Schools Direct pre-course assignment (01)
Learning Theories in Practice

Dr Andrew French

August 13, 2013

1 Summary

The *Taxonomy of Educational Objectives* (Bloom, 1956) is summarised and compared to the theory of *Cognitive Development* (Piaget 1896-1980) and the *constructivist* theory of *Social Development* (Vygotsky, 1962). Personal educational experiences are then described within the structure of these models.

2 Introduction

2.1 The theories of Bloom, Piaget and Vygotsky in the context of other models of learning

There are four main learning paradigms, which are summarised below. Key contributors are in brackets.

- *Behaviourism* (Pavlov, Watson, Skinner, Thorndike, Bandura, Tolman). Stimulus, response. Praise and punishment. The interior workings of the learner are irrelevant. Only the inputs and outputs of the learning mechanism are relevant.
- *Cognitivism* (Merrill, Reigeluth, Gagne, Briggs, Wagner, Bruner, Schank, Chomsky, Piaget). A learner is an information processing machine. Focuses upon internal mental processes.
- *Humanism* (Maslow, Rogers). Focuses on the personal needs of learners and how to fulfil their potential. Places value upon concepts of dignity, freedom and happiness, i.e. not just the efficacy of knowledge exchange.
- *Constructivism* (Vygotsky, Dewey, Vico, Rorty, Bruner). See below.

The Social Development theory of Vygotsky is *constructivist*, the overall thesis being that learning is an "information construction" process by the learner. The role of a teacher, or as Vygotsky would describe as a "More Knowledgeable Other" (MKO), is that of a facilitator; providing resources, direction and context to a learning environment. As one of my colleagues often quips "a guide on the side, not a sage on the stage." (Possibly from King, 1993). In other words, the focus is on the inherently social context of asymmetric information exchange between teacher and student rather than the internal mental processes associated with an individual learner. The latter is the primary concern of *Cognitivism*.

Bloom's taxonomy is described as a "Descriptive or Meta theory" (Learning Theories, website). Rather than a learning paradigm, it describes echelons of development, i.e. akin to Maslow's (1943) hierachy of needs, the *four stages of enlightenment* in Buddhism [1], military ranks or indeed ability levels in *Dungeons & Dragons*.

[1] The four stages of enlightenment in Buddhism (Sotapanna, Sakadagami, Anagami and Arahat) are the four progressive stages culminating in full enlightenment as an *Arahat*. At this point the cycle of rebirth, and human suffering, is believed to cease. The *Noble Eightfold Path* is the recommended scheme of work for such an endeavour.

2.2 Bloom's Taxonomy of Educational Objectives

Bloom's taxonomy is a sequential model of development under *domains* (headings) that are most readily understood as Knowledge, Attitude and Skills. These are described below in figure 1. It is essentially a framework of educational goals, assembled following conferences held between 1949-1953 relating to the improvement of curricula and examinations in academic institutions. Dave (1970), Simpson (1972) and Harrow (1972) have published somewhat expanded versions of the Skills (or Psychomotor) domain, which are perhaps a more prescriptive framework and better tailored to the design of practical skills courses. (See also Business Balls, website).

Knowledge	Attitude	Skills
Cognitive	*Affective*	*Psychomotor*
1. Recall data	1. Receive (awareness of)	1. Imitation (copy)
2. Understand	2. Respond (react)	2. Manipulation (follow instructions)
3. Apply (use)	3. Value (understand and act)	3. Develop precision
4. Analyse	4. Organize personal value system	4. Articulation (combine related skills)
5. Synthesize, create	5. Internalize value system (adopt behaviour)	5. Naturalization (automate, become expert)
6. Evaluate (assess, judge in relational terms)		

Figure 1: Bloom's Taxonomy of Educational Objectives (Bloom, 1956).

Forehand (2012) uses the story of *Goldilocks and the Three Bears*[2] as a example for the Knowledge domain. Note the Evaluate and Create levels have been switched as per the revisions of Anderson *et al* (2001), Krathwohl *et al* (2002). Figure 2 quotes Forehand and then continues with the theme for the Attitude and Skills domains. Another contemporary example is presented by Evans (2013), who develops Bloom's taxonomy into a practical framework for the facilitation of class discussions.

Knowledge	Attitude	Skills
Cognitive	*Affective*	*Psychomotor*
1. Recall data Describe where Goldilocks lived.	**1. Receive (awareness of)** Listen to the story.	**1. Imitation (copy)** The little bear copies his parents when they re-make their porridge.
2. Understand Summarize what the Goldilocks story was about.	**2. Respond (react)** Be scared when Goldilocks is found in the little bear's bed. She's about to get punished!	**2. Manipulation (follow instructions)** The little bear follows the instructions on the back of the packet of *Bear's Best Oats* without assistance from his parents.
3. Apply (use) Construct a theory as to why Goldilocks went into the house.	**3. Value (understand and act)** Comprehend that breaking into someone's house and eating their food is wrong.	**3. Develop precision** The little bear consistently makes his porridge "just right".
4. Analyse Differentiate between how Goldilocks reacted and how you would react in each story event.	**4. Organize personal value system** Judge the level of wrong in the context of other misdemeanours. Would eating Goldilocks be an *appropriate* punishment?	**4. Articulation (combine related skills)** The little bear applies his new found culinary confidence to other dishes such as bacon & eggs.
5. Evaluate (assess, judge in relational terms) Assess whether or not you think this really happened to Goldilocks.	**5. Internalize value system (adopt behaviour)** *Not* breaking into someone's house and eating their food next time you are hungry on a walk is intrinsic to your moral fabric.	**5. Naturalization (automate, become expert)** The little bear opens a gourmet breakfast bar.
6. Synthesize, create Compose a song, skit, poem, or rap to convey the Goldilocks story in a new form.		

Figure 2: Forehand (2012) refers to the use of *Goldilocks and the Three Bears* as an example of the *Knowledge* domain of Bloom's taxonomy. I have continued with this theme for the *Attitude* and *Skills* domains.

[2] Southey, R., 1837. "The Story of the Three Bears". Collection of essays and miscellanea called *The Doctor*.

2.3 Piaget's four stages of cognitive development

The Swiss psychologist and philosopher Jean Piaget (1896-1980) postulated four stages of cognitive development, apparently based upon epistemological studies of his children (Learning Theories, website). My interpretations of these are listed in figure 3 below.

Cognitive stage	Age range /years	Abilities
Sensori-motor stage	0-2	Understands concept of self and can differentiate and classify physical objects. e.g. "mum", "bus", "biscuit". New objects (e.g. "tractor") will be added to the existing taxonomy (e.g. "things with wheels"). When a new object (e.g. aeroplane) is encountered the structure is automatically modified. (e.g. "big metal things with people in them that move").
Pre-operational stage	2-4	The child is not yet able to conceptualize abstractly and needs realistic physical situations. i.e. a brightly coloured picture book "Planes, trains & automobiles" will be better understood than a un-illustrated poem about a penny-farthing bicycle.
Concrete operations	7-11	Abstract thinking is now developed. A story about the number of teeth in an enormous crocodile should indeed bring to mind a toothy reptilian without the need of a pictorial prompt.
Formal operations	11-15 +	Cognition reaches its final form. The child's ability for abstract thinking is very similar to an adult. By this stage, physical objects are no longer needed to convey meaning. For example, numbers can be manipulated as algebraic quantities and emotional states can be inferred from literature. Hypothetical reasoning ("what if" chains of thought) is now possible prior to just doing (or indeed not doing) something.

Figure 3: Piaget's theory of Staged Cognitive Development, applied to the development of the intellect of children from birth to teens.

Although Piaget's work was aimed at intellectual growth from birth, the model could indeed be applicable to any new learning situation, regardless of age of the learner. The sequence illustrated in figure 4 below could describe the broad stages of development of an adult pianist.

Cognitive stage	Abilities
Sensori-motor stage	Correlates the names of keys to positions on the keyboard, and eventually the sound of notes.
Pre-operational stage	Can mechanically read musical notation and play the right sequence of keys as required.
Concrete operations	Knowledge of the underlying musical structure of a known style. Can discuss effects and techniques independently of a specific piece.
Formal operations	Being able to efficiently compose in a particular style (e.g. Debussy-esque) or synthesize musical phrases which convey a desired emotion.

Figure 4: Piaget's theory of cognitive development is possibly applicable to adult as well as child development.

2.4 Vygotsky's Social Development Theory

The pioneering Russian psychologist Lev Vygotsky (1896-1934) developed his theory of Social Development between 1925 and 1934. His ideas were published posthumously in the West in 1962. As described in section 2.1, this theory belongs to the Constructivist paradigm. In contrast to a potentially didactic transmission-based or instructivist model, the focus is on how the More Knowledge Other (MKO) can construct an environment which best facilitates learning in collaboration with the student. As represented in figure 5, learning occurs in the Zone of Proximal Development (ZPD), i.e. the gap between what the learner currently cannot do, and what they can achieve independently.

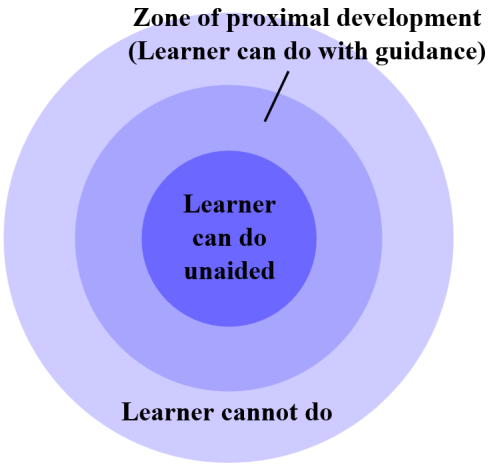

Figure 5: In the Social Development Theorey of Vygotsky (1962), active learning between student and More Knowledgeable Other (MKO) occurs in the Zone of Proximal Development (ZPD). Image source: Wikipedia (August 2013).

3 Theoretical analysis: Similarities, differences and gaps in the theories of Bloom, Piaget and Vygotsky

A comparison between the learning models of Bloom, Piaget and Vygotsky is presented in figure 6 below.

Theory	Paradigm	Thesis	What it ignores
Taxonomy of Educational Objectives (Bloom)	Descriptive of any learning process. Paradigm independent?	Learning in domains categorized as Knowledge, Attitude and Skills proceeds in stages from 'parrot fashion' recall (stage 1) to a creative synthesis, internalized moral values and automatic physical mastery.	• How these stages are attained. • Scope of mental or social process required to transcend levels in the hierarchy. • Individual human needs.
Cognitive Development (Piaget)	Cognitivism	Learner is an information processing machine. Focus is on models of mental processing germane to a given activity.	• Social , interpersonal effects • Individual human needs.
Social Development (Vygotsky)	Constructivism	Learner is an information constructor. Teachers (i.e. 'More Knowledgeable Others') are facilitators, collaborating with the student. Two-way information exchange rather than didactic broadcast from teacher. Focus is mostly on the learning environment external to the learner, rather than a theory of mind.	• Practical efficacy. Impacts of social learning. e.g. "groupthink", peer pressure, distraction, diffusion of attention. • How an individual processes and synthesizes information. • Individual human needs.

Figure 6: Comparison of the learning theories of Bloom, Piaget and Vygotsky.

All three theories neglect the human needs associated with the learning process. For example, what is the motivation behind the learning? What is the emotional impact of the experience? The *Humanism* paradigm of theories aims to address these factors.[3]. As one might conclude, the cognitive theory of Piaget neglects the impact of social learning whereas the constructivist theory of Vygotsky ignores the differing strengths and weaknesses associated with the internal mental processing of each learner. Unlike the others, Bloom's taxonomy does not really belong to a paradigm of learning theory, as it is essentially only a set of labels of various stages of aptitude. How one could most efficiently progress through the hierachy requires an additional model.

[3]Millward (2013) has constructed a network of the classical works, visualizing the connectivity between the ideas in each thesis. A copy is provided in Appendix 1.

4 Personal educational experience

My personal educational experience spans a relatively conventional British state school experience until eighteen, four undergraduate years at Cambridge University studying Natural Sciences, one year postgraduate research in fluid dynamics at Cambridge University, eight years of professional experience of radar and meteorological systems engineering at BAE Systems, a PhD in radar engineering, a certificate in management at Lancaster University and, most recently, two years of full-time mathematics teaching at Winchester College.[4] So far I have never experienced explicit reference to a particular academic theory in discussions of learning methodology, although their presence might well be implied as a result of teacher training. Professional conversations are typically on more practical lines such as "what introductory problems should I present when teaching differential calculus for the first time?" (i.e. subject pedagogy) or "how do I persuade student X to cease his constant interruption?" (i.e. behaviour management). However, I think it would be instructive to retro-fit a past teaching experience into each of the three frameworks discussed in this essay. It could serve as a form of gap analysis and hopefully inform my future teaching strategies. For fairness and brevity I shall choose the same topic example, the teaching of quadratic equations to 13-14 year olds. (Year 9, or *Junior Part* in Wykhamical notion).

4.1 Bloom's taxonomy

Quadratic equations are a suite of algebraic forms[5] with associated *properties* and *methods*.

Level 1. (Recall, Receive, Imitate). Students watch and listen as these forms are presented by the teacher both as algebra and as graphs. Small signed integers are typically used to reduce the complexity of the problem and keep focus on the mathematical properties of the quadratic equation rather than associated arithmetic. Students will begin their study by imitating the teacher, in the first instance copying a solved problem off the board.

Level 2. (Understand, Respond, Manipulation). Students tackle problems on their own. They respond to a written problem and manipulate the algebra, following one of a fairly standard collection of methods. e.g. factorization, completing the square, use of the quadratic formula, use of symmetry to work out the stationary points from roots etc.

Level 3. (Apply, Value, Develop precision). GCSE examination-style questions are typically of an applied variety. The quadratic equation is a model of a practical situation (e.g. the area of a shape in terms of one unknown quantity) and the students are led through this modelling process. Precision is acquired by repetition of a cycle of {attempt question, review model solution, revise theory}.

Level 4 and beyond. Bright GCSE and Advanced Level students will encounter topics in physics, chemistry, and economics (as well as mathematics) whereupon a student will need to solve a problem using their quadratic equation toolbox of methods, although this course of action may not be clear from the outset. Mastery of the algebraic techniques mean that a student will at least be able to proceed through this phase with confidence, even if may not yield the final answer!

4.2 Piaget's cognitive development theory

Level 1. (Sensorimotor). Students will learn to recognize the three algebraic forms of a quadratic equation. They will start with simple special cases and then begin to generalize. For example problems involving the factorized form $y = (x-1)(x+3)$ might be extended to $y = (2x-1)(x+3)$ and then to $y = (2x-1)(4x+3)$.

Level 2. (Preoperational). Problems involving quadratic equations can now be applied, i.e. involving money, areas etc. However, context is specific and numbers are fixed apart from one variable x (which is quadratically related to some desired output y).

Level 3. (Concrete operations). Fully algebraic manipulations are now possible. Formulae which relate the constants in each of the forms can be derived using pure algebra.

[4] I also engaged in a teaching investigation period, which involved visits to many schools in the Dorset region, in particular Thomas Hardye and Sherborne. I taught physics at the latter for one term in the summer of 2011.

[5] Expanded $y = ax^2 + bx + c$
Completed square $y = a\left(x - \beta\right)^2 + \gamma$
Factorized $y = (Ax + B)(Cx + D)$

Level 4. (Formal operations). The quadratic form, and the opportunity for subsequent algebraic manipulation, is recognised in a range of other problems. The quadratic may be disguised: the student will need to recognize its mathematical signature in order to proceed.[6]

4.3 Vygotsky's Social Development Theory

At Winchester College we have a programme of acceleration which aspires to stretch young mathematicians. I would strongly suggest most students will find themselves deep within the Zone of Proximal Development for the majority of their education! The role of a teacher as a transmitter of knowledge is probably more typical at Winchester than a Vygotskian learning facilitator, although I have observed extremes of both from experienced, and successful, colleagues. However, a culture of two-way questioning during a new-knowledge exposition phase of a lesson is very much the norm. Boys are not expected to be passive learners during classes, and teachers are expected to adapt their presentation in response to appropriate questioning. This does make life somewhat exciting.

5 Conclusion

The theoretical frameworks of Piaget, Vygotsky and Bloom have been presented in the context of a wider canon of learning theory, and also exemplified via the teaching of quadratic equations, the story of *Goldilocks and the Three Bears* and the development of a pianist with compositional aspirations. Piaget's theory focuses on the internal cognition of the individual whereas Vygotsky's constructivist approach relates to interpersonal effects. Both theories neglect wider needs and motivations, which are the principal concern of the Humanism paradigm of learning theory.

One of my personal objectives for the Schools Direct course is to develop a theoretical underpinning of the learning models I use to plan my mathematics lessons. Although common sense predicts a hybrid of paradigms is likely to be the most effective, I would be very keen to analyse the spectrum between traditional didactic pedagogies and extremes of "guide on the side" Constructivist, facilitatory learning. Are there theories which predict where the optimum lies in a given learning context?

[6] For example the equation $x^4 - 6x^2 + 8 = 0$ can be written as $\left(x^2\right)^2 - 6\left(x^2\right) + 8 = 0$, thus revealing its quadratic nature. Applying the method of factorization we can write $\left(x^2 - 2\right)\left(x^2 - 4\right) = 0$ and therefore solutions are $x^2 = 2, 4$ which means $x = \pm\sqrt{2}, \pm 2$.

6 References

1. Bloom, B. S. & Krathwohl, D.R., 1956. *Taxonomy of educational objectives: The classification of educational goals, by a committee of college and university examiners. Handbook 1: Cognitive domain.* New York, Longmans. (Current copyright: Allyn & Bacon, Boston USA).

2. Chapman, A., 'Business Balls' website. `http://www.businessballs.com.` Downloaded August 2013.

3. Dave, R.H., 1970. *Developing and writing educational objectives* (Psychomotor levels pp. 33-34).

4. Evans, S.Y., "The FACTS Reading & Discussion Guide." Clark Atlanta University.

   `www.ProfessorEvans.net.`Downloaded August 2013.

5. Forehand, M., 2012. Bloom's Taxonomy (from *Emerging Perspectives on Learning, Teaching and Technology*). The University of Georgia. `http://epltt.coe.uga.edu/index.php?title=Bloom%27s_Taxonomy.` Downloaded August 2013.

6. Harrow, A.J., 1972. *A taxonomy of the psychomotor domain: A guide for developing behavioral objectives.*

7. King, A., 1993. "From Sage on the Stage to Guide on the Side". *College Teaching.* **41**, Issue 1.

8. Krathwohl, D.R., Bloom, B.S., Masia, B.B., 1964. *Taxonomy of Educational Objectives. The Classification of Educational Goals, Handbook II: Affective Domain.* David McKay Company, Inc.

9. Anderson, L.W. (Ed.), Krathwohl, D.R. (Ed.), Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R.,Raths, J., & Wittrock, M.C., 2001. *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives* (Complete edition). New York: Longman.

10. Krathwohl, D.R., 2002. "A Revision of Bloom's Taxonomy: An Overview." Theory into practice. **41** (4). College of Education, The Ohio State University.

11. Learning theories. `http://www.learning-theories.com.` Downloaded August 2013.

12. Maslow, A.H, 1943. "A theory of human motivation." Psychological Review, **50** (4), pp370–96.

13. Millwood, R., 2013. "Report on good practice of innovation applications of learning theories in TEL". HoTEL project.

    `http://research.unir.net/proyectos/hotel/`

14. Simpson, E.J., 1972. *The classification of educational objectives in the Psychomotor domain.*

15. Vygotsky, L.S.,1978. *Mind and society: The development of higher mental processes.* Cambridge, MA: Harvard University Press.

7 Appendix 1: Learning theory paradigms

A network model (figure 7) by Millwood (2013) illustrates the interconnections between different learning theories. Greater sophistication in classification is used compared to the four paradigms of *Behaviourism, Cognitivism, Constructivism* and *Humanism* alluded to in this essay.

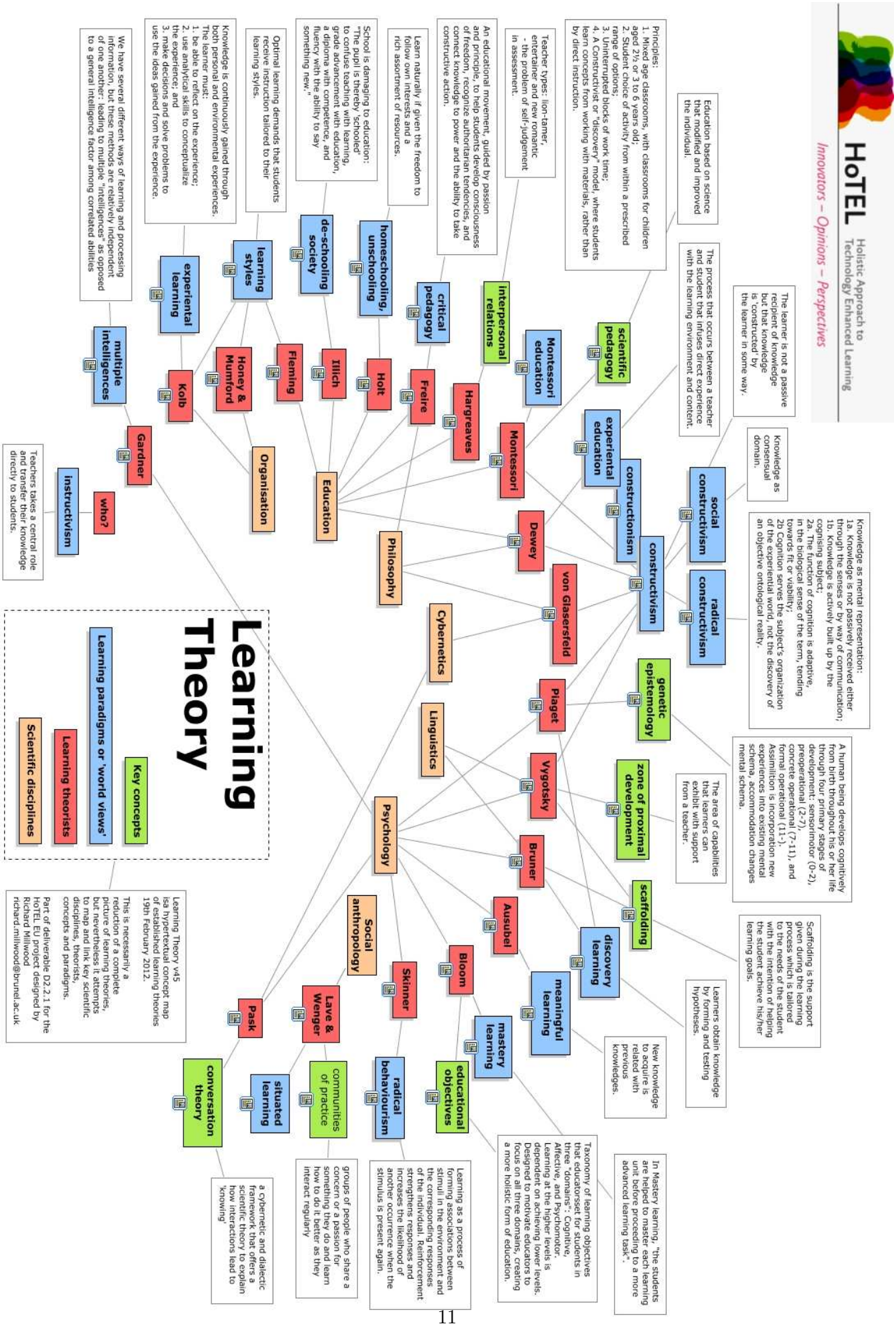
HoTEL
Holistic Approach to Technology Enhanced Learning
Innovators – Opinions – Perspectives
Learning Theory
Key concepts
Learning paradigms or 'world views'
Learning theorists
Scientific disciplines
Learning Theory v45 isa hypertextual concept map of established learning theories 19th February 2012.
This is necessarily a reduction of a complete picture of learning theories, but nevertheless it attempts to map and link key scientific disciplines, theorists, concepts and paradigms.
Part of deliverable D2.2.1 for the HoTEL EU project designed by Richard Millwood
richard.millwood@brunel.ac.uk
constructivism
social constructivism
radical constructivism
Knowledge as mental representation;
1a. Knowledge is not passively received either through the senses or by way of communication;
1b. Knowledge is actively built up by the cognising subject;
2a. The function of cognition is adaptive, in the biological sense of the term, tending towards fit or viability;
2b Cognition serves the subject's organization of the experiential world, not the discovery of an objective ontological reality.
Knowledge as consensual domain.
The learner is not a passive recipient of knowledge but that knowledge is "constructed" by the learner in some way.
A human being develops cognitively from birth throughout his or her life through four primary stages of development: sensorimotor (0-2), preoperational (2-7), concrete operational (7-11), and formal operational (11-).
Assimilation is incorporation new experiences into existing mental schema, accommodation changes mental schema.
Piaget
genetic epistemology
Vygotsky
zone of proximal development
The area of capabilities that learners can exhibit with support from a teacher.
Bruner
scaffolding
Scaffolding is the support given during the learning process which is tailored to the needs of the student with the intention of helping the student achieve his/her learning goals.
Ausubel
discovery learning
Learners obtain knowledge by forming and testing hypotheses.
meaningful learning
New knowledge to acquire is related with previous knowledges.
Bloom
mastery learning
In Mastery learning, "the students are helped to master each learning unit before proceeding to a more advanced learning task".
educational objectives
Taxonomy of learning objectives that educatorsset for students in three "domains": Cognitive, Affective, and Psychomotor. Learning at the higher levels is dependent on achieving lower levels. Designed to motivate educators to focus on all three domains, creating a more holistic form of education.
Skinner
radical behaviourism
Learning as a process of forming associations between stimuli in the environment and the corresponding responses of the individual. Reinforcement strengthens responses and increases the likelihood of another occurrence when the stimulus is present again.
Lave & Wenger
communities of practice
groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly
Pask
situated learning
conversation theory
a cybernetic and dialectic framework that offers a scientific theory to explain how interactions lead to 'knowing'
Social anthropology
Linguistics
Cybernetics
Psychology
Philosophy
Education
Dewey
von Glasersfeld
Montessori
Montessori education
Hargreaves
interpersonal relations
Freire
critical pedagogy
Holt
homeschooling, unschooling
Illich
de-schooling society
Flaming
learning styles
Honey & Mumford
Kolb
experiential learning
Gardner
multiple intelligences
who?
instructivism
Teachers takes a central role and transfer their knowledge directly to students.
Organisation
Optimal learning demands that students receive instruction tailored to their learning styles.
Knowledge is continuously gained through both personal and environmental experiences. The learner must:
1. be able to reflect on the experience;
2. use analytical skills to conceptualize the experience; and
3. make decisions and solve problems to use the ideas gained from the experience.
We have several different ways of learning and processing information, but these methods are relatively independent of one another: leading to multiple "intelligences" as opposed to a general intelligence factor among correlated abilities
School is damaging to education: "The pupil is thereby 'schooled' to confuse teaching with learning, grade advancement with education, a diploma with competence, and fluency with the ability to say something new."
Learn naturally if given the freedom to follow own interests and a rich assortment of resources.
An educational movement, guided by passion and principle, to help students develop consciousness of freedom, recognize authoritarian tendencies, and connect knowledge to power and the ability to take constructive action.
Teacher types: lion-tamer, entertainer and new romantic - the problem of self-judgement in assessment.
Principles:
1. Mixed age classrooms, with classrooms for children aged 2½ or 3 to 6 years old;
2. Student choice of activity from within a prescribed range of options;
3. Uninterrupted blocks of work time;
4. A Constructivist or "discovery" model, where students learn concepts from working with materials, rather than by direct instruction.
Education based on science that modified and improved the individual.
The process that occurs between a teacher and student that infuses direct experience with the learning environment and content.

Figure 7:

8 Appendix 2: Bloom's taxonomy of educational objectives

Various representations of the Knowledge domain of Bloom's taxonomy adopt a cyclic form. The Bloom Rose (figure 9) in particular alludes to a multi-cycle version of Bloom's hierarchy. To achieve true mastery of a subject, one must transcend through many macro-iterations of Knowledge, Attitude and Skills. This is certainly true of mathematics. One could master the subject at IGCSE, then begin at Pre-U (or equivalent) back at the recall, receive and imitation stage as new topics are encountered.

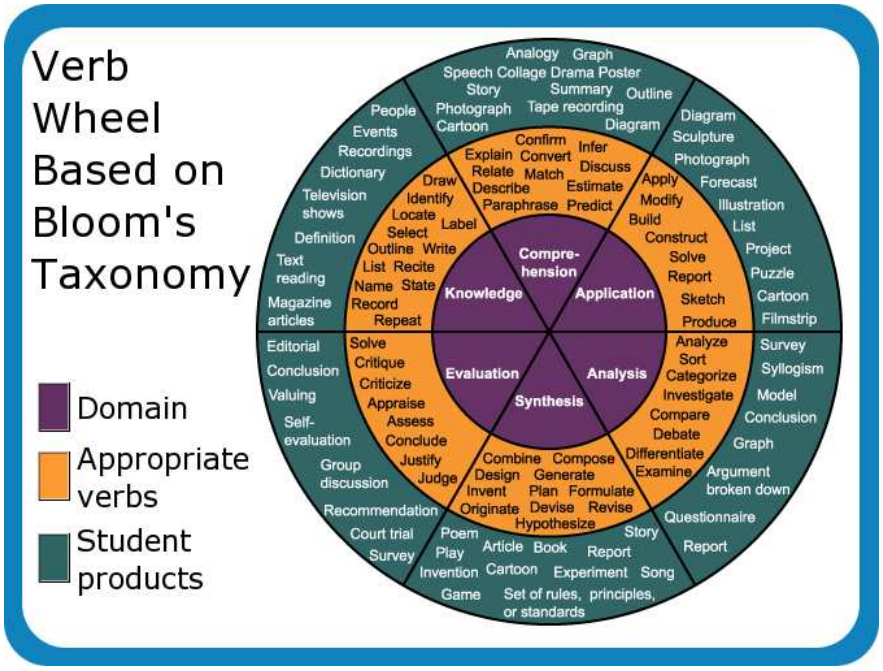

Figure 8: Verb Wheel based upon Bloom's Taxonomy. `http://www.alline.org/euro/images/bloomwheel.png`

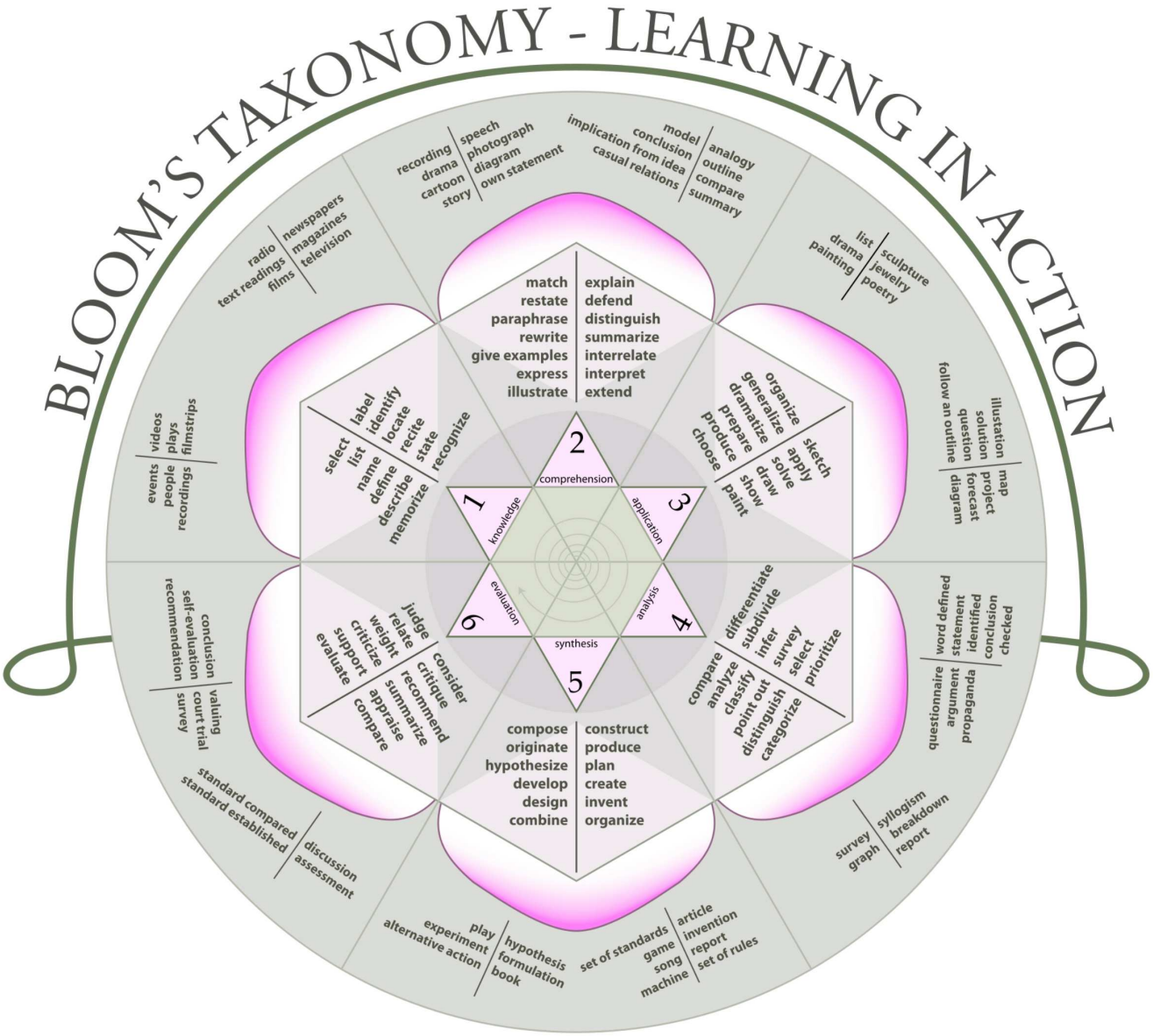

Figure 9: Aainsqatsi, K., 2008. Bloom's Rose.