

## **D - NEW TEACHING STRATEGIES AND LEARNING METHODS**

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### **Discussion Workshop D Report**

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During the previous Panel sessions for Theme D, a diverse range of topics were presented, but broadly, topics could be grouped under four main sub-themes:

- Virtual experiments, simulations
- Challenging pupils' misconceptions
- New approaches to 'informal' learning
- Evaluation studies of pupils' learning

The Discussion workshop was well attended (20 participants), but only five participants were presenters in the panel sessions, so, at an early stage in the discussion, it was decided not to constrain the discussion to the four sub-themes, but to focus generally on the principal seminar theme of how *informal learning* contributes to successful learning in physics.

The perception of some members that not all educators share a common interpretation of the term 'informal learning' was borne out when the group began to consider the distinction between informal and formal learning. For some, 'informal learning' occurs in settings outside the confines of lessons in school classrooms; for others, 'informal learning' described a general style of learning borne of teaching methods which emphasise pupil autonomy, especially in processes which demand individual thought such as problem solving. It was clear that we would not agree on a single definition of 'formal' and 'informal'; it appeared that our understanding of the terms was based on a variety of criteria borne of different experiences and educational traditions in different countries. Thus we agreed that this initial topic of discussion should be curtailed, but also recognised that we probably shared a common understanding of the continuum of teaching and learning styles embracing the range from informal to formal. It was suggested that, if this continuum stretches between the two extremes from 'formal' to 'not-formal', then 'informal' lies somewhere between these extremes, but our individual opinions about its precise position are likely to vary. In succeeding discussion, there emerged a consensus of the most prominent characteristics of informal learning as follows:

- Spectacle, drama and wonder are often present in science centre (SC) activities
- Pupils are given freedom to explore ideas
- Teachers/presenters are highly responsive to pupils reactions and readily allow interactions to influence the conduct of the activity.
- There is strong empathy between informal learning and the constructivist model of learning proposed by modern educational psychology. SC presenters appear to have embraced this model more widely than have teachers.

The goal of all types of physics teaching is to help pupils come to the view that physics is not a boring subject, and the main outcome of successful teaching is the self-motivation of pupils to learn more with reduced aid from the teacher. The discussion recognised that the essence of pupils' experience in a SC is to increase their motivation to become more interested in science; motivation was a key feature of pupils' response to activities in science centres (SCs), whereas, there was an implicit belief that motivation in the school context was much more variable. The links between SCs and schools became a dominant theme of discussion which sought to explore ways of developing mutual understanding between SC presenters and schoolteachers. It was considered helpful if teachers could acquire knowledge of the content and method of science centre presentations, so that they could better understand how they can enhance the regular work of the teacher in school.

Compared with teaching methods prevalent in many (but not all) schools, science centre (SC) methods offer new styles of learning experience which can be regarded as complementary to the teacher's method to give a generally broadened experience. The out-of-school context of the activity is itself a stimulus to a different, and hopefully positive, attitude towards learning. SC presenters hope that the emotional response of pupils (e.g. a sense of wonder) long outlives the actual visit. On a cautionary note, it was observed that although physics may be presented as 'fun', it is perhaps misleading to convey the subject as 'easy'; a better emphasis is that it is 'understandable' and the process of seeking understanding is itself exciting.

It was suggested that when children are encouraged to think about practical tasks in an active manner, they find the quest for understanding a stimulating experience. Good teaching can prepare pupils to engage successfully in this manner by equipping them with appropriate concepts and knowledge and by attempting to develop positive attitudes in pupils. Perhaps SCs need to advise teachers on this sort of preparation of pupils? Teacher interventions have to be managed in such a way that there is a good balance between instruction and exploration.

An interesting episode in the discussion considered the value of play as an activity which contributes to learning, especially in the early years of children's development. Neuropsychology research has shown that play invokes important neural activity in certain parts of the brain which have a crucial role in integrating sensory experiences needed for interpreting observations. Teachers should learn to consolidate this and help pupils become good interpreters and develop the skill of asking good questions. They could reinforce this by modelling such practice themselves in their teaching approach. The discussion returned to the theme of the teacher equipping pupils with a 'set of cognitive resources' and developing their 'reasoning skills' to support informal learning and secure its effectiveness. The teacher's beliefs and attitude towards the learning process are likely to be constraints or affordances in adopting these teaching approaches.

The discussion went on to consider why the stimulating characteristics of SC activities have not been widely adopted in school settings. One issue is the widespread belief of teachers' that didactic exposure is the most effective method of learning. For most teachers, the 'transmission' model of learning was implicit in their own education, which possibly makes it difficult for them to understand active methods of learning implied by the 'constructivist' model of learning. Ways have to be found of convincing teachers that learning is an active process. Teachers are too often not interested in exploratory experiments, whereas pupils can be highly motivated in exploration! Perhaps science centres can be agents for changing teachers' beliefs? The group heard about two examples in which a SC sought collaboration

with teachers in the preparation of informal activities, one in the development of new laboratory sessions and another on the preparation of exhibition materials.

A second issue is that in many countries there exist constraints such as government policies and lack of time for new developments which inhibit a teacher's ability to innovate. However, in countries such as Italy, where schools appear to enjoy a certain measure of autonomy, a more significant constraint has proved to be the teacher's lack of expertise in physics knowledge or lack of vision of new teaching methods and technology. In the Czech Republic, since government reforms in recent years, schools have been given the freedom to define their own curriculum, but in general teachers have been unprepared to cope with this and have had to call upon external support from universities to confront the task. The group heard of other examples of university-schools collaboration such as teachers calling upon university expertise to fulfil the need for specialist information for the completion of student projects or when new topics are introduced into the curriculum. Further, SCs are often able to provide experience of new topics and methods that are difficult for schools to cope with.

The group heard examples of successful collaborations between teachers and outside agencies which resulted in an interesting mix of informal and formal learning methods:

#### *1. International exchange activities*

A Slovenian school has organised a three day event offering practical physics projects to 30 pupils drawn from six different countries. Pupils work in pairs on experiments which feature the use of innovative technologies. The extra-curricular context, the international mix of participation and the innovative nature of the projects provided an interesting blend of informal and formal learning. The model of international exchanges is more common in modern languages and arts subjects, but this example demonstrated how the model can be applied to physics.

#### *2. Challenger Learning Centre*

This facility is based in the National Space Centre in Leicester, England. Parties of 30 pupils visit the centre for a half day and experience a simulation of a space mission in which pupils play the roles of space scientists and astronauts. Their tasks involve solving practical scientific problems and demand good communication and teamwork skills as well as science skills. A pre-requisite of the visit is for teachers to attend a familiarisation session in advance of the visit, so that pupils can be suitably prepared for the mission. Teachers also gain vision of follow-up ideas for use in school after the visit.

#### *3. Primary school / university links*

A project at the University of Udine, Italy has organised practical sessions for primary school pupils using novel physics experiments employing informal approaches. Teachers have been encouraged to repeat and develop some of the experiments into further activities in their own schools. The interaction between university staff and teachers has succeeded in helping teachers innovate in their schools.

It was suggested that the successful integration of school learning and the learning from visits requires careful planning on the part of the teacher. There appear to be two main aspects:

1. As a pre-requisite to a visit, pupils need certain specific knowledge and skills for engaging with a SC activity.

2. The SC activity needs to complement the syllabus and curriculum requirements in schools.

To address the first of these, teachers need to equip pupils with interpretative skills but also themselves learn how to intervene appropriately in activities in order to maximise the learning potential. The teacher's approach to interactions with pupils in practical activities seems to be a key factor in managing the co-existence of SC learning and school learning to make both more productive and to avoid the impression that 'formal is boring'. Although it is natural for teachers to devise structures for learning, they should take care not to intervene so invasively that an informal situation does not become converted into a formal experience! Excessive teacher control can kill pupil motivation.

In the school context, new technology can come to the aid of teachers and pupils in promoting and facilitating this genre of activity. ICT tools can be very useful for investigating ideas and engaging in 'mind play' activities. ICT can help overcome time constraints, extend the range of sensory measurement, can facilitate electronic learning environments to which the new generation of pupils is well adapted. Amongst the sciences, physics may be in a special position to benefit from new ICT resources; in particular, the need for quantitative understandings is well supported by new developments in modelling and simulation software.

### Some reflections

In focussing on the comparisons between the styles of learning in science centres and schools, the discussion uncovered parallels between learning, teaching and psychology: informal learning settings appear to be associated with 'active' participation, 'interpretive' teaching methods and a 'constructivist' model of learning; formal learning settings appear to be associated with 'passive' participation, 'didactic' teaching methods and a 'transmission' model of learning. The continuum represented in each aspect may be summarised by the diagram:

learning style	Informal <.....> Formal
pupil participation	Active <.....> Passive
teaching style	Interpretive <.....> Didactic
model of learning	Constructivist <.....> Transmission

Much of the discussion implied that science centre and school activities tend to be at opposite ends of each continuum. In summary, the challenge to schools is to broaden practice to embrace more of each continuum.

### Conclusions and Recommendations

- It is important to establish links between SCs and schools to cultivate teachers' understanding of the SC visit and the potential for its exploitation in the school context. The preparation of pupils for visits to SCs requires coordination with the school syllabus. SC links can contribute to the education of teachers about new approaches to their school work (In-service training).

- Informal learning experiences need an essential ‘minds-on’ component to be effective (questions, discussion, analysis) Acknowledge the role of emotion (sense of wonder; ‘hearts-on’) for sustaining motivation in the future. Move teachers’ beliefs about learning towards a constructivist model. SCs can infuse teachers beliefs.
- In the school context, ICT has a valuable role in supporting teachers to offer active learning experiences.
- Research is needed on the school-SC collaboration; GIREP members to collate publications of existing research and promote further researches.

### **Participants**

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