning to a level included in the 'zone of proximal development' (Vygotsky, 1962), the facilitation in Vygotsky's theory related to a latent type of functioning that may eventually be reached without the intervention" (p. 80).

Kozulin (1994) observed that:

For Piaget, learning occurs in an unassisted interaction between the child's mental schemas and the objects of the external world. As a result, the child is having "wonderful ideas" of his or her own. The only requirement for the learning milieu is to be sufficiently rich so that the child has enough objects and processes with which to practice his or her schemas. Alternatively, from Vygotsky's point of view, learning occurs in the collaboration between the child and adults who introduce symbolic tools – mediators to the child and who teach him or her how to organize and control his or her natural psychological functions through these cultural tools. In the process, the natural psychological functions of the child change their nature becoming culturally and socially informed and organized. (p. 273)

Kozulin (1994) further noted: "Still, the role of the human mediator is not fully elaborated within this theoretical framework. This theoretical gap can be filled with the help of Feuerstein's (1990) theory of mediated learning, which assigns the major role to a human mediator" (p. 284).

Mediated Learning Experience

Mediated learning experience (MLE) as a determinant of cognitive development thus represents an advancement of cognitive theories (Kozulin, 1994; Kozulin 1998). More importantly, MLE provides the theoretical basis for the reversibility of deficient cognitive processes under specified conditions of intervention. According to the theory of MLE (Feuerstein et al., 1987; Feuerstein, 1990; Feuerstein, et al. 1991), the formation and development of modifiability is a corollary of the quality of mediated learning experience. In other words, an effective intervention would depend not only on the design of the instrument or lessons but more importantly characteristics of the mediation process. Feuerstein described these characteristics as parameters of MLE. According to Feuerstein, three indispensable parameters are: the mediation of intentionality and reciprocity, the mediation of transcendence and the mediation of meaning.

It has been argued that from the philosophical perspective these are universally pervasive and omnipresent qualities in human mediated interactions and this is true for all cultures irrespective of technological development and modality of communication.

MLE Parameters

Feuerstein and Feuerstein (1991) identified a list of 12 parameters of which the first three constitute a necessary and sufficient condition for a mediated interaction. The 12 parameters are: (i) Intentionality and reciprocity, (ii) Mediation of meaning, (iii) Transcendence, (iv) Mediation of feeling of competence, (v) Mediation of regulation and control of behaviour, (vi) Mediation of sharing behaviour, (vii) Mediation of individuation and psychological differentiation, (viii) Mediation of goal seeking, goal

setting, and goal achieving behaviour, (ix) Mediation of challenge: the search for novelty and complexity, (x) Mediation of an awareness of the human being as a changing entity, (xi) Mediation of the search for an optimistic alternative, and (xii) Mediation of the feeling of belonging.

Tzuriel and Haywood (1992) observed that some authors consider only the first five or six parameters as important (e.g. Haywood, 1987; Tzuriel & Ernest, 1990). In this paper the parameters have been reframed, with the descriptions summarized in Table 1. The descriptions are based on Feuerstein and Feuerstein's (1991) explanations. This paper examines a number of these parameters in terms of their relevance in the context of mediation for students in today's education.

Table 1
MLE Parameters

Parameter	Description
Intentionality and reciprocity (IR)	IR creates like-minded attitude expressed by the mediated towards the ongoing interaction, its nature, its goals, and its content.
Mediation of meaning (ME)	The awareness of meaning constitutes a major component of the motivation system. The mediator makes known to the mediatee "the meaning of the interaction, its significance, its "why" and its "what for".
Transcendence (T)	This involves moving beyond the "here and now". This is particularly important when we are addressing the individual's capacity to adapt and cope with change and new environments.
Mediation of feeling of competence (FC)	Competence does not necessarily imply a feeling of competence. FC involves the mediator turning the mediatee's experience into an awareness, feeling and consciousness of competence. FC involves removal of the unwarranted fear of failure. FC addresses the fear of making mistakes that may result in the lack of investment of time and effort to try again.
Mediation of reflective practice (RP)	RP is about regulation of behaviour, self-evaluation, reflective thinking and metacognition. Such mediation creates the propensity for a reasoned way of behaving adaptively.
Mediation of the search for an optimistic alternative (OA)	The mediation of an optimistic alternative impacts on the cognitive structure and the affective motivational components. The search for an optimistic alternative represents a style of life which affects one's readiness to attack those environmental factors which threaten the physical, mental, and emotional equilibrium of the individual.
Mediation of change awareness	CA mediates the awareness of the human being as a changing entity. This can help the mediatee gain

(CA)	accessibility to extreme and radical changes in all possible directions and contents: competence, skills, moral judgements, emotions, and affect.
Mediation of challenge: the search for novelty and complexity (NC)	This involves preparing the individual for adaptation to the novelty and complexity of the world. The propensity to confront a challenging novelty and complexity rather than giving up is vital for successful adaptation.
Mediation of goal seeking, goal setting, and goal achieving behaviour (GO)	The lack of GO results in a living that often manifests itself in the urge for immediate gratification and the incapacity to delay impulsive behaviour in favour of a more remote goal which should have a higher priority. CA is about "having the end in mind", setting goals and aspirations.
Mediation of individual uniqueness and esteem (IU)	The mediation of individuation relates to recognizing the uniqueness and esteem of the individual. It is related to the development of a sense of independence and self-confidence. IU also relates to recognizing individual differences in terms of personalities and cognitive styles.
Mediation of interdependency and sharing (IS)	This relates to the mediation of the feeling of belonging and sharing behaviour. IS also relates to the importance of teamwork, interdependence and knowledge sharing.

Discussion and Conclusion

Intentionality and Reciprocity

In the MLE interactionist model, the mediator not only has a clear intention to mediate the stimuli (namely, the environment) but also demonstrates and shares his/her intentions to the mediatee. Rand (1991) described reciprocity as "the likeminded attitude expressed by the mediated towards the ongoing interaction, its nature, its goals, and its content" (p. 72). Reciprocity calls for the mediatee's response to turn an implicit intention into an explicit and purposeful outcome. The "IR" parameter helps to highlight the fact that the quality of interaction is not accidental or coincidental in nature. Furthermore, it is the "IR" parameter and not just the specific content to be taught that is going to determine the effectiveness of a teaching-learning situation. In the case of a polytechnic classroom, this implies that a good teacher must have clear intentions and clear aims of what he seeks to intervene or train. He/she needs to communicate these to the students and ensure that the students are indeed responding to the intervention. This calls for highly interactive sessions and the teacher playing an effective coaching role. These appear to be commonsensical yet in many classrooms didactic teaching often goes on which reflects poor intentionality and an absence of reciprocity. How can students develop higher order thinking skills if for most of the time what is happening is a transfer of notes from the teacher's notepad to that of the students'?

It can also be argued that given the rapid proliferation of information technology, the impact of innovations, information accessibility and globalization, there are two

corollaries that call for the emphasis on the IR parameter. Firstly, content knowledge and technical knowledge easily become obsolete and irrelevant especially in the context of tertiary education. For example, the various versions of software and technical systems would have changed drastically by the time the students graduate from their courses. Hence the teacher who sees his primary role as content teaching and knowledge dissemination would be failing to meet the future needs of the students. There is a need to teach process and learning skills through a more interactive approach and this calls for teachers to pay much more attention to the IR parameter. Secondly, information accessibility brought about by the advent of the Internet implies that the teacher is no longer the primary source nor the authority in a field of expertise. Rather than defining the scope of knowledge or acting as a source of knowledge, the teacher's role becomes that of a coach to facilitate the students' search and access to knowledge and learning. The IR parameter calls for staff development in effective interactive learning as well as lesson design highlighting key elements of aims, clarity of communication, active learning, questioning and so on.

Mediation of Meaning

The next major characteristic of MLE is the mediation of a continuous and intensive search for meaning. In MLE the awareness of meaning constitutes a major component of the motivation system. Meaning relates to the individual's cultural background, value system, aspirations and needs. According to Feuerstein and Feuerstein (1991), the mediator makes known to the mediatee "the meaning of the interaction, its significance, its "why" and its "what for" (p. 24).

It has been mentioned earlier that given today's world where information is easily accessible, the role of a polytechnic teacher is not merely that of content dissemination. The teacher needs to act as a coach in providing meaningfulness and purpose to motivate the search for information. Thus addressing the "whys" is probably more important than just the "hows". Otherwise, if interaction has "limited efficiency", then human interface in teaching could well be replaced by online learning and technology. Dansereau (1985, p. 213) noted, for example, that in a learning situation intrinsic motivation appears to be maximized when learners realize "a need to improve their skills" and when "substantial rationale for the strategies" is provided. This has to be done through a mediator.

It should also be noted that beyond the acquisition of academic and vocational knowledge, teenagers like polytechnic students are seeking for meaning from their involvement in various activities and pursuits, and are constantly in search of the meaning of life. The mediation of meaning calls for teachers to play a role in helping students develop positive career goals and healthy life aspirations.

Transcendence

According to Rand (1991), transcendence is about leading the mediatee away from the "here and now" of the learning situation. In transcendence, the mediator goes beyond the immediate primary and elementary goal of the interaction, changing them and widening them by including other more remote and important ones. This is particularly important when we are addressing the individual's capacity to adapt and cope with change and new environments. For instance, polytechnic students are not

only acquiring specific theoretical or technical knowledge but more importantly developing heuristics for solving a wide range of problems and applications as well as confronting problems in real-world industry and business situations. The intervention they receive impacts on developing capacities for learning how to learn and developing life skills. Hence the intention to make a student feel competent transcends the immediate goal of acquiring competence. According to Feuerstein and Feuerstein (1991), transcendence "creates in the mediatee a propensity to enlarge his cognitive and affective repertoire of functioning" (p. 21). It results in the mediatee constantly engaging in the ever growing areas of cognition and increasing positive emotions in the face of novel situations. The mediation of transcendence is thus about facilitating the application of learning across situations and contexts as well as developing a mental paradigm that would be future-oriented and far-sighted.

Other MLE Parameters

A number of the other parameters described in Table 1 are relevant to polytechnic education. Some of these will be described here. The parameter on mediation of feeling of competence (FC) relates to the need to provide "successful experiences" in the tasks given to students and to remove the unwarranted fear of failure. FC is also important as the fear of making mistakes often results in the student's lack of investment in time and effort to try again.

The mediation of reflective practice (RP) which relates to self-regulatory and metacognitive behaviours is important for classroom learning situations (Brown, Campione & Day, 1981; Baker & Brown, 1984; Brown, Armbruster & Baker, 1985; Bielaczvy, Pirolli & Brown, 1995). RP is also important for polytechnic students given the demands of college life and the challenges confronting their personal and social development.

The mediation of interdependence and sharing (IS) parameter incorporates the "sense of belonging" and "sharing behaviour" parameters of Feuerstein's original list. For a small nation like Singapore, the sense of belonging is an important notion especially in relation to national education and survival (Ministry of Education, 1998). Even at the polytechnic level, there is a need to create this by encouraging students to appreciate their being an integral part of the community and institution. Furthermore, teamwork, interdependence and knowledge sharing are attributes emphasized for polytechnic graduates, hence the relevance of the IS parameter. The recent educational emphasis on preparing students to be more creative and entrepreneurial (Ministry of Education, 1998) makes the "GO" and "NC" parameters increasingly important in the polytechnic curriculum.

Hence the cognitive revolution emphasizes not only the importance of understanding cognition but also the modifiability of cognition through contextualisation and mediation. In the knowledge-based era, the educator's role will shift towards that of being a facilitator, coach and designer of the learning environment and the need to apply such cognitive mediation principles and practices will be of increasing importance.

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