Learning in schools and learning in museums: which methods best promote active learning?

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Introduction

As part of the SMEC project activities, schools and museums worked together for the development of projects on science and technology. The projects were based on active learning encouraging engagement in the study of a specific topic and skill development. The chapter focuses on the learning methodology to be used in such work, and analyses the characteristics of the learning process, the methods and their effects and the role of the museum as learning resource and milieu.

Learning in the museum

In the last decades, both schools and museums found, and still find themselves, parts of an increasingly challenging debate regarding learning initiated by the change of paradigm in learning theory. The constructivist approach gained ground on the basis of the work of Piaget on cognitive development. Piaget, as early as 1920, pointed out that knowledge cannot be merely "transmitted" from the head of the educator into the head of a pupil; but, rather, that the child (and any learner, for that matter) treats information actively *constructing* personal structures of knowledge (Richter 1999). Dierking (1991, 5) identifies ten characteristics of learning:

1. Perception is central to learning process; individuals prefer different modes of perception like reading, hearing, touching.
2. Learning is an active process in which frameworks are constructed and organized. New information is linked to prior knowledge, while processes of retrieval and transfer of information also take place.
3. Learning is both a cognitive and a metacognitive[1] process.
4. People of the same age group can be of different developmental levels.
5. Learning is not always orderly or sequential.
6. Learning is strongly influenced by prior knowledge, beliefs and experiences; these factors often predict how much a person will learn.
7. Learning occurs within a physical and social context; also, appropriate contexts promote learning, that is, what you see should fit to what you hear or what you can read.
8. Motivation strongly influences learning, the learner's choices about what and how to learn, the persistence on a learning task or the continuation of motivation.
9. People learn in different ways. Learning depends on people's different perception or social interaction preferences, age etc., all of which form what is called 'individual learning style'.
10. Memory is central to the learning process: During information processing – in which three sections of memory (ultra short-time, short-time and long-time) are involved – incoming information is ranked according to its importance for the learner. At first, information is sent to the ultra short-time memory and is ranked as relevant or not for the learner. If not relevant, the information would be forgotten at once. If relevant, it is transferred to the long-time memory. If the information is somewhat relevant, it is sent to the short-time memory for further ranking (Vester 1975). This model maintains that only information which has a special relevance for the learner is stored in the long-time memory. For schools, this implies the necessity for developing new ways for making new incoming information relevant and exceeding the brief "motivational impulse" at the beginning of a lesson. For museums, it means start thinking about ways to change the traditional classification approach to exhibitions.

However, 'relevance' is different for each person. Hence, how do we make information relevant for more than twenty individuals in a single classroom or for thousands of individuals coming to a single museum exhibition? A

[1] Metacognitive means thinking about how we learn.

basic principle is to offer opportunities to the learner to use information actively, that is, to create situations and environments which inspire and stimulate active participation.

At the beginning of the 20th century, innovative educators like Dewey and Montessori insisted that self-guided and self-controlled discovery should play a more important role at school. Bruner refined the concept of 'learning by discovery' during the 1960s and 1970s. These concepts changed the teaching methods from a teacher-centred approach to learner-centred one, while the role of the educator changed from a role of authority, setting the pace of teaching and learning processes, to the role of *facilitator* who offers support to the learners. Museums find themseves in a similar situation:

> "By defining knowledge in relation to the larger social and historical context, visitors are being empowered to know and speak in ways that are meaningful to them. They now share with the museum personal responsibility for and control over defining their experiences with the collections. Consequently, several long-standing tenants have been eroded, such as the authority of the curator, the sanctity of objects, and even the prestige of the institution itself as a source and distributor of knowledge." (Roberts 1997, 132).

With regard to schools, Richter (1999) states that many teachers still hesitate to use these more open forms of teaching, possibly because of the controversial results still presented by research on the effectiveness of such approach: open-teaching methods influence positively social behaviour and the performance of working skills, but in terms of knowledge of facts, traditional teacher-centred lessons emerge as more effective.

Discussions on school curriculum reforms as well as general debate emphasise that contemporary demands concerning the skills of the current generation are quite different from those for the past generations. Knowledge about the world is rapidly growing, while increasingly more information is widely available. It is therefore ever more important acquiring skills for selecting and evaluating information, for building one's own knowledge structures, for using and reconstructing one's knowledge according to the needs of changing situations, as well as acquiring skills for lifelong learning.

Working with schools

The projects which were developed with a collaboration between schools and museum during the SMEC project are presented in the following chapters offering examples and ideas for the development of further activities by other schools or museums across Europe. The projects should enable pupils to:

- *develop questions*. That is, help open up the mind and look 'under the surface' of a apparently certain fact;
- *investigate/research*. In order to find the answers to questions, pupils need to build up examination skills, exercise their view upon things, become aware of nuances, learn where to seek information, etc.;
- *develop hypotheses.* That is, draw meaningful connections between different information and evaluate them;
- *discuss hypotheses*. Study multiple points of view, discuss pros and cons, decide what is right or wrong;
- *explain to others*. Full comprehension of the topic should lead to the identification of the right mode for presenting findings to others and leading them to understanding. Expressing thoughts verbally helps to clarify ideas – and at the same time develops language skills;
- *document the process and the results*. This is an opportunity to reflect on process and on findings and develop creativity in the ways of presentation;
- *develop creativity.* For problem-solving processes and becoming able to work in teams.

Learning by discovery

Most of the methods suggested in the proposed projects can find a common ground in the concept of *learning by discovery*. As Hartinger (2001, 332) argues, there are three basic types of this kind of learning:

- *learning by examples*: inductive learning, especially for learning concepts/terms, focuses on building and discussing hypotheses. Pupils identify the characteristics of a term by analysing examples and counter-examples.

- *Learning by experiments*: the main aim is the construction of knowledge about rules and laws and the development of self-control in pupils.
- *Learning by conflict-solving*: a problem, often risen by the teacher, is meant to initiate a 'cognitive conflict' in the pupils, who will then work on the problem in order to find a solution.

Bruner supported these forms of learning by discovery as a way to encourage the development of intellectual intelligence, to promote intrinsic motivation, support learning through heuristic methods and to help recollection of acquired information in the long-term (see Hartinger 2001, 333). There are many forms of learning which can be defined as *discovery learning*:

> "... inductive teaching, inquiry teaching, learning by examples, active learning, learning by doing, questioning, experimental methods, problem-oriented and problem-solving learning, socratic teaching."[2] (Hartinger 2001, 332).

Let us take a closer look to some of the suggested methods. Beginning with a question or a problem most probably initiates a *problem-solving process*, which will motivate and activate pupils (Gudjons 2001, 337). To start, a question should be asked or a problem set, for example the task of comparing the state-of-the-arts with their ideal condition. Pupils have to plan and carry out step by step the process which will lead them to the solution and, in the end, check and evaluate the solution. During this process they need to build and discuss hypotheses (e.g. through experiments), find information (e.g. looking into books, talking to experts, investigating objects) and present their findings (e.g. with a report or an exhibition). In other words, pupils construct knowledge and at the same time build skills for planning, checking results, reflecting on the work as well as general co-operative and communicative skills. If the start question is posed by the pupils themselves, the probability of involving personal experiences and prior knowledge are increased.

Work in groups means that the class is divided in teams of, ideally, three pupils. These groups can either all work on the same task or on different tasks, one for each team. Working in groups promotes participation of pupils, during which the input of every person is equally important, contributing to reaching the result. Shy pupils are encouraged to express their ideas and thoughts, while the group is not forced to follow the pace set by the teacher or the class as a whole, but can find a pace appropriate for the learning styles of the three participants. This guarantees more space for pupils, wider use of prior knowledge and experiences, deeper study of the subject. Pupils can better identify themselves with the task and be more ready to take responsibility for their own learning process. When they report to the other teams, they are in the role of expert, fact which promotes self-confidence and increases motivation for further learning.

Learning in corners (or learning circles) implies work in different 'stations', each referring to diverse aspects of a topic, inter-related by common learning objectives. As opposed to a 'closed learning circle approach', which forces children to follow a pre-set way, 'open learning circles' allow pupils to decide the progression of work. According to the priority and/or complexity of a station, pupils can decide how much time to spend on each phase. Most pupils choose spontaneously the station that is most appropriate to their own learning styles, fact which raises the probability to solve the problem set at the particular station, even if it is a more complex (Eigel 2002). This means that pupils can better use their individual strengths and skills and work intensively on single foci. At the same time, less gifted pupils can concentrate on their work without time-pressure. While pupils are free to change different social forms in which they work (on their own, in groups of two or three), collaborative work is reinforced.

Learning by doing (invent, construct, paint) gives pupils the opportunity to work with different materials, learn about their characteristics and function, while it also stimulates their imagination and creativity. If, for example, pupils are asked to reconstruct things of the past, they have to observe closely the different parts and functions. This helps understanding of the history of technology and the problems relating with modern equipment. Making things requires and promotes planning skills, sensory-motor skills as well as understanding, for example, the way something functions.[3]

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[2] There is a strong connection to terms like handlungsorientierter Unterricht, Projektunterricht oder situiertes Lernen.

[3] The article *"From hands-on to minds-on"* acknowledges the importance of doing things with one's own hands as motivation and support in order to think in depth and to arrive to understanding. The concept was developed by Dewey in early 20th century and then developed by Kerschensteiner in his "working school" (*Arbeitsschule*) and in the exhibitions of the Deutsches Museum.

Learning through the use of materials and tools, especially through museum objects. Books, magazines, pictures, photographs and films are well-known materials for seeking information, inspiration and motivation within a learning process. In the projects developed in the SMEC school-museum cooperation, museum objects play an important role. These objects can be art works, historical or technical artefacts, reconstructions or interactive exhibits. Almost each object on exhibition is a rich "container of knowledge" conveying a personal story: when, where and why it was made, who was its creator, who owned it, where was it used before being moved into the museum. The object also contains the 'story' about the artistic, scientific or technological development, information about the historical context in which it was invented, about the social context which it might have contributed to change – and as such it can be used multidisciplinary learning.

Learning through real objects

As opposed to most learning resources used at school, the museum object is *real*, it has a touching and attracting aura of authenticity, which rises awe. Only few of its 'stories' can be discovered at a first glance. Therefore, the museum object invites new interpretations and close investigation. Investigations of the object could also lead to an interview with the museum curator or with witnesses of its time. They may lead to library or internet research.

Also, looking at the object with different eyes may stimulate new questions. Interactive exhibits have a high potential to attract visitors (adults as well as children) and to draw them into active examination which involves both hands and minds. Hofstein and Rosenfeld quote a study by Javlekar at the Nehru Science Centre in India, which showed that:

> "Pupils who visited the exhibits out-performed the control group in the understanding of scientific concepts underlined in the exhibits […] interactive techniques are the best approach to achieve a better understanding of the concepts..." (Hofstein and Rosenfeld 1996, 96).

The museum object can be the focus of a teaching unit. Using museum objects can be the basis for developing questions and initiate problem-solving process or reflection on what pupils have already learned, comparing information or come to new conclusions. Object-based work is more effective if part of a three-part unit, consisting of preparatory work at school, the museum visit and follow-up work. The preparatory work at school aims to set a framework for the examination of the museum object without describing in advance everything about the object, killing thus curiosity and amazement. During the visit pupils work on the objects, while during follow-up work they reinforce the newly acquired knowledge and proceed with the solutions to the problem.

The methods shortly described above can be used in all three parts of the proposed unit, helping to overcome distinctions traditionally made between formal learning (at school) and informal learning (in the museum) (see Bitgood 1988; Hofstein and Rosenfeld 1996). Dierking argues on these distinctions:

> "... it may not be appropriate when focusing on the nature of the learning process. In my opinion, learning is learning and it is strongly influenced by setting, social interaction and individual beliefs, knowledge, and attitudes. Learning situations (...) include classrooms, museums, zoos, homes, and, believe it or not, shopping malls. Each of these settings can be formal or informal, depending on the structure of the learning opportunity and the manner in which the individual perceives the context." (Dierking 1991, 4)."

The museum as a special learning place

The main reasons to visit a museum are, of course, the objects on exhibition. These objects are, as mentioned above, 'containers of knowledge', not only offering information about artistic or scientific phenomena, but also embodying cultural heritage. Out of the visible, tangible objects abstract ideas can be developed or, vice versa, abstract ideas take a concrete form and become more understandable. The encounter of the *real thing* helps broaden horizons, provokes amazement, curiosity and inquisitiveness. Museum objects invite the pupils to find out about their hidden stories using a range of approaches; they invite to discovery.

The museum is a place with a very high potential to evoke learning by discovery. Among the many advantages of this type of learning McCrory identifies "the empowering sense of discovery (...) seen as an important outcome in its own right, rather than simply part of a process working towards specific cognitive outcomes" (McCrory 2002, p.10). Museum objects invite to compare, to form hypotheses and to discuss. This

cognitive aspect of learning occurs in a rich, multiple environment which not only supports the cognitive, but also the affective and social development of children. According to Semper, people try to organize their surroundings in a way that offers them many possibilities of choice (Semper 1996); in the museum children find exhibitions offering many choices; an almost perfect setting for active, self-governed learning.

The impacts of interactive learning are classified, according to McCrory (2002), in cognitive, affective, "conative", behavioural and social. *Cognitive* includes building memories and connections, thereby developing knowledge about content and process. The *affective* impact – like enjoyment of the visit or improved attitude towards science – may lead to changing attitudes. The term "*conative"* refers to motivating and empowering, that is, increase of pupils' belief in their ability to engage with science. *Behavioural* implies the way in which pupils engage in processes, e.g. their behaviour within the exhibition or the way and extent to which they engage in science after the visit. The social impact increases relations with others which involve interpersonal skills, teamwork, extending social experiences and self-confidence (McCrory 2002, 10). These categories emphasise the broad range of potential impact of a museum visit as well as the range of skills, knowledge, behaviours involved in the museum experience.

Although there have been many changes in the traditional methodology for teaching at school, interactive learning has still limited use in schools. The are many reasons for this, related mainly to the lack of equipment and material or the lack of training for teachers relative both to methodologies and contents. Museums, due to their basic self-conception, are places which offer the preconditions for self-guided, active and joyful learning.

The co-operation of schools and museums within SMEC is expected to contribute to the debate on the use of museums in science teaching and learning in primary school. As the following examples of work will show, the project aims to link the expertise of teachers with that of museum educators:

- teachers are experts of school learning and pupils' needs and interests in different ages and use a range of methods in order to engage them in educational tasks.
- Museum educators are experts of museum objects, of their history and meaning, and of the appropriate approaches to informal learning through museum objects.

Co-operation of the two institutions means comparing.

Bibliography

Bitgood, Stephen (1988) A Comparison of Formal and Informal Learning. *Technical Report* No 88-10, Jacksonville.

Dierking, Lynn (1991) Learning Theory and Learning Styles: An Overview. *Journal of Museum Education*, Volume 16, No.1 Winter.

Gudjons, Herbert (2001) Projektorientiertes Lernen. In Einsiedler, W. et al. (eds) *Handbuch der Grundschulpädagogik und Grundschuldidaktik*. Bad Heilbrunn, p. 340-345.

Hartinger, Andreas (2001) Entdeckendes Lernen. In Einsiedler, W. et al (eds) *Handbuch der Grundschulpädagogik und Grundschuldidaktik*. Bad Heilbrunn, p. 330-335.

Hofstein, Avi and Rosenfeld, Sherman (1996) Bridging the Gap Between Formal and Informal Science Learning. *Studies in Science Education*, 28, pp. 87-112.

McCrory, Paul (2002) Blurring the boundaries between science centres and schools. In: *ECSITE Newsletter* Autumn, Issue 52, p. 10-11.

Richter, Sigrun (1999) Grundlinien des Unterrichts in der Grundschule der Zukunft. In: *Grundschulmagazin* 11, S. 37-40.

Roberts, Lisa C. (1997) *From Knowledge to Narrative. Educators and the Changing Museum. Washington*.

Semper, Rob (1996) The importance of place. *ASTC News*, Sept/Oct 1996.

Stefan Eigel (2002) *Lernzirkel. Theoretische Grundlagen des Lernzirkel*. In www.lrz-muenchen.de/Umweltbildung-Ausarbeitung-Projekte-Lernzirkel-theoretische Grundlagen.

Vester, Frederik (1975) *Denken, Lernen*, Vergessen. Stuttgart.