# DEALING WITH LEARNING IN PRACTICE: TOOLS FOR MANAGING THE COMPLEXITY OF TEACHING AND LEARNING

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*Drawing on the so-called CULTIS model of learning theories developed while working with students in the UK and Denmark and insights gained through the experiences of teachers' learning through Networks of Learning developed in Pakistan, we suggest that the complexity of learning can be tackled with the CULTIS model at the conceptual level and can be supplemented while taking insights from the experiences of working through the Networks of Learning. An example of the Network of Learning is the Mathematics Association of Pakistan (MAP). The paper also discusses the implications of how the juxtaposition of CULTIS and Networks for Learning can be used to develop mathematics teachers' understanding for various demands of learning mathematics in an informed manner.*

## INTRODUCTION

This paper brings in the experiences and ideas developed by each author. Sikunder Ali Baber (SAB) has worked on Networks of Learning and further theorized on this through the creation and continually running of various activities of Mathematics Association of Pakistan (MAP). SAB has chaired MAP the last four years. Bettina Dahl (BD) developed the CULTIS model of learning theories during her Ph.D. study. Below this model is explained. At the end of the paper, we discuss why we think it is necessary to combine both approaches to tackle the complexities of learning theories.

## NETWORKS OF TEACHER LEARNING

What are networks? It is difficult to find one suitable definition of a network given the range of purposes for which they are established. However, Clarke (1996) quotes a useful definition proposed by Alter and Hage (1993, p. 46): "Networks constitute the basic social form that permits inter-organizational interactions of exchange, concerted action, and joint production. Networks are unbounded or bounded clusters of organizations that, by definition, are non-hierarchical collectives of legally separate units. Networking is the art of creating and/or maintaining a cluster of organizations for the purpose of exchanging, acting, or producing among the member organizations" (Clarke, 1996, p. 142). Darling-Hammond and McLaughlin (1995) have stressed the importance of networks as a powerful tool in teacher learning for both pre-service and in-service teachers, as cited by the report named Networks@Work (Queensland Board of Teacher Registration, 2002). Networks provide the 'critical friends' or 'peers' that teachers need to be able to reflect on their own teaching experiences associated with developing new practices in their

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classrooms. Teacher networking often provides an opportunity for teachers to visit the various schools of participants and to gain 'practical pedagogical clues' (Moonen and Vooget, 1998, p. 102), from other teachers' classrooms. Also, "Professional relationships forged outside the immediate working environment enable teachers to gain valuable insights into new knowledge and practice beyond that gained from interactions with colleagues in their own schools" (Board of Teacher Registration, 1997, pp. 6-7). Lieberman (1999) says that "Networks are becoming popular, in part, because they encourage and seem to support many of the key ideas that reformers say are needed to produce change and improvement in schools, teaching, and learning".

Networks therefore seem to provide:

- Opportunities for teachers to both consume and generate knowledge;
- A variety of collaborative structures;
- Flexibility and informality;
- Discussion of problems that often have no agreed-upon solutions;
- Ideas that challenge teachers rather than merely prescribing generic solutions;
- An organizational structure that can be independent of, yet attached to, schools or
- universities;
- A chance to work across school and district lines;
- A vision of reform that excites and encourages risk taking in a supportive environment; and
- A community that respects teachers' knowledge as well as knowledge from research and reform (Lieberman and Grolnick, 1997).

Various writers (e.g., Darling Hammond and McLaughlin, 1995; Smith & Wohlstetter, 2001; Lieberman & Wood, 2003) have identified two distinctive features that teacher networks exhibit in their pursuit to better support teachers' learning on a regular basis:

**Personal and Social Relationships:** improved relationships, flexibility, risk-taking, commitment, openness in interacting with each other and clarifying values and expectations.

**Academic and Professional Aspects:** innovation, enriching practice, continual development of teachers focused on professional concerns such as student learning, sharing and getting relevant professional information (dissemination), developing healthy and shared norms, enriching curriculum and influencing policy makers.

Networks should also continually get engaged in the process of diversifying their activities and programs so that evolving and changing needs can be accommodated. This requires training of network leaders in managing the complex relationships and meeting the evolving needs in an effective manner. Also networks can get engaged with processes of follow-up of their professional development activities through engaging different individual and institutional members. These follow-up activities

can also help participants to develop insights into the issues that the professional networks are supposed to tackle. This continual sharing of professional practice of teachers within the networks can help all the participants to develop the culture of evidence essential to develop teaching practice along professional lines.

**Why are networks important in the context of Pakistan?**

Recently Aga Khan University Institute for Educational Development (AKU-IED) in Pakistan, a leading Institute mandated to uplift the quality of education through its innovative programs and research initiatives, has supported six professional associations; namely, Mathematics Association of Pakistan (MAP), School Head Teachers Association of Development of Education (SHADE), Science Association of Pakistan (SAP), Pakistan Association of Inclusive Education (PAIE), Association of Primary Teachers (APT) and Association of Social Studies Educators and Teachers (ASSET) to form a network called Professional Teachers Associations Network (PTAN). This network has some funding support from the Canadian International Development Agency (CIDA). The overarching aim of this Network is to promote an enabling environment for the professional growth and development of educators from diverse backgrounds, as a contribution to the improvement of education in Pakistan (PTAN Funding Proposal, unpublished). In the funding proposal of PTAN, an assessment is made about the status of teachers in Pakistan. It states: "Teaching in the context of Pakistan continues to remain as a neglected profession thus leading to poor status for the teachers within society. This status quo also remains prevalent due to the absence of networking amongst Pakistani teachers and an authentic platform to raise genuine issues to broader audiences as well as to support their own professional development. Pakistani teachers today, find themselves as an ignored identity, in most educational reforms and quality improvement initiatives in the country. This despondency has further perpetuated nonchalance and lack of conviction within their profession leading to the educational system working in a dismal situation" (PTAN Proposal, unpublished p. 1.). PTAN, through its constituent members is helping teachers from different sectors (public, private not-for-profit and private for profit) to come together and discuss their professional matters in a more open manner and develop a collaborative strategy to approach their professional matters. For example, the composition of working committees of these professional associations is made up with fair representation of teachers from all the constituencies such as government and private and other non-governmental organizations that they are serving. This coming together of teachers from different sector schools helps members of these networks to understand their particular issues and develop a holistic approach towards creating greater cooperation to deal these issues on a more sustained and focused manner.

MAP was established as a professional association of mathematics teachers to upgrade the quality of mathematics education in Pakistan. Since its inception, July 4, 1997, it has been committed to providing a learning platform for all those related to the field of mathematics education whether directly or indirectly. MAP has adopted a

three-pronged approach to address the matter of the continuing development of mathematics teachers. Firstly, it has created and structured focused programs for mathematics teachers both pre-service and in-service to provide opportunities for them to interact freely with each other on professional matters. For example, MAP organizes a regular workshop every month on various topics such as teaching fractions meaningfully or geometry - making connections etc.

Secondly, for children to develop positive attitude towards mathematics, MAP has been very active in organizing separate programs for them. In these programs, the children have opportunities to work in teams to experience mathematics as an interesting and challenging subject. MAP has also organized three Olympiads for children of different grade levels to work on interesting and challenging mathematics in a collaborative fashion.

Thirdly, in order to create a strong support mechanism for teaching and learning worthwhile mathematics, MAP has worked on various projects where important stakeholders are being encouraged to re-learn mathematics so that they can see the broader role of mathematics in daily life situations. In this regard, MAP has been actively engaged into the process of rewriting textbooks with the Provincial bodies such as Sindh Text Book Board, a policy level body to design and produce text books for the province of Sindh in Pakistan. In Pakistan not too distant the government regulates the guidelines of mathematics curriculum to be taught at secondary and high schools in Pakistan. Also the governmental agencies have been significantly involved in the production of the textbooks of mathematics.

MAP is also organizing workshops for parents so they can see what it means to learn mathematics and how they would be able to support children's mathematics understanding. This work with the wider society enables MAP to create greater synergy and networking amongst different stakeholders to achieve quality mathematics education within Pakistan and beyond. Within this scenario the learning of mathematics can be seen as an important subject for making informed decisions in today's fast changing world.

## CULTIS AND ITS SIGNIFICANCE FOR TEACHER LEARNING

Dahl (2003, 2004) developed a model combing a number of different widely recognized and classical learning theories. This was done as part of a study on high-achieving Danish and UK high school students' mathematics learning strategies. To have a range of possible analysis, mainly the following theorists were used: von Glasersfeld (1995), Hadamard (1945), Mason (1985), Piaget (1970), Polya (1971), Skemp (1993), and Vygotsky (1962, 1978). These theories express themselves in various categories: Consciousness-Unconsciousness; Language-Tacit; Individual-Social (CULTIS). The categories cut the theories into modules that to some extent interact and overlap but each category has nevertheless its own identity.

**Category 1: Consciousness**

Polya described four phases for working on a mathematics problem. First: understand the problem; second: device a plan; third: carry out the plan, and the fourth is to examine the solution. The student should also be motivated and "desire its solution" (Polya, 1971, p. 6). Since it is a practical skill to solve problems and since we require all practical skills by imitation and practice, this also applies for solving mathematical problems (Polya, 1971, p. 4-5). Mason writes that practice is important but without reflection it may leave no permanent mark. Time and a questioning, challenging, and reflective atmosphere is also needed (Mason, 1985, p. 153). This reflects many teachers' and students' experience that through practice and repetition, one gets a feeling for the mathematics but also that if one only learns a technique, an algorithm, then soon after, these are forgotten.

**Category 2: Unconsciousness**

Hadamard (1945, p. 56) states that there are four stages in learning: preparation, incubation, illumination, and verification. Conscious work (preparation) is therefore preparatory to the illuminations. Polya states that "only such problems come back improved whose solution we passionately desire ... conscious effort and tension seem to be necessary to set the subconscious work going" (Polya, 1971, p. 198). This is the experience that after one has worked on a problem, one leaves it, and then later one feels a sudden shed of lighting and everything is clear. The illumination is generally preceded by an incubation phase where the problem solving is completely interrupted (Hadamard, 1945, p. 16). Teachers can organize time for the incubation phase e.g. through repetition and after the illumination spend time on verification, as in Category 1, to reflect consciously on the unconscious inputs.

**Category 3: Language as thinking-tool and concept formation**

Vygotsky describes language as *the* logical and analytical thinking-tool and that thoughts are not just expressed in words but come into existence through the words (Vygotsky, 1962, p. viii & 125). Mathematics is also itself a language, wherefore the formations of concepts are an essential part of learning mathematics. A basic principle in concept formation is that all concepts, except the primary ones, are derived from other concepts and they take part in the formation of higher order concepts (Skemp, 1993, p. 35). It is therefore important to let new concepts build on old ones and that these old ones are firmly learnt. These concepts form a schema in the student's mind and if a concept is learnt and understood, the student does not need to remember it, he knows it. A change in a schema is always difficult since the existing schema needs to change (accommodate) when it is inadequate to assimilate new knowledge. Assimilation of new knowledge to an existing schema gives however a feeling of mastery (Skemp, 1993, pp. 29-42).

**Category 4: Tacit knowledge and obstruction by language**

Hadamard argued that thoughts die when they are embodied by word but that signs are nevertheless necessary support of thought (Hadamard, 1945, p. 75 & 96). Piaget (1970, p. 18-19) states that "the roots of logical thought are not to be found in

language alone, even though language coordination is important, but are to be found more generally in the coordination of actions, which are the basis of reflective abstraction". Individual actions are thus the root of mathematical thought. In relation to tacit knowledge, one can observe that a person has a certain kind of knowledge but when one asks the person he is not aware that he knows this (Polanyi, 1967, p. 8).

**Category 5: Individual**

Constructivist epistemology is that "knowledge … is in the heads of persons, and that the thinking subject has no alternative but to construct what he or she knows on the basis of his or her own experience (Glasersfeld, 1995, p. 1). Piaget argues that the basis of abstraction is the action, not the object (Piaget, 1970, p. 16-18). The individual is therefore active and learning comes as the individual manipulates with the objects and reflects on this. These reflective abstractions are based on coordinated actions, not individual actions. Examples of coordinated actions are actions that are joined together or who succeed each other (Piaget, 1970, p. 18). Furthermore: "To know is to assimilate reality into systems of transformations. … knowing an object does not mean copying it - it means acting upon it" (Piaget, 1970, p. 15). Students therefore need to manipulate e.g. with concretization materials, algebraic concepts, or geometrical figures. It is important to leave time for students to do this individually since learning happens as the individual interacts with the surrounding.

**Category 6: Social**

Social interaction plays a fundamental role in shaping students' internal cognitive structure. This is a gradual process that has two levels: "first between people … and then inside the child" (Vygotsky, 1978, p. 56-57). In the beginning a teacher controls and guides the student's activity but gradually the student takes the initiative and the teacher corrects and guides, and at last the student is in control and the teacher is mainly supportive. The potential for learning is limited to the "zone of proximal development (ZPD)" (Vygotsky, 1978, p. 86), which is the area between the tasks a student can do without assistance and those that require help. The teacher is essential since on his own, the student might not enter his ZPD. Verbal thinking is an example of a social activity since "audible speech brings ideas into consciousness more clearly and fully than does sub-vocal speech" (Skemp, 1993, p. 91-92). Vision is therefore individual and hearing is collective (Skemp, 1993, p. 104). The students should appropriate and internalize. Also discussions among classmates facilitate learning.

## CONCLUSIONS

A conclusion in Dahl (2004) is that if a teacher uses teaching methods that are too far away from teaching styles the students are used to, learning becomes difficult. However, the study also confirms that students learn in a variety of ways. Hence balance and eclectism is necessary. This does however not mean that anything is as good/bad as anything else but the teaching style must be targeted towards the specific students. Networks are good at helping teachers establishing new practices in their

classroom and CULTIS would be useful to gain input to ensure that the "area" of possible student learning processes is covered.

Networks also respect both teachers' knowledge and knowledge from research. CULTIS could therefore also be a tool from which to discuss the teachers' experience. The teachers might in some of the theories recognize elements of ideas that they have developed from their experience. Kilpatrick argues: "Why is it that so many intelligent, well-trained, well-intentioned teachers put such a premium on developing students' skill in the routines of arithmetic and algebra despite decades of advice to the contrary from so-called experts? What is it that teachers know that others do not?" (Kilpatrick, 1988). CULTIS is a holistic approach and we assume that since CULTIS shows a broad range of different theories, CULTIS might give teachers a language for theories that are not "in" for the moment and give them some arguments and reasons to hold on to their old stuff. We assume that any teacher in CULTIS can find something that "fits" the teacher's own ideas. At the same time CULTIS might give the teachers new insight. It might therefore be a "safe" arena for discussing professional matters in an open manner and hopefully also create some openness for other ideas. Diversity of ideas, trust, and teachers feeling that they are being valued are also essential elements in Networks of Learning.

Networks provide flexibility, informality, and a forum for discussing problems that often do not have an agreed-upon solution. This fits with CULTIS's "neutrality" since it exhibits a wide range of learning theories. These theories are different, opposing, but they have been widely accepted at some point in time. They are thoughts where one might foresee revised versions recurring in the future. This insight is based on Hansen (2004) who argues that there seems to be pendulum swings between child centered/understanding and content centered/skills in the mathematics curriculum reforms. The teachers can disagree with the theories in CULTIS, but they nevertheless need to know the existence of these theories partly since it can provide insight into how to tackle individual student's learning, and partly since it will give the teachers a tool to "recognize" the theoretical roots of future new theories and/or reforms.

In Pakistan the Networks of Learning have up to now not focused on learning theories, but the CULTIS model could be a useful tool for the continual development of teachers focused on professional concerns such as student learning. The implementation of CULTIS into Networks of Learning has not yet happened but based on the experience we anticipate that this will be a useful tool to tackle the complexity of learning.

## References

Board of Teacher Registration (April 1997). *Partnership in Teacher Education.* Australia, Queensland: Board of Teacher Registration, Toowong.

Clarke, David (1996). *Schools as Learning Communities.* London: Cassell.

Darling-Hammond, L., & Mc Laughlin, M. W. (1995). *Policies that support professional development in an era of refor*m. New York: National Center for Restructuring Education, Schools, and Teaching.

Dahl, B. (2003). What can we learn about cognitive learning processes by asking the pupils? In N. A. Pateman, B. J. Doherty, & J. Zilliox (Eds.), *Proc. 27th Conf. of the Int. Group for the Psychology of Mathematics Education* (Vol. 2, pp. 277-284). Honolulu, USA: PME.

Dahl, B. (2004). Analysing cognitive learning processes through group interviews of successful high school pupils: Development and use of a model. *Educational Studies in Mathematics, 56*, 129-155.

Hadamard, J. (1945). *An Essay on The Psychology of Invention in the Mathematical Field.* New York: Dover.

Hansen, H.C. (2004). Skolematematikkens formative årtier 1903-1937 [School mathematics 1903-1937]. In *Proc., 2nd Nordic Conference*, (pp. 69-80) NTNU, 17-18 November 2003. NTNU: Norwegian Centre for Mathematics Education.

Kilpatrick, J. (1988). Editorial. *Journal for Research in Mathematics Education, 19* (4).

Lieberman, A. (1999). Network*s*. *Journal of Staff Development, 20* (3).

Lieberman, A., & Grolnick, M. (1997). Networks, Reform and the Professional Development of Teachers. Chapter 10 in A. Hargreaves (Ed.)*, RethinkingEducational Change with Heart and Mind.* Alexandria VA: Association for Supervision and Curriculum Development, pp. 192-215.

Lieberman, A., & Wood, D. (2003). From Network Learning to Classroom Teaching. *The Journal of Teacher Education and Change*, 3, 3 and 4, pp. 315-337.

Mason, J., Burton, L., & Stacey, K. (1985). *Thinking Mathematically.* Amsterdam: Addison-Wesley.

Moonen, B., & Voogt, J. (1998). Using Networks to support the Professional Development of Teachers. *Journal of In-service Education, 24* (1), 99-110.

Piaget, J. (1970). *Genetic Epistemology.* New York: Columbia University Press.

Polya, G. (1971). *How To Solve It - A New Aspect of Mathematical Method.* Princeton: Princeton University Press.

Polanyi, M. (1967). *The Tacit Dimension.* London: Routledge.

Queensland Board of Teachers Registration (2002). *Networks@Work: A report of Queensland Consortium for Professional Development in Education*. Toowong, Brisbane, Australia: Queensland Board of Teachers Registration.

Skemp R. R. (1993). *The Psychology of Learning Mathematics.* London: Penguin.

Smith, A., & Wohlstetter, P. (2001). Reform Through School Network: A new Kind of Authority and Accountability. *Educational Policy, 15* (4), 499-519.

Von Glasersfeld, E. (1995). *Radical Constructivism: A Way of Knowing and Learning.* London: Falmer.

Vygotsky, L. S. (1962). *Thought and Language.* Cambridge, MA: M.I.T.

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes.* Cambridge, MA: Harvard University Press.