The six counties technology project: evaluative outcomes on management, teaching and learning

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The simulation of commercial design as an integrative strategy in National Curriculum Technology: Some observations from the literature and fieldwork.

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Abstract.
The nature of simulation is discussed. Simulation is then related to National Curriculum Technology and a potential role is established for the use of simulation techniques:

a. in the integration of the `subject` areas of Technology at appropriate times.
b. in the delivery of economic aspects of Technology.
c. in building moral, social and environmental awareness of technological impact.

This is followed by some observations from the literature and a current programme of fieldwork. These include the role of the teacher within simulations; the role of the learner within simulation; the question of competition and its effects on learning; and transfer limitations both into and from simulation.

What is simulation?

Rediffusion Simulation Ltd, in a report to the MSC (1986), stated that:

Simulation, as used in training, is a dynamic representation of a system, process or task.

The `representation` is effectively a model established by changing scale (physical and/or time), language of representation, and/or levels of complexity. Examples include a full scale mock up of an aircraft cockpit or a computer based model of the finances of a company. They both convey information more conveniently and cheaply than using the real thing. Mathematical models may represent the financial environment of a company or the behaviour of a bridge under load. Some models may also be based within computer software allowing the model to be sophisticated, and yet quickly manipulated.

Models need not be equipment based. An interview may be modelled in a classroom with no special equipment at all other than an outline of the intentions and structure.

The essential difference between a model and a simulation is that the simulation is dynamic and designed for learning. Participants interact as a part of the simulation and gain feedback on the effects of their interaction. A simulation is used iteratively, allowing experiential learning in appropriate stages. In a
simulation individuals act with autonomy. To `play roles` such as being `a hard manager`, is to remove autonomy (Jones 1989). This then becomes role play, a form of experiential learning with objectives which centre on empathy with a role rather than the broader learning objectives which may be set within a simulation.

Simulations are imitations of reality, with limits and limitations. They are used to focus on selected aspects for specific purposes. In this respect they can be used to simplify complex situations and so possibly improve learning. Complexity may be increased incrementally and focus changed and/or broadened in order to develop the learner. This echoes the learning cycle proposed by Kolbe (1984):

* concrete experience
* reflective observation
* abstract conceptuality
* active experimentation

As each cycle is completed the individual rises to a higher level and the cycle begins again. Iteration promotes learning in these cases as it assists the learner in recognising relevance (Perry and Euler 1988). Megarry (1976) observed that, it is only when the learner recognises the importance of the question that answers are remembered or understood.

Simulation may be realised through many techniques, but all involve the learner `doing`. Usually a short briefing at which the objectives and structure of the exercise are outlined is followed by immediate experience. Jones (1989) pointed out that simulations should be `non-taught`, that participants should be allowed to make their own mistakes. People do not, however, always learn immediately from their mistakes. The debriefing follows and is intended to pull together experience, to help individuals to stand back and reflect so that experience is transformed into learning (Pearson and Smith 1986). If the experience is complex or long it may be better to simplify it and use a series of iterative cycles rather than one.

**Why use simulation in education?**

Simulation may be used to integrate a range of subject expertise. It is possible to eliminate the subject boundaries found in the conventional school curriculum by simulating commercial activities which do not contain such boundaries. At the same time the simulation would assist in broadening perspectives and increasing the perceived relevance to children. Simulations enable participants to experience more learning events in a given time than would be the case in reality. At the same time simulation offers staff versatility. Commercially produced simulations may be easily modified to enable staff to swing the focus of objectives, and also manipulate time scales to suit their own situation.

There is evidence that simulations are not as effective as more conventional
teaching for mastering facts (Percival 1987, Jones 1990). Adams (1977) considered simulation techniques more effective for modifying attitudes and developing confidence. They may be used to provide experiences upon which to base discussion. This discussion may centre on a broad range of objectives specified by staff, for example the ethics of design and marketing or the physical and psychological effects of working to tight deadlines or on production lines. The immediate experiential base provides a sense of relevance which may not otherwise be easy for staff to generate.

There is evidence that simulation, when used effectively, can boost motivation and that this may be marginally more positive with ‘less able’ pupils (Percival 1978, Adams 1977). Simulation events tend to be enjoyable for participants (fieldwork) which may be one factor in boosting motivation. This may be due to novelty effects and so it is possible that frequent use of such techniques may cause a lessening of this extra motivation.

Staff may incorporate elements of competition to simulate commercial practice and to boost motivation. This must be handled sensitively as motivation may easily turn to anxiety.

**National Curriculum Technology**

*a. Integration of aspects of the subjects contributing to Technology*. There are several statements encouraging staff to interpret Technology in a wholistic way, both from the point of view of the AT’s and also the five constituent ‘subject areas’.

...the introduction of design & technology should be planned to avoid fragmentation into areas such as CDT, IT, home economics, business studies and art and design, ... Non-Statutory Guidance, B8 3.1

The simulation of commercial design would not be subject led. For example, one school simulated the development and marketing of muesli type snack bars by companies. The activity included work typically done in all of the above areas, and children could see the relevance of each part of the work to the success of the ‘company’ as a whole. In this case the simulation was run by a team of teachers with the equivalent of four classes, but even a single teacher can broaden a subject approach by adopting simulation techniques.

*b. Economic awareness*. Technology should develop awareness of the economic implications of their designs and how goods and services are bought and sold. (D&T working group final report, C11, 3.6).

Similarly business and industry must be used as a context for designing (A1, 2.2). In the past design work in schools has tended to be prototype orientated with few examples of relating work to commercial production and distribution. Simulation may offer a methodology which allows children to design and
make in a broader context including business and industry. School based simulations may be enhanced by working with local industries and bringing in company personnel to discuss aspects with staff and children. Software such as the Banking Information Service ‘Financial Planning and Management of Design and Technology Projects’ may be used to simulate financial aspects. The requirements for an ability to work to a deadline and keep to budget (A1, 1.3), may also be serviced by simulation.

c. Moral, social and environmental aspects. Children should:

Recognise that economic, moral, social and environmental factors can influence design and technological activities. (PoS KS3 p31).

As above, simulation can provide a focus for discussion on moral, social and environmental factors within a context of personal experience from the simulation.

Simulation, then, may be used as a teaching strategy to deliver several aspects of Technology. However, these techniques should be used in conjunction with other methodologies such as visits as repetition of a methodology may lead to a dilution of its effects.

Observations from the literature and fieldwork

The changing role of the teacher

Within a simulation the role of the teacher changes. Initially, in planning and briefings, the role is much as normal teaching. However during the working phase of a simulation and debriefing the role moves towards one described by Shirts (1976) as ‘facilitator’. The term has been used by others and so suffers from different interpretations, but Shirts used it in the sense of emphasising that the teacher promotes learning in others rather than adopting the role of ‘expert’. Facilitation is more demanding than may be evident. Fieldwork has shown that teacher found it very difficult to stand back and let children make mistakes as proposed by Jones (1989). It appears that many teachers are used to continual interaction with the class and close control of the activity of the classroom. Breaking that contact appears to raise anxiety and the teacher responds by becoming directly involved.

The teacher must be an observer. Standing back provides opportunity for observation and selective intervention. Roebuck (1978) used the term ‘adaptive interventionist’ to explain the teachers’ role adapting the intervention to match the learner and context, helping the participant draw meaning from the simulation rather than attempting to impose meaning. This intervention should, however, be minimal and only as necessary if children are not to lose autonomy.

At debrief the teacher should remain a facilitator, but act as a chair person
drawing out discussion from the group. There is a danger of reverting to an authority role at this point (Glandon 1978, Roebuck 1978), although the teacher can never abandon the authority of being the responsible adult amongst children.

The form of the debrief may vary but the objective is to help participants learn from their experience. This requires high levels of professional competence in areas which may not normally be a part of the teachers’ work. Acute observation is necessary during the running phase in order to have a comprehensive perspective on the performance of the simulation and the individuals within it. At debrief it is necessary to be flexible and be prepared to allow participants to move in a direction which may not be that seen by the teacher.

The changing role of the learner

The effects of competition

Evans and Sculli (1984), working on management simulation games, considered that competition does increase motivation and sustain effort. Evidence from fieldwork would appear to support this, but it is difficult to identify the specific causes of what was undoubtedly increased endeavour over conventional classroom work. Observation over a large number of simulation exercises, however, indicates that when staff have avoided competition endeavour appears to have dropped.

Competition may, if allowed to rise to high levels, detract from learning within a simulation (Evans and Sculli 1984). These authors used the words `value of learning` but did not explain what they saw as value. Competitive team work appears to assist motivation, but high levels detract by causing teams to adopt rigid structures with authoritarian leadership. Levels of discussion drop whilst teams become insular and mistrust of other teams builds.

Competition in real life commerce is inescapable. Questions must be asked as to the value of competition in an educational simulation at a school level. It is not clear at this point whether it is competition or the increased motivation it generates which becomes dysfunctional at higher levels. Research is necessary to question the origins; whether levels can be measured and controlled and what levels, in which conditions, provide optimum motivation with minimum dysfunction as a learning experience.

Transfer limits and limitations

Learning episodes rely on the transfer of existing knowledge into the new situation where it it used, in context to develop new understanding. This understanding is then subsequently transferred into other contexts. Such transfer is not automatic. Menis (1987) reported limited transfer of even simple mathematical ability into chemistry. Fieldwork has indicated limited
transfer of mathematical ability into simulations for financial or design purposes. This was evident not only with pupils but also teachers during INSET. The phenomenon was very apparent for mathematics but less so for other subject areas. This may have been due to the relatively finite results of mathematical endeavour in comparison with an aesthetic activity.

Much learning transfer theory is based on ‘common elements’. This considers that transfer is improved when there are elements common to the situations from and to which transfer is intended to occur. Pea (1987) developed common elements theory, and pointed out a cultural aspect to transfer. He stated that common elements are not necessarily in the nature of the concepts but may be culturally determined. This view has been reinforced by fieldwork which indicates that children see transfer in physical and personality contexts. One case study revealed a conscious negative attitude to mathematics within a simulation, because the activity was in an art room and some children regarded this as ‘doing maths in an art lesson’. There was also evidence of the effect when children worked with a teacher they saw as a specialist. Note how again the effect was only obvious with mathematics.

It is necessary to teach for transfer (Klauer 1989), that is to be explicit as to the concepts involved (also Sugden and Newall 1987). Klauer pointed out that repetition is a useful strategy in developing transfer in a given situation. Note the iterative nature of simulation, which may support transfer. Similarly Voss (1987) saw transfer as a problem solving process, as most simulation is. Transfer is active, requiring information to be interpreted, stored and subsequently utilized in other contexts. In this respect the organisation of the information is important and the simulation de-brief is an important opportunity for staff to help children organize information gained.

Conclusion

Technology is about action. Whilst simulation is not suitable for fact orientated learning. It has been shown to be a good vehicle for developing attitudes and providing opportunities for staff to draw out essential moral, social and environmental aspects of Technology. The experiential nature of simulation harmonises with the spirit of Technology.

The iterative nature of simulation has been shown to assist retention and transfer of concepts. Iterative cycles within a simulation should be short, enabling frequent thinking, feedback and experimentation. The de-brief should be given due weighting for its important role in gathering together learning and organising it for retention and transfer.

Simulation may also integrate the subject areas of Technology and others such as English, mathematics and sciences in a very natural manner. This has the advantage of putting learning in a ‘real world’ context answering Pea’s (1987) call for greater subject synergy and the application of knowledge in an integrated manner, matching and incorporating everyday life into learning.
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