

Principal Objects of Knowledge (POK's) In Colloquial Approach Environments

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1. Introduction and Motivation

Does the following describe your class: Students unhappy about their lack of understanding of core material despite your efforts to present such material in a well (i.e., hierarchical and sequential manner)? Students are visibly discouraged about assignments and about their weak ability to apply your “masterfully” delivered lecture. Students are strongly complaining about the fact that “this way” of presenting ideas does not allow them to differentiate what is the most important “stuff” from what is not. If this is what you see after working very hard in organizing, re-structuring, and polishing the material up to the point that you could even recognize when there is a missing step in the text you wrote on the blackboard, then you probably realize that “masterfully” organized pieces of material do not work very efficiently. They do not work effectively in helping the students “capture” the “good stuff” from those pieces that may be necessary but are not essential!

Then, obviously, in the framework mentioned above, something must be changed in the way you present class material in order to impact the ability of the students to identify the core part of a piece of material. This core must be identified from the other parts that play a secondary role in the understanding of the whole. The first step is, perhaps, to promote an active learning environment and make sure that everybody is involved in the class (see, for example, Arce-Trigatti and Arce, this meeting). Second, the organization of the material must be constructed in such a way that allows the students to be engaged in the process of building blocks of knowledge. This type of organization departs substantially from the one that presents the material from a “bottom up” strategy and in a highly polished fashion!

In my class activities (or I should say my learning practices) the “Colloquial Approach” (Arce, 1994a) plays a very important role in the promotion of active learning environments. Within this style of teaching, the identification of

“Principal Objects of Knowledge”, or POK’s is an important aspect of activating the knowledge already built in the students’ minds. These objects are part of a structure of a given lesson plan that allow the students to build up more blocks of knowledge based on what they already know. The students can achieve this by adding elements to their present knowledge with the help of carefully coached approach. The POK’s are usually an intermediate part of an almost naturally organized framework that is not necessarily a “bottom-up” structure from the point of view of the learner. The instructor should make an efficient use of these objects to interconnect what the student knows and what the student-instructor must bridge in order to build the next block.

In this contribution, we will review the main instructional blocks used in “Colloquial Approach Environments,” identify the role of POK’s within an active-learning environment, give examples of POK’s and discuss the identification and use of them in selected topics. Finally, some thoughts about the instructor’s ability to identify and efficiently use the POK’s will also be given.

2. Brief Review of the Colloquial Approach Technique

The colloquial approach (see Arce, 1994; a&b) is an instructional methodology where the students (and not the professor) are at the center of the learning process. Thus, the learning of the material is driven by the students and the role of the professor has been moved to that of a “team coach”. The approach integrates classroom work, quizzes, homework assignments, exams, group projects, and the preparation of class folders to stimulate and promote the strong involvement of the student in the process of building blocks of knowledge. This is achieved in a very active and constructive-progressive fashion. As a result, the students in this type of environment enhance the development of their individual confidence, individual judgment, and creativity.

Within the colloquial approach environment, the organization of the classroom activities is very different compared to that usually found in a lecture or other passive modes of teaching. Table 1 (see appendix and Arce, 1994a) shows the main blocks of activities within a colloquial approach environment of learning. Block 2 (at the top of the Table) is focused on the Class/Group activities that are very relevant to efficiently achieve some of the objectives presented above.

The activities in the colloquial approach environment are designed by following the set of “Strategic Elements” shown in Table 2, (see appendix and Arce, 1994a). These elements are classified into four different categories; the *organization* of the material of the course as learning units, the *identification of primary objects* for a specific topic within a given unit, the *assessment* of the background material that the students have in order to discuss the primary objects mentioned above, and the *selection* of material to be covered in class assignments, exercises, homework, and exams.

The different activities of the approach are implemented by following the blocks indicated in Table 1. These activities are organized into three different types of structures. The first one is the *generation* group (i.e., blocks 1-5), the second structure is the *evaluation, consultation, and improving* group (i.e., blocks 6-9), and the final structure is the *implementation* group (i.e., blocks 10-12). The role of each one of these groups has been explained with details and examples in Arce (1994a). Therefore, in this article we will only focus on the identification, selection, and role of POK's. This will be the subject matter of the next section.

3. Role of POK's in Active Learning Environments.

One of the most important elements of the colloquial approach environments is the selection of Primary Objects of Knowledge as indicated in Table 2 (appendix and Arce, 1994a). This must be chosen for the given topic to be learned. A POK is an idea or set of ideas that allows the students to use their prior acquired knowledge to build additional blocks of knowledge in order to perform higher level tasks in the process of learning. The ideal case is found when the POK meets the students and the new block of knowledge half way through. In this manner, the students can apply what their already knows to understand the new piece of material in a very efficient way.

In many cases, the POK's are already available and the instructor role is to make a careful selection to achieve the type of results that she/he wants for her/his class. A series of examples will be given in the paragraphs below in order to illustrate some of the points made above.

Example #1: Constitutive Equations in Transport Phenomena: Table 3 (see appendix and Arce, 1994a) shows an organization that has been suggested to teach transport phenomena (Cerro, 1989) and that has been used, for example, to teach Heat Transfer at the undergraduate level at the College of Engineering. This is jointly operated by Florida A&M and Florida State University, Tallahassee, FL. The sketch of this table suggests an organization of the material from the fundamental concepts to the applied or engineering examples. Located at the middle of the road from the top part to the bottom part of the organization, we can observe the presence of the constitutive equations. These equations are a direct relation between the fluxes and gradients of the dependent variables under analysis (i.e., temperature, concentration, velocity). The detailed understanding of the relation between the fluxes and gradients of fundamental variables allows the students to then derive the conservation equations either for mass, heat, or momentum in a very efficient way.

Example #2: Inclined Plane-Ball Rolling System in the Analysis of Forces in Analytical Mechanics: The derivation of the mathematical equations to describe the trajectory of an object under the action of gravity is an important and often difficult task to learn. Some of the basic concepts involved in the topic include the identification of the coordinate system and the selection of the origin of such a

coordinate system (i.e., anchoring of the system). Then, the identification of forces, and the description of such forces with respect to the choice of the coordinate system, are very important tasks in the description of the particle trajectories. The adoption of an inclined plane-ball rolling system offers an excellent choice for the POK from an active learning point of view. Students usually have a very good idea about inclined planes from every day examples that they have found in their life. The use of a rolling object (such as a solid ball) on the surface of the inclined plane complements the choice excellently. With this choice of POK, the students are given a very powerful tool for the learning of role of gravitational forces on the motion of objects in a Newtonian model of motion.

Examples #3: Beat and Spring Model in the Analysis of Forces in Colloidal Materials. The introduction of the subject of fundamental of colloidal materials and their applications to undergraduate students in chemical engineering, physical chemistry, and material engineering is not a straightforward matter. There are two aspects that need to be addressed (Arce, 1999) and they parallel very much the introduction of concepts related to fluid mechanics. Within this framework or point of view, one of them is related to “colloidal statics” and the other is related to “colloidal dynamics.” Both sub-subjects involved the use of force in the description of the motion of colloidal particles in their environments.

The introduction of these forces to the students is effectively performed by using a POK based on the “beats and spring” concept that has been around a number of years (Bird et al., 1987). This model is a beat interacting with a surface of another beat or a surface of a domain (i.e., duct, channel, or tube) that is used to move the particle in a give direction of flow. This interaction can be effectively described by using a Hookean spring to describe the type of force involved in each case. Two main types of forces are the Hammaker (or “short” range) and the Coulombian (or “long” ranges). The students are motivated and coached to understand the role and action of these forces by following a mechanistic type of approach.

Example #4: The Soccer-Ball Model [SBM] in the Introduction of Students to Continuum Mechanics Concepts. One of the most difficult aspects in the learning of transport phenomena is the introduction of students to the continuum mechanics concepts after they have learned almost every subject in mechanics from the “discrete point of view”. Many textbooks only say “by a decree” when the students should view the world from the “new perspective”. Students are usually encouraged to forget about the “old conception.”. The SBM offers the possibility of building the continuum from the perspective of the discrete world that the students have been exposed to during their courses in mechanics. By a process of changing the size of the soccer balls in a given container, the students are able to visualize the connection between discrete and continuum views. The concepts of limits, Riemann’s integral definition, and Riemann’s sums complete the analysis of the picture. The SBM also allows the students to construct some mechanical models or lab prototypes to visualize the changes in the system. The

SBM is a very good POK to help the students learn the basis aspects of a continuum which is one of the cornerstone pieces of knowledge in fluid mechanics and transport phenomena.

4. Discussion

The identification of the POK's depends on the structure of the concepts to be taught (i.e., transport phenomena, Newtonian forces, or colloidal phenomena) and it must be performed by the instructor of the course. Several factors play an important role in the selection of efficient POK's. Some of them include, for example; the familiarity with the material, a very good understanding of the psychology of learning and how the POK's are related to the type of concepts that need to be taught. In addition, a good evaluation of the students' background is helpful to adapt what the student already knows to the building of new blocks of knowledge.

Once a good selection of POK's have been made, then the instructor must be concerned with the implementation of the POK's and how these objects can be used to bridge the students's background with the new knowledge to be built. In addition, the instructor must integrate the students's view of the new concepts within the use of the POK's.

Another interesting aspect of using POK's is the fact that instructors are continuously interacting with the students and, therefore, they are constantly assessing the mastering of the concepts by the students. In addition, variations of the POK aspects are useful for challenging the students to build more blocks of knowledge and for quizzing the students' level of understanding within a given framework. For example, the suggestion to derive energy conservation equations has been used after the Fourier law has been introduced (see Arce, 1994a), and variations of the SBM (see below) have been used to assess the students' understanding of concepts related to the continuum. By using some of these activities, the instructors can effectively assess the level of comprehension in the students and propose corrective measures to achieve the required level of mastering in a given topic.

During this presentation, several aspects of the identification and use of POK's will be discussed and the examples given in section 3, above, will be used as "model cases" for a geometrical illustration. Furthermore, tips for the selection of POK's will be given and other aspects of POK's related to students' assessment will also be discussed.

5. Concluding Remarks

The role and use of *Principle Objects of Knowledge* in an active learning environment such as the colloquial approach have been identified. The selection of POK's have been illustrated with three main examples related to the teaching of transport phenomena, analytical mechanics, and colloidal materials. These examples are fairly well structured cases of POK's where the instructor must help the learning of a complicated subject. Further discussion will be offered at the time of the presentation of the material.

6. References.

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Appendix

Table 1: Blocks of Activities in A Colloquial Approach Environment
(Arce, 1994a)

Group #1: Generation

- New material; Fresh reading and POK (1)
- Class/Group Discussion (2)
- Sketch of Notes (3)
- Clean up notes; Questions; Generation (4)
- Questions Answered (5)

Group #2: Evaluation, Consultation, and Improving

- Evaluation and Consultation with TA (6)
- Consultation with the Instructor (7)
- Reading Material; Discussion with Partners (8)
- Exercises (9)

Group #3: Implementation

- Homework (10)
- Problem Solving Strategies (11)
- Exams and Quizzes (12)

Table 2: Strategic Elements in A Colloquial Approach Environment
(Arce, 1994a)

1. *Organization* of the material in units
2. *Identification* of the POK's
3. *Assessment* of the students' background
4. *Selection* of the material for the different activities (see Table 1)

Table 3: Organization of Transport Phenomena
(Cerro, 1989; also see Arce, 1994a)

Fundamental Concepts and Postulates

-----[First Level→ Mathematical Tools]

General Balances Equations

-----[Second Level→ *Constitutive Equations*]

Transport Equations

-----[Third Level→ Simplified Models]

Applications to Basic Problems and
Engineering Design

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