Empirical Modelling and Learning

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What is Learning?

Basic idea

to gain knowledge, or a skill

We learn:

how to walk, speak, write, etc

facts about countries, planets, numbers, etc

Human Learning

Humans are good at learning, but there is no agreement (or theory) about how we learn.

(See Ch.3 of PhD thesis by Chris Roe.)

Two important processes are:

instruction ('transmission' theory)

construction ('discovery method')

Learning is not imitation but needs a *creation, or understanding* (constructed personally)

Programmed Learning

Computers can be programmed to behave *as if* they had learned something.

For example, they might get a friend's address (given their name), solve an equation, play chess, recognise a number-plate from a camera image. These involve storing records, pattern matching to apply rules, or something more advanced …

Machine Learning

This is a branch of artificial intelligence that typically works with very large data sets seeking ways of finding patterns and significance. It focuses on prediction, based on *known* properties. An allied field is Data Mining which focuses on the discovery of (previously) *unknown* properties of the data. Artificial neural networks are a major approach to machine learning. How is machine learning related to human learning? (I do not know.)

5

Instruction and Construction

Instruction can be given by a book, a person, a computer, the Web etc. It can be ignored by the learner, or attended to passively. (No learning)

Construction is needed *within the learner* to turn instruction received into personal knowledge.

Constructionism is the thesis that construction *inside the mind* (learning) is made easier by some construction *outside the mind* (artefact/construal).

6

Computing for Lifelong learning

Programmed learning, or e-learning, suits instruction and works best when there are prescribed learning paths.

Adapting to students with varied experience ('modelling the student') is very hard.

Lifelong learners need fewer constraints, and bring greater variety, than other learners. They especially need support from alternative approaches – including support for construction.

7

Construction through construal

A construal is something central to EM, it is an artefact (a thing *made*). As such it is well-suited to giving support to construction in learning.

The entire approach to computing in EM is better-matched to the needs of the learner for flexibility, opportunism, blending of models, and the continuous evolution of both context and knowledge.

The example of the clock construal.

8

New conception of computing technology

Conceptual framework for classical computing – that of achieving functional efficiency through abstraction and decomposition – is ill-suited to the needs of learning. Learning involves blending new experience, and concepts, into a unique personal body of experience. 'Making it your own', *understanding*, involves a kind of internal, personal, construction quite unlike anything mechanical, or given by rules.

9

Modelling with Dependency (1)

Dependency ensures meaning of model directly understood by human (cf spreadsheet)

Key idea of EM methodology: construction driven not simply by 'function' but by full domain understanding in terms of ODA

Not the same as just 'adding' dependency to programming. Soundness of the method rests on the claim that construals are a good way to express understanding of domain interaction.

10

Empirical Modelling as *Construction*
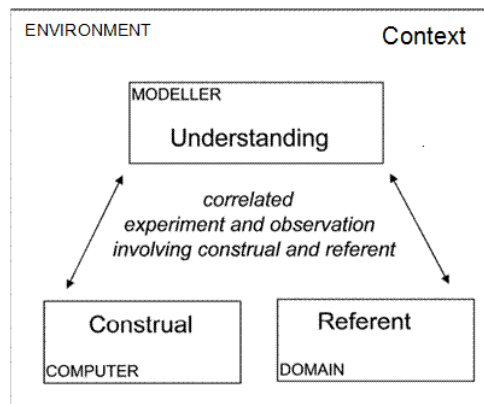
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Modelling with Dependency (2)

Emphasis is on the situation as experienced by the modeller – rather than a 'target' behaviour.

Semantics is rooted in direct correspondence of experiences. E.g. spreadsheet without any names/labels – could recover semantics by experiment to find the patterns of change. (Cf the scientist - who has no 'labels'!)

Supports subjective understanding and pre-articulate knowledge.

12

Important implication

Educational software is conceived by teacher, implemented by developer, used by learner – in quite different contexts. Such separation based on distinction of formal computing and informal activities to do with meaning. In EM, supporting a constructionist approach, each role is adopted in same environment and with same methods of ODA framework. The roles are blended, student can become teacher, both can be developers.
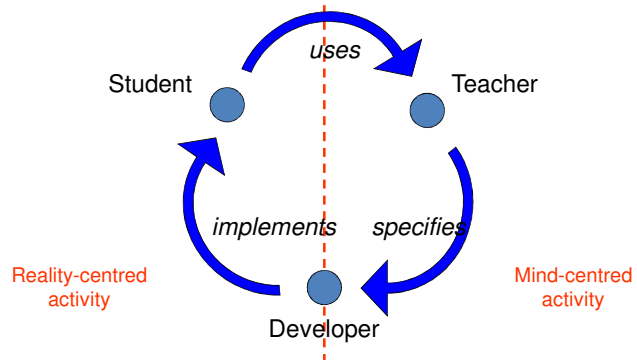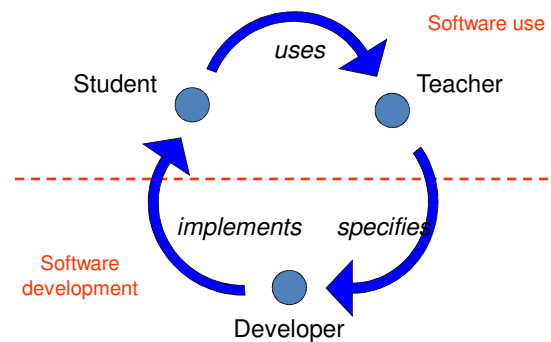
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Developing educational software
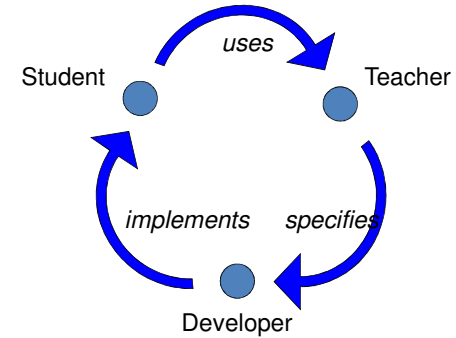
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Developing educational software

15

## Developing educational software

16

Perspectives of educational software

- Student vs teacher vs developer

- Mind-centred vs reality-centred

- Software development vs software use

➢ How can we bring together these different perspectives? Why?

Empirical Modelling (EM)

- Offers a set of principles for model building in any of the student, teacher and developer roles:

Student *interacts*   *interacts* Teacher

model

interacts

Developer
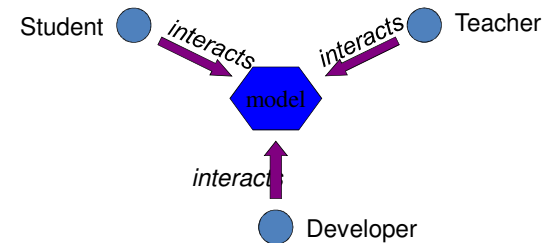
Support for Constructionism

'Active learning' is learning in a constructionist fashion - it involves the building of public artefacts. The mental processes during building are more important than any final product.

Seymour Papert pioneered constructionist learning with the LOGO programming environment.

But there is major difference between an artefact developed in active learning, and a computer program.

Artefacts for active learning

Artefact is a source of experience.

Learners' questions:

"What can I do with this now?"

"How can I interpret this particular interaction?"

Some interactions are familiar (artefact embodies knowledge), many remain unexplored (embodies ignorance).

Status of computer program

Understanding of a program is in terms of:

"This is what the program is intended for."

"These are the kinds of interaction you can have."

"These are the ways this interaction should be interpreted."

Inappropriate to regard a learning artefact as a *program*, instead we propose the notion of *construal* as developed in Empirical Modelling.

Construal in EM

Construal is something more primitive than program – possibilities for interaction and interpretation depend on the experiences offered and how they relate to a referent.

Developing a construal is 'voyage of discovery'.

Quite unlike a conventional program capturing intended behaviours. Beam detector example.

Significance of construal understood in relation to the Experiential Framework for Learning.

Experiential Framework for Learning

private experience / empirical / concrete

interaction with artefacts: identification of persistent features and contexts
practical knowledge: correlations between artefacts, acquisition of skills
identification of dependencies and postulation of independent agency
identification of generic patterns of interaction and stimulus-response mechanisms
non-verbal communication through interaction in a common environment
directly situated uses of language
identification of common experience and objective knowledge
symbolic representations and formal languages: public conventions for interpretation

public knowledge / theoretical / formal

Papers summarised in slides

Re-thinking Lifelong Learning: Slides 7 - 8
EM paper #089 (2006)

Computing technology for learning – in need of a radical new conception: Slides 9 - 18
EM paper #096 (2007)

Computer Support for Constructionism in Context: Slides 19 – 22
EM paper #080 (2004)