A Model for the Development and Implementation of Field Trips as an Integral Part of the Science Curriculum

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The field trip has long been recognized as a teaching tool in education, particularly in geology and biology sciences. However, the general agreement on the educational value of field trips has not been reflected in their use by schools. In truth, teachers seldom use outdoor activities, including field trips, as an integral part of the curriculum. Common explanations for the gap which exists between the educational potential of field trips and its realization refer to three sources (Mirka, 1970; Fido & Gayford, 1982; McKenzie et al. 1986):

1. *Logistic limitations exist in the school system.* Organizational difficulties, cost factors, safety/security concerns and the lack of time are common barriers to field trip implementation.
2. *Adequate teaching/learning materials are lacking.* Field trip activities are not included in syllabi by teachers and curriculum developers because outdoor activities are viewed as marginal to the curriculum.
3. *Teachers are unfamiliar with the outdoor as a learning environment.* Teachers often avoid using the outdoor environment because they are unfamiliar with the philosophy, organization and didactics of field trips.

The purpose of this paper is to present a practical model for planning and implementing a field trip as an integral part of the curriculum. This model might help educators realize the educational potential of field trips and encourage them to use the outdoor environment in spite of the limitations mentioned above. This paper mainly addresses science teachers and curriculum developers.

What Can We Learn From the Literature?

Since the 1960's about 40 investigative studies in science education have addressed various aspects of outdoor education (Koran & Baker, 1979; Mason, 1980). Some important conclusions can be drawn from these studies in the following areas:

1. The role of the field trip in the learning process.
2. The learning style(s) preferred for field trips.
3. The importance of preparation.

These issues, which are considered in detail in the next section, have been used as the basis for development of the field trip planning model presented in this article.

The role of the field trip in the learning process

The literature provides convincing evidence that field trips are beneficial, especially when the teacher combines concrete learning experiences, as an intermediate step, with higher levels of cognitive learning (Vinci, 1969, Folkomer, 1981; MacKenzie & White, 1982).

Novak (1976) in describing the implementation of Ausubel's learning theory in biology education (Ausubel, 1968), points out the need for concrete experiences as a transitional learning stage from primary concepts to secondary concepts. This idea is similar to the "hands-on experiences" which Piaget (1970) identified as very helpful aids for the transition from a concrete to a more abstract level of cognition. The literature suggests two groups of concepts that could be taught on field trips: (a) primary concepts derived through sensorimotor experiences, and (b) phenomena-related concepts which could act as concrete "subsumers" for further learning in the classroom.

It is suggested that the main role of the field trip in the learning process is the *direct experience with concrete phenomena and materials.* The uniqueness of the field trip is not in the concrete experiences themselves, which could also be given in the classroom, but the type of experiences. Students could view slides of a dune and investigate quartz grains in the laboratory, but only climbing the back and gliding down the steep front slope of a sand dune, during a field trip, could provide them a direct sensorimotor experience of learning about the dune and its structure. Experiential (hands on) activities can facilitate the construction of abstract concepts and can enhance meaningful learning, providing the framework for long term memorized episodes.

In summary, the research literature supports two important conclusions regarding the role of a field trip as a tool for concretization: (a) The field trip should be placed at the early stages of the learning process, and (b) The field trip should focus on concrete activities which cannot be conducted effectively in the classroom.

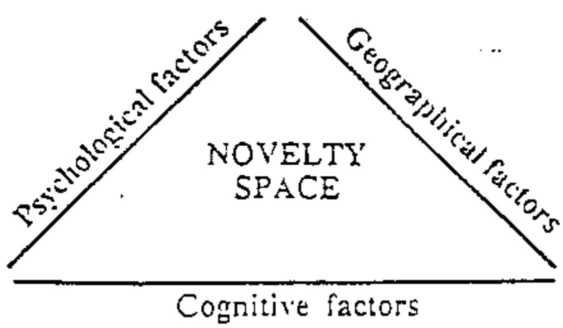
The learning style(s) preferred for field trips

A process-oriented rather than content-oriented approach seems to be the preferable learning strategy in field trips. The process approach focuses on the interaction between the student and the environment; students actively construct information from the environment, rather than passively absorb information from teachers. For example, MacKenzie & White (1982) compared three groups which studied the same subjects with the same teacher. The control group studied in the classroom only while the two experimental groups also studied via field trips. One experimental group used a content-oriented approach while the other group adopted a process-oriented approach. The study found that the knowledge acquisition and long term memory of the "process-oriented" students group were significantly better than the others. However, no significant difference was found between the "content-oriented" and the "classroom" students groups. These findings support two important conclusions. First, field trips in themselves do not guarantee higher cognitive gains. Second, realizing the maximum educational impact of a field trip depends upon the optimal use of concrete interactions between students and the environment.

The importance of preparation

Falk et al., (1978) and Falk & Balling, (1982) indicated that the ability of students to carry out assignments during a field trip is related to the novelty of the field trip setting. They found that if a setting was novel, students had to explore it and only after becoming familiar with it could they concentrate on their assignments. Orion & Hofstein (1991b) expanded the idea of the field trip setting's novelty by identifying three novelty factors which constitute a "novelty space." This novelty space includes cognitive, psychological and geographical components (Figure 1). The idea of novelty space emphasizes the importance of adequate preparation for a field trip, that which will reduce the novelty space to a minimum and thus facilitate meaningful learning during the field trip.

Figure 1. *The three factors which define the novelty space of a field trip learning environment.*



Description of the Model

A model for the development and implementation of field trips was developed to take into account the following conclusions of the above literature review.

1. The main instructional strategy of the field trip should be hands-on experience, concentrating on those activities that cannot be conducted in the classroom or laboratory.
2. A process-oriented approach should be used to achieve the objective of hands-on experience. This approach involves assignments that direct the students towards activities such as: observing, touching, identifying, measuring and comparing. Follow-up activities of interpretation and drawing conclusions should be based on these basic processes.
3. Students should be prepared for the field trip. The more familiar they are with their assignment (cognitive preparation), with the area of the field trip (geographical preparation) and the kind of event in which they will participate (psychological preparation), the more productive the field trip will be for them.
4. The field trip should be used as an integration to a particular unit because the concrete activities provide a basis for meaningful learning.

In addition to these operational conclusions, the following three criteria were also addressed:

Administrative-teaching criterion.

The field trip should be easy to organize and convenient to operate. This criterion relates to the teacher's ability to organize a field trip with a practical investment of resources (economic and administrative), to identify easily the learning stations in the field and to provide adequate learning-teaching aids.

Curricular criterion

The field trip should cover basic concepts which could be best taught in the field. This criterion relates to the field trip as an integral part of the curriculum.

Educational criterion

The field trip should be a learning experience. This criterion may seem trivial, but in reality, most field trips can be summarized as adventure-social events. In order to make a field trip more educational, a teacher should develop learning materials that both prepare students for the trip as well as guide them through it.

The Multi-Stage Model

In order to meet the three above criteria and to respond to the conclusions of the literature review, the following multi-stage model was developed (Figure 2).

Stage 1 - Hierarchical organization of curriculum concepts, from concrete to abstract.

The first stage addresses the curricular criterion. The curriculum concepts are classified according to their concreteness/abstraction level and assigned to the appropriate teaching environment: laboratory, outdoor, classroom. The appropriate teaching times - before, during and after the field trip - are also determined according to this classification.

Stage 1a - Choice of the study area of the field trip.

The field trip area should be chosen according to the potential study stations where the selected concepts could be taught (curricular criterion), and by taking into account the administrative criterion e.g., this area should be as close as possible to the school.

Stage 2 - Educational mapping of the field trip area.

This stage includes a field survey of sites which may serve as study stations. The outcome of the survey should include a map and a description of the educational potential of each station. Factors relevant to the selection of a study station are:

- The phenomena at the site should be clear enough "to speak for themselves";
- The site should be located easily;
- There should be enough room around the site for uninterrupted activity by the relevant number of students;
- Safety (e.g., distance from main road, steepness of slope) must be taken into account;
- The microclimate of the station should not inhibit work.

Although these factors may seem trivial, many field trips fail due to faulty selection of the learning stations. Following this list in planning a field trip is a crucial requirement, since the inappropriate choice of only one factor in a learning station can dramatically reduce its educational effectiveness.

Stage 3 - Matching curriculum concepts and the field concept inventory.

In this stage the study stations which demonstrate concepts included in the curriculum are selected. This stage is actually a product of the two previous stages.

Stage 4 - Planning the route.

Now is the time to organize a route using the selected study stations. In order to satisfy the educational and the administrative criteria the planning of the route should address the following points:

- The distance between the stations should be reasonable i.e., about a 15-minute walking distance, or less than a half-hour driving distance.
- A one-day field trip should include not more than 6-8 study stations, at each of which the learning activity should last about an hour.
- The route should be convenient in terms of transportation.
- The route should relate to a major topic in the conceptual framework.
- There should be an educational logical connection between stations.
- It is desirable to locate stations at attractive sites, but the attractiveness should not inhibit learning.
- The trail should be easy, in terms of physical effort.
- Weather conditions, such as, sun direction and daily temperature change, should be considered.

As above, missing only one factor can dramatically reduce the effectiveness of the learning in the field trip. Even though these directions may seen trivial, many teachers fail to address them while planning the route.

Stage 5 - Development of teaching/learning aids.

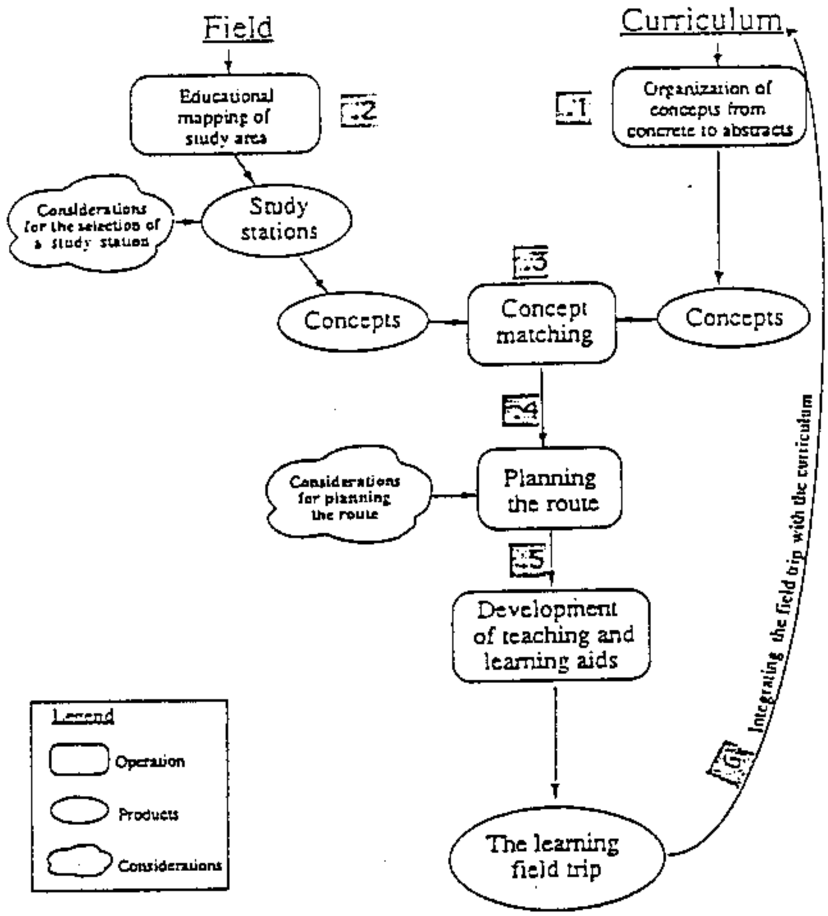
This stage aims to provide effective educational materials. In order to answer the educational and administrative criteria, the curriculum package should include aids such as:

- Learning aids for the student, such as a field trip booklet which directs student work at the study stations.
- Teaching aids, such as a series of mini-posters to help the teacher explain field observations, teacher's guides for the preparatory unit and for the field trip itself. It is also recommended that the study stations be marked on site. Since most teachers have no experience and training in field teaching, it is very important that the development of materials for a new field trip be accompanied by an in-service training program.

Integrating the Field Trip in the Curriculum Unit

The field trip should be conducted early in the learning process but, not as the first learning activity. It should be preceded by a relatively short preparatory unit designed to decrease the "novelty space" factors. The suggested model (Figure 3), is a three dimensional development of "the learning cycle" strategy (Karplus & Lawson, 1974). The learning spiral ranges from the concrete to the abstract and is built of three parts. Each

Figure 2. *Stages in the development of a field trip as an integral part of the curriculum*



concrete to the abstract and is built of three parts. Each part is a structured independent learning unit and at the same time, serves as a bridge to the next learning unit. The three learning cycles which constitute the spiral are:

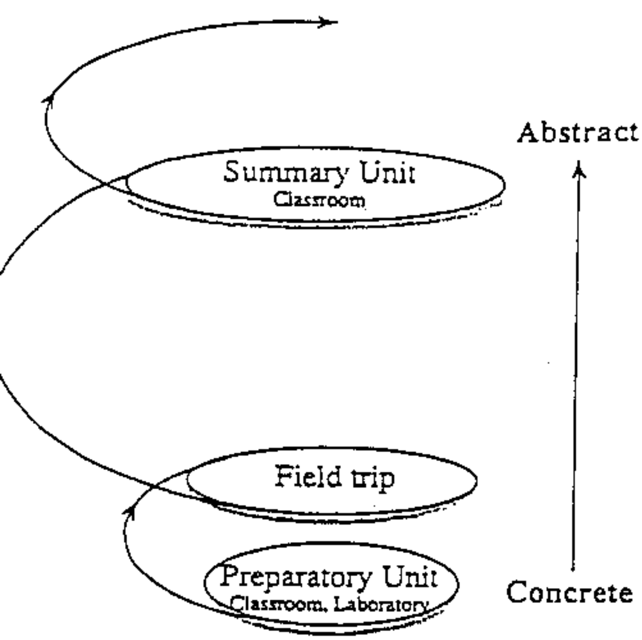
The preparatory unit. This unit is based on concrete learning activities in preparation for the field trip. The purpose of this unit is to reduce the three components of the novelty space to a minimum. The cognitive novelty can be directly reduced by using several concrete activities, for example, working with the materials the students will meet in the field, or simulating field phenomena and processes through laboratory experiments. Thus, a preparatory unit for a geology field trip can deal with the identification of hand specimens of rocks, minerals, soils and fossils; observing the micro-structure of the rocks through a microscope; and conducting simple laboratory experiments to illustrate processes such as crystallization, spring and seepage rate.

The geographic and psychological novelty factors can also be reduced in the classroom, by slides, films and working with maps, as well as providing detailed information about the event (e.g., purpose, learning method, number of learning stations, length of time, expected weather conditions, expected difficulties along the route).

The field trip. The field trip is the central part of the the module. The structured field trip is based on the criteria and the stages which have been described above. The field trip together with the preparatory unit constitute an independent module which serves as a concrete bridge towards more abstract learning levels.

The summary unit. This unit includes the "heavy" part of the curriculum. It includes more complex concepts which demand a higher abstraction ability and a higher concentration level from the students. Teaching aids may include blackboard, slides and

Figure 3. *The three stages model for integrating*



field. For example, a summary unit of an introductory course in geology would deal with time and space dimensions, as well as physical and chemical processes which take place deep in the earth's crust.

Table 1 provides one example of using the learning cycle method in a spiral version. Each of the three units mentioned above starts with an exploration stage: laboratory investigation in the preparatory unit, field investigation in the field unit and investigation of data in the summary unit. The conclusions of the exploration stage are used by the teacher for the invention of the learning concepts and encouraging the students to generate questions about the phenomenon they investigated. These questions serve as a bridge to the next cycle and also to the next environment learning. In order to find the answers, the students should explore a new phenomenon by using the knowledge they acquired in the former stage i.e., the "exploration" stage of the new cycle is in the same time the "discovery" stage of the former cycle. The development of such spiral learning cycles might seem quite complicated. However, following the three first stages of the model ("hierarchical organization of curriculum concepts", "educational mapping of the field trip area" and "matching curriculum concepts and field concept inventory") makes it a much easier task.

The Implementation of the Model: An Example

Four one-day geological field trip modules were developed on the basis of the above model, as an integral part of an introductory geology course for high school students in Israel. A detailed description of the development phase can be found in Orion (1989). The implementation of the field trips was accompanied by an in-service training program of 120 hours. About 40 geography teachers participated in the entire program during the years 1985-1986. Since then, about 15 teachers from this group each year conduct at least one of the field trips with their classes. In addition more teachers are participating in the field trip program.

An evaluative study was conducted over a two year period (1986-1987). The study included 298 students from 8 high schools in 17 classes (grades 9, 10 and 11), who participated in the geology field trip "From the Foothills to the Mountains." The research design included pre/post measurements of students knowledge and attitudes; observations of the students during the field trip; and interviews with the students and their teachers (Orion & Hofstein, 1991a and 1991b). The multi-stage model for the development of a field trip as an integral part of the curriculum, was found to be very useful. The educational effectiveness of the field trips is indicated by the following findings:

- About 20 teachers have conducted one of the geological field trips for the last five years and each year new teachers join the field trips program. It is important to note that most of those teachers did not conduct geological field trips before participating in this program.
- An evaluative study following the implementation of the field trip "From the Foothills to the Mountains" indicated that, in general, the students showed high learning performance in the field through active interaction with the environment.
- In general, the students found the field trip to be an event that improved their knowledge and attitudes towards learning in the field and towards geology.
- The students' responses were supported by the observations of objective observers.
- Similar outcomes were reported by the teachers and the observers concerning other geological field trips, which were also developed according the model.

Summary

The model presented above was designed to help teachers overcome some of the obstacles they may

Table 1

An Example of the Implementation of the Learning Cycle Method.

The cycles' development	Context
Learning cycle A of the preparatory unit	
Observation 1: *(Exploration)*	Investigation of limestone specimens and comparing their fossils with recent shells find in the sea shore.
Obtaining of information:	Students receive "outside" information (by tables and posters) about typical fossils associate with limestone and the beach's typical shells' assemblage.
Conclusion:	The fossils found in the limestone indicate that this rock was formed in a shallow sea environment.
Observation 2 *(Exploration)*:	Laboratory activity to form stratification.
Conclusions:	1) Stratified rock can indicate a sedimentary origin. 2) Sediments which had settled down in a law energy aquatic environment form horizontal layers.
Summary conclusion: *(Invention)*	Limestone is a marine sedimentary rock.
Raising questions opening the field trip cycle:	What are the rock types which is our surrounding built of ? How did they form ?
Learning cycle B of the preparatory unit	
Observations: *(Exploration and application)*:	Investigation of folding and faulting structures using plasticine.
Conclusions: *(Invention)*	Identifying folding and faulting structures
Raising questions opening the field trip cycle:	Can rocks be folded and faulted like a plasticine? Is it possible recognize such structures in the field?
Learning cycle A of the field trip	
Observations: *(Exploration and application)*:	Investigation of an exposure of declined limestone layers.
Conclusions: *(Invention)*	1) The field trip's area had been covered by a sea while the limestone layers were deposited. 2) The limestone layers are not in their origin position. 3) The limestone layers were tilted after deposition.
Raising questions opening the field trip cycle:	What was happened to these layers ? did they were folded or faulted?
Learning cycle B of the field trip	
Observations: *(Exploration and application)*:	The limestone layers form an anticline structure.
Conclusion: *(Invention)*	The limestone layers were folded.
Raising questions opening the field trip cycle:	What kind of forces can fold a solid rock like a plasticine ? Where did they come from ? When did they act ? etc.
Learning cycles of the summary unit	
Cycle A: The geological forces which influence the Earth's crust	
Cycle B: The geological development of the field trip area	

encounter in the development of field-related activities. It addressed school system limitations, teachers' needs/concerns, and influential factors in a field trip setting. The model links out-of-door activities in the field with classroom instruction. Therefore, it should be useful for teachers and educators who would like to develop field-related activities and integrate them in their curriculum.

The evaluation of geological field trips which were developed and implemented on the bases of the model supported its applicability. Since the geological field trips were developed according to the general model, the author believes the model could be used for field trips in other disciplines and teachers who will follow the model might find meaningful educational profits for their investment.

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