

The Potential of Christopher Alexander's Theory and Practice of Wholeness: Clues for Developing an Educational Taxonomy

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Bauer, Reinhard, and Peter Baumgartner. 2010. "The Potential of Christopher Alexander's Theory and Practice of Wholeness: Clues for Developing an Educational Taxonomy." In , 12:1–12:21. EuroPLoP '10. New York, NY, USA: ACM. doi:10.1145/2328909.2328924.

ABSTRACT

This is a paper about how to transfer design patterns from architecture and software engineering to education. It is about the nature of pedagogical patterns – what specific structures they have – and about the potential of Christopher Alexander's theory and practice of wholeness as a theoretical starting point for classifying them to develop an educational taxonomy. It is about understanding computer scientists and pedagogues who try to define patterns and pattern languages suitable for educational needs. Analyzing an exemplary educational scenario this contribution will compare the ability of three different ways of description. Demonstrating the applicability of Alexander's fifteen properties of living centers in education the authors intend to open discussion and reflection about the important role of an educational taxonomy for classifying existing pedagogical patterns.

Categories and Subject Descriptors

D.3.3 [Programming Languages]: Language Constructs and Features – *patterns*.

General Terms

Theory.

Keywords

Living centers, wholeness, taxonomy, education, educational scenarios, pedagogical patterns, methodology.

1. INTRODUCTION

"Once we have the view of wholeness and centers, linked by the 15 deep properties, we have a general view of the type of whole which must occur as the end product of any successful design

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process."¹ — Christopher Alexander

This contribution investigates the potential of Christopher Alexander's fifteen properties of living centers as a foundation and starting point for the analysis and classification of different stocks of educational scenarios, the "phrases" in a system of pedagogical patterns. In our perception, the lack of an agreed educational taxonomy has its root in a misunderstanding of how to define educational scenarios (e.g. different didactical levels are usually confounded) and, with regard to taxonomies, assuming a strict hierarchic structure of taxonomies, forgetting the importance of a holistic approach. Another reason is probably the fact that in the education sector there are a lot of different views. This is all the more important when working with (very abstract) didactic models. The more general you get, the less specific (and arbitrary) it becomes.

It has become apparent, of course, that this issue does not only exist in the educational context, but also with regard to biological taxonomy, where there are still different classification systems (e.g. classical evolutionary classification, numerical taxonomy or phenetics, consistent phylogenetic systematics, and, in the future, systematics based on genetic comparisons). In comparative biology, all these classification systems follow a mechanical approach.

In contrast to this, with his hermeneutic-phenomenological work "The Wholeness of Nature: Goethe's Way of Science" physicist Henri Bortoft comments on Goethe's way of science and the move away from reductionism in biology practised by Wolfgang Schad. In his classification of the mammals he illustrates the difference between a genuinely holistic perspective and the analytical counterfeit:

"The details of an organism would be omitted in favor of a broad generalization, resulting in the kind of uniformity which is characteristic of all attempts by the analytical intellect to find unity in multiplicity. But Schad's way of proceeding is the reverse of this. He does not try to group the mammals artificially into an ordered system. The result of his discovery, that the order among

¹ This citation of Christopher Alexander is taken from his speech "The Origins of Pattern Theory: The Future of Theory and the Generation of Living World" at The 1996 ACM Conference on Object-Oriented Programs, Systems, Languages and Applications (OOPSLA) [3, p. 78].

the mammals is the same as the order inherent in each mammal, is that Schad sees the mammals in the nonreductionist perspective of 'multiplicity in unity' instead of 'unity in multiplicity'. [...] The difference here is between the perception of multiplicity in a holistic perspective (multiplicity in unity) and the perception of unity in an analytical perspective (unity in multiplicity). [11, p. 98].

The difference lies in the perception of the whole: It is not possible to reduce the whole to a set of small parts. The whole is present throughout its parts, i.e. the whole can be found in any one of the different parts. David Seamon [18] identifies a process of reciprocal insight: A better understanding of the parts leads to a better definition of the whole to which they belong; a better understanding of the whole characterizes the parts and makes them more understandable.

Another example of wholeness, closer to pedagogy, in the humanities and social sciences, is the well known hermeneutic circle: If we want to understand a text, we must try to understand and interpret its individual parts (paragraphs, sentences, words). This interpretation is not context-free, independent of the whole text, but in the light of the already read. This new understanding may offer a new interpretation of the sentence which has implications for the whole text, etc. So we can say: every sentence reflects the whole text, every sentence expresses the content of the whole text.

With that said, it becomes clear why there does not exist an agreed educational taxonomy: The classical abstraction tries to find the "unity in multiplicity", with the result that multiplicity gets lost. Traditional educational models reduce and thus lose the real multiplicity of teaching processes. Looking at the Ball Bearing method, we see how this method, in a particular case, reflects its character. The challenge now is to describe the essence of the Ball Bearing, regardless of the particular case, since the method is said to be transferable.

In these premises, with the following considerations we attempt to transfer Alexander's fundamental properties of life discussed in the 5th chapter [4, pp. 143-142] of his book "The Nature of Order – The Phenomenon of Life" (TNO) to pedagogy. To provide a basis, first of all we deduce five premises from Alexander's conceptions.

(1) "Life" is Structural

The concept of life is far more than our traditional biological understanding. For Alexander, "life" is an emergent property of structures, i.e. the nature of order. Life emerges from the wholeness, the structural coherence and therefore is an emergent property of matter:

"The key idea in this book [TNO] is that life is structural. It is a quality which comes about because of the existence of a discernible structure in the wholeness – and therefore explains what we perceive as the quality of buildings of artifacts." (TNO, p. 110).

We dare to suppose that the quality named in this quote refers to the former QWAN². Particularly with regard to Alexander's understanding of wholeness, David Seamon [18] adverts to the fact that, over the years, Alexander has applied consistently

different labels to the wholeness he seeks: "the quality without a name", "the timeless way of building", "creating pattern languages", "density", "degrees of life", "fundamental properties sustaining wholeness", or "wholeness-extending transformations". According to Seamon, Alexander realized "that the pattern-language process alone offered little help in transforming a particular design vision into actual construction and wholesome places".

In our opinion, this is an important remark, especially concerning different views on the world. We can interpret the world as a world of objects divided in stores, traffic lights, kiosks, etc. Such a division has consequences: It leads to a view of design, which distinguishes a particular object, recognizes its external conditions and aims to improve and create a better object. But we can also divide the world differently. With his pattern language Alexander does not attempt to distinguish between house, street, and kiosk for building better houses, streets and kiosks, but he tries to differentiate the integrated urban street corner from other urban complexes. He does so, because the kiosk lives on the fact that the bus has not arrived yet, and it is possible to buy a newspaper, and the bus stops here, because multiple streets converge and the passengers have a direct connection to another bus. The term street corner is only the visible paraphrase of the phenomenon which also contains parts of organizational systems like bus lines, schedules, magazine sales, traffic light phases, etc. This type of design, so says sociologist and design theorist Lucius Burckhardt [12], also involves the invisible parts of a system.

In a world, divided into ambient spaces, which indicate particularly the relations between the visible and the invisible, e.g. passages, like a street corner, different form systems collide. In other words, design is not only a social field that deals with the visible (functional, beautiful) forms, but also with its invisible, open, receptive, self-reflective dimensions. Bearing this in mind, we have to emphasize that Alexander's approach is structural, but not structuralist. Although his pattern language offers a hierarchical structure, Alexander's concept of wholeness is based on gestalt theory, and this approach is precisely the opposite of structuralism. According to gestalt theory, people are seen fundamentally as open systems dealing actively with matters related to their environment, and organizing their perceptions in certain patterns.

In terms of education, there may be seen a connection between Alexander's structural approach and the lesson entities that we call 'educational scenarios'. The term educational scenario is only the visible paraphrase of the phenomenon which also contains invisible parts of organizational systems like curriculum, annual plan, timetable, etc.

(2) "Life" is a Gradual Property of Matter

"Life" is not a yes-no property, but according to its degree of wholeness, degree of harmony, and degree of structural coherence a gradual property of matter:

"[...] almost all of us perceive this quality, and feel it as it occurs in varying degrees in different parts of space. [...] this quality is not merely the basis for a distinction between beautiful things and ugly things. It is something which is detectable as a subtle distinction in every corner of the world, [...]. It is a quality which changes from place to place and from moment to moment, and which marks, in varying degrees, every moment, every event, every point in space." (TNO, p. 64).

² QWAN means "Quality Without a Name" [1, 2].

Therefore, life, as it defines Alexander, is not understood as an exclusive opposition, i.e. a contradiction. With regard to a contradiction, there is always a pair of fundamentally opposing terms that exclude each other forever. When we regard the two propositions “alive” and “dead” as contradictory opposites, the negation of a term always leads to the other. For Alexander, however, life is a part of a contrasting pair, a polar opposite, but there are gradations between the two extremes. The negation of one extreme does not automatically lead to the other. So “not hot” may mean “cool” or even “warm”. At first glance it may irritate that “warm” – because of its close proximity to “hot” – is an antonym for “hot”. But it becomes clear when we say “It is not hot but warm”, where we use “warm” as antonym for “hot”.

Transferring this premise to pedagogy and recognizing that there is missing one of Alexander’s fifteen properties in an educational scenario, this scenario can be regarded as a living scenario nevertheless. A teaching process may be perceived sometimes more, sometimes less alive. We can subsume it as a certain degree of life.

(3) “Life” and the Inner “I”³

By introspection “life” can be perceived as a feeling. This “sense of life” can be sharpened by practice. The determination of the degree of life cannot be reduced to individual opinions and/or values, but can be empirically confirmed. In this context, especially the comparison of objects and /or situations in pairs is helpful:

“What we call ‘life’ is a general condition which exists, to some degree or other, in every part of space: brick, stone, grass, river, painting, building, daffodil, human being, forest, city. And further: The key to this idea is that every part of space – every connected recognition of space, small or large – has some degree of life, and that this degree of life is well defined, objectively existing and measurable.” (TNO, p. 77).

What does this mean? Can good teaching be felt? We think so. Students intuitively sense whether their teacher is happy in the classroom, whether he likes his students, whether he likes his subject and the current theme - or not. But how can we measure it?

Alexander’s ideas about the existence of objective criteria and experimental methods, i.e. the pairwise comparisons for discriminating empirically between living structure and not living structure did gain only little scientific recognition because they are considered methodically unclear and so there are no empirical evidence.

Independently of that concern, we believe, however, that the main problem lies in the fact that Alexander’s statement “this degree of life is well defined, objectively existing and measurable” and its alleged objectivity just infiltrate the central idea, namely the wholeness. A holistic view, i.e. also considering

the context as a whole, may not fade out the structure of the individual (the individual as center). An objective contemplation, however, just separates the object from the subject.

With regard to this, Alexander’s keynote speech at OOPSLA ’96 seems very interesting because of his defence against his critics:

“My belief, by the way, when I began trying to find these experimental methods, always was that there really is such a thing [a living structure in any object], and that actually everybody knows it, but that it has been suppressed. That is because of the world view that we have and the way of looking at things and the nervousness about intellectual rigor ... that people of our era have. [...] these kind of measurements do correlate with real structural features in the thing and with the presence of life in the thing measured by other methods, so that it isn’t just some sort of subjective I-groove-to-this, and I-don’t-groove-to-that, and so on. But it is a way of measuring a real deep condition in the particular things that are being compared or looked at.” [3, pp. 76 et seq.].

Jenny Quillien [19] emphasizes that Alexander’s theory may not be seen as a scientific theory based on solid methodology but rather “an algorithm about wholeness” (p. 145). The important thing, in our opinion, is that he shows a possible way to wholeness, a different form of seeing and interpreting things. In terms of his fifteen structural properties, what this means is that they “provide us the ability to be precise about the nature of living structure, in just precisely such a way that it is connected, not only to all mechanical function, but also to the depths of human feeling” [3, p. 77].

(4) How “Life” Comes from Wholeness

How wholeness can be analyzed? Disassembling something into individual elements destroys its configuration, its internal consistency, i.e. that which represents the wholeness. Therefore Alexander uses a recursive concept of centers: centers are induced by the wholeness and refer to their relations with other parts, which contribute as centers themselves, i.e. a center itself consists of centers:

“There are four key ideas, all arising from the structure of centers [...]”

1. Centers themselves have life.
2. Centers help one another: the existence and life of one center can intensify the life of another.
3. Centers are made of centers (this is the only way of describing their composition).
4. A structure gets its life according to the density and intensity of centers which have been formed in it.

These four points, simple as they are, give us the secret of living structure, and of the way life comes from wholeness” [3].

A center is a pattern that emphasizes the context. It is not a question that the pattern matches the context and is determined by the forces therein. It rather is that the context changes the form of the centre itself. This is the result of the field-like structure of centers. When we draw a curve, this curve can, depending on the context of the other drawing, be regarded as a nose or mouth. That means, it is not just a question of whether the curve matches its environment, but the environment determines whether the same drawn curve is nose or mouth.

³ In volume 4 of TNO Alexander transcends architecture and tries to connect human beings with the universe. According to this he explains his hypothesis of the inner “I”: *“My hypothesis is this: that all value depends on a structure in which each center, the life of each center, approaches this simple, forgotten, remembered, unremembered ‘I’... that in the living work each center, in some degree, is a connection to this ‘I’, or self [...]”* [7, p. 3].

Applied to pedagogy, educational situations, such as a study at a university for example, arise from parts such as lectures, but are not composed of lectures: Lectures themselves have life, they help one another, i.e., a student will better understand a certain lecture in the context of a former or/and later one, lectures are made of centers (presentation, questions, etc.) and the whole study at a university gets its life according to the density and intensity of lectures and other centers like seminars, etc.

(5) Wholeness as a Pattern of Centers in Space

The wholeness is a type of field structure and is defined as a pattern of centers in space. Even if it is a social, action, movement and/or cultural center, there is always a spatial dimension, the dynamics are a configuration of forces in space:

"A center is not a primitive element. Centers are already composite. Yet they are the most primitive element available. They are bits of wholeness which appears as structures within the wholeness. [...] Centers are always made of centers. A center is not a point, not a perceived center of gravity. It is rather a field of organized force in an object or part of an object which makes that object or part exhibit centrality. This field-like centrality is fundamental to the idea of wholeness." (TNO, p. 118).

Especially in the last premise, the universal importance of space as a structural characteristic – used as a concept of space on a meta level, and not in a physical sense – becomes clear. Based on his professional interests as an architect, Alexander tried to find out over 20 years, why, at certain constellations, emerges the feeling of aliveness of structures and other artifacts. He has met here on fifteen fundamental properties and structural features which, in his opinion, are responsible for life.

In our opinion, that is the crux of the matter: until now, the whole pattern discussion focuses on a mere transfer of Alexander's pattern description language to other fields. Rather than dealing with his substantive conceptions, his taxonomy of patterns or pattern grammar, his description method concerning design patterns (name – context – problem – solution – forces) was copied. Therefore the discussion within the pattern community often revolves around the structure of this description, e.g. if there should be included another sub-item which shows and analyzes the interaction of forces.

With regard to the object-oriented work on patterns, for example, Alexander [3] criticizes that the format of a pattern is understood as a mere but nice vehicle of communication which allows *"to write down good ideas about software design in a way that can be discussed, shared, modified, and so forth"* (p. 74). However, as Alexander explains,

"that is not all that pattern languages are supposed to do. [...] First, it has a moral component. Second, it has the aim of creating coherence, morphological coherence in the things which are made with it. And third, it is generative: it allows people to create coherence, morally sound objects, and encourages and enables this process because of its emphasis on the coherence of created whole" [3].

We share Alexander's view: the main goal is not to make a program better, i.e. better in terms of merely technically efficient, but to make a program actually good. That means that it would be more important to think about how to implement the fifteen characteristics of life which, according to him, are responsible for

good design solutions. Certainly, this raises the question whether the properties may be transferred to other fields – such as pedagogy – at all.

The properties described by Alexander are structural characteristics of matter (here used in a philosophical sense). From our perspective, they are so general that, in the context of education, we can apply them not only to space but also to time, content and social interaction.

The use of teaching methods is not merely the application of certain techniques, but also a methodological, more or less elaborate course of instruction resulting from learning tasks, learning objectives, learning abilities of the students, the school environment etc., i.e. a lot of small parts which together form a whole, an instruction.

In this context, the number of properties does not matter; Alexander himself notes: "Throughout my efforts to define these properties, it was always clear that there were not five, and not hundred, but about fifteen of these properties" (TNO, p. 242). So we do not want to describe a certain number of properties applicable to education, our principal aim is to demonstrate

- that the spatial properties of life described by Alexander can be regarded as structural aspects of a holistic approach and should be used on a meta level for design and other fields,
- that in pedagogy, i.e. with regard to educational design, apart from spatial structures content, social and temporal aspects are very important for the learning course and process as well. In this context, Alexander's properties may be useful for the development and description of a taxonomy for educational scenarios.

2. TOWARD AN EDUCATIONAL TAXONOMY

Talking about Alexander's 15 properties and their benefits for developing an educational taxonomy, the first thing we have to do is to clear up four crucial questions:

2.1 What Do We Mean by Taxonomy?

A taxonomy is a classification schema built by a system of consistent generative principles, procedures and rules guided by a functional logic appropriate for reflecting the (assumed) mechanism of action of the classified object [9, p. 16].

2.2 Why Do We Need an Educational Taxonomy?

Pedagogy has not succeeded so far in establishing a consistent taxonomy of educational scenarios. Developing an educational taxonomy is primarily a theoretical enterprise, but it does not mean that the result itself is only important to theoreticians. If, for example, a teacher wants to design a successful lesson, it is vital to reflect in detail all the features that are necessary to achieve the desired result (cf. Figure 1). As a product, a good taxonomy should serve as a convenient and helpful tool for practical purposes to support and facilitate teaching and learning process. The process of developing a systematic classification scheme for educational scenarios itself is an important step in the construction of a new theory on education which pursues a holistic approach. As Kurt Lewin [17, p. 169] said: *"There is nothing as practical as a good theory."*

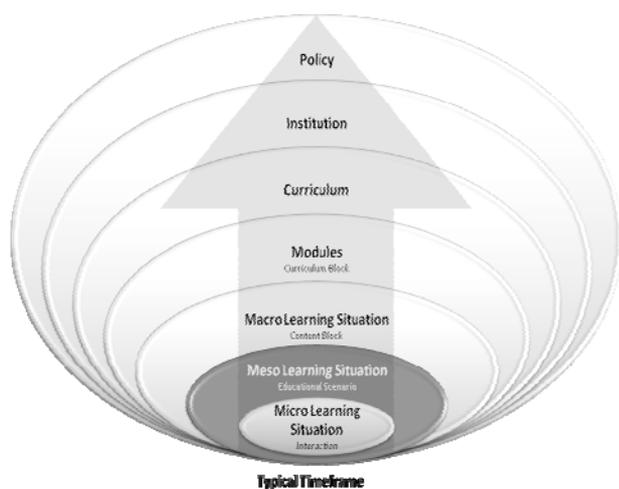


Figure 1. Hierarchical levels of an educational framework [10]

2.3 Does a Taxonomy Bolster Wholeness, Rather Than Destroy It?

In our opinion, taxonomy and wholeness are not necessarily a contradiction. The analysis of individual aspects will help to see and understand the whole. For instance, when we want to talk about the grammar of a certain (natural) language, i.e. the set of logical and structural rules that govern the composition of sentences, phrases, and words, we have to study and analyze these rules, including morphology and syntax. Then, knowing the different components and rules of the language helps to understand the system of the language as a whole. When we try to explain one kind of entity by showing it to be constructed of other different kinds of entities – e.g. a phrase is build of words – we have to realize that “[yet] all these things are themselves centers. That is why we notice them” (TNO, p. 117). With this in mind, it is comprehensible why developing a taxonomy might contribute to be aware of wholeness.

2.4 What Are the Advantages of and the Challenges with Taxonomies?

A good taxonomy has to meet the following tasks [9, pp. 17-19]:

- **Integration:** isolated phenomena are bundled into groups (Taxa); they are classified;
- **Orientation:** a taxonomy provides a consistent framework;
- **Information:** facilitates communication;
- **Cost reduction:** uniform description facilitates re-usability;
- **Transfer:** similarities become evident, main types are easier to learn, distinctions between types and variants are easier;
- **Innovation:** (so far) unknown methods and systematic frameworks come into view;
- **Heuristics:** Quest for new types (classes) are inspired (e.g. compare periodic table of the elements).

Based on the diversity of these tasks it becomes clear that the development of a taxonomy is a central desire within the continuous development and use of didactically meaningful e-learning offerings. Accordingly, already the *Best Practice and Implementation Guide* [15] suggests that “a taxonomy of pedagogies, or some examples of such taxonomies” would be

important and should be introduced as element in the IMS Meta-Data classification.

To summarize: There is no educational taxonomy for e-learning because it is missing as well an agreed classification scheme of general learning processes. There is a reason for that: In the phase of development of a good taxonomy we will be confronted with some troubles:

- **Categories:** How many and what kind of criteria should be constructed out of the infinite pool of characteristics (attributes)?
- **Operationalisation:** How to confine/delimit and how to measure the different characteristics?
- **Structuring:** What kind of attributes are to what extend decisive for a new category (new class vs. variant, version, mutation)?
- **Granularity:** Which hierarchic level has to be chosen to get a taxonomy serving the desired practical purposes?

In our opinion, Alexander’s fifteen fundamental properties which are showing the vitality of centers, might be very useful for answering these questions, and, in conclusion, for providing the development of a good educational taxonomy. In the following paragraphs we will try to demonstrate where there could be benefits for educational scenarios from exploring these fifteen properties of living centers.

3. WHAT IS AN EDUCATIONAL SCENARIO?

Talking about educational scenarios requires a short definition of this concept. For our purposes we will draw on former investigations in this realm [10].

3.1 Definition

The concept of a “scenario” is adopted from the theater or movie language. It describes the essential factors of a screenplay. The technical specification IMS Learning Design [15] which provides a language for describing learning activities in a standardized way, has applied exactly this term.

As a first approximation, we can perceive an educational scenario as a representation of an educational setting, which comprises of an arrangement (configuration) of social, spatial, content-related, and temporal variables (= action patterns). This definition includes both, abstracting unnecessary details of action situation and characterizing necessary conditions and environments for the implementation.

3.2 Why Do We Need Educational Scenarios?

We will now go into more detail regarding the second layer of the educational hierarchy (cf. Figure 1). This meso learning level (cf. Figure 2) is orientated to a certain didactical situation like “presentation”, “group work” and so on. We think that one of the biggest challenges in educational theory is to overcome these rather abstract didactical concepts. The descriptions of these scenarios are too general since these situations can be implemented in a range of different ways. There are many different kinds of “presentation” and “group work”. These abstract educational settings only indicate the predominant teaching/learning mode: The educational scenario “presentation” refers to a speaker/audience setting. Detecting the predominant

mode with regard to “group work” is more difficult: It could be a group exercise (e.g. group discussion within a lesson) or a collaborative creative act (e.g. editing a wiki page). On the other hand, detecting the predominant teaching/learning mode is not enough for the practice of educational design. That is why we need a much more defined description/notation system for the educational setting.

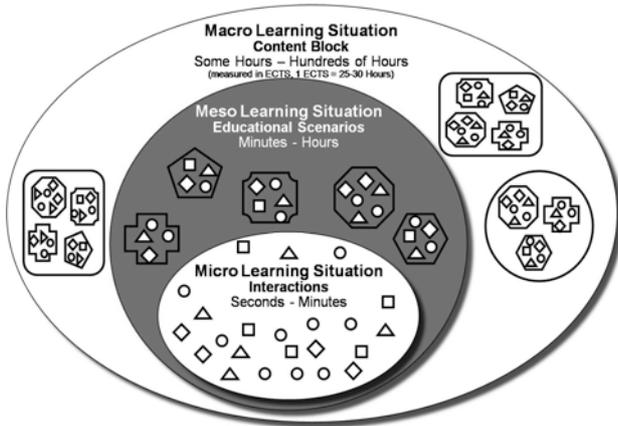


Figure 2. The educational stratification model

3.3 The Four Dimensions of an Educational Scenario

We can sum up our line of argument emphasizing the main dimensions of educational scenarios (cf. Figure 3):

- It is essential and typical that an educational scenario includes the detailed description of social interaction (How many people interact? What are their roles of interaction?), space (Within what kind of spatial surrounding do they interact?), content (What is its form of presentation?) and time (How long does each activity last?).
- It is important to understand that at this level the description of the educational setting is not determined by specific content or specific subject areas. A presentation, whether implemented in form of a talk or as a “Ball Bearing scenario” (see the following example), can be designed for any kind of subject.

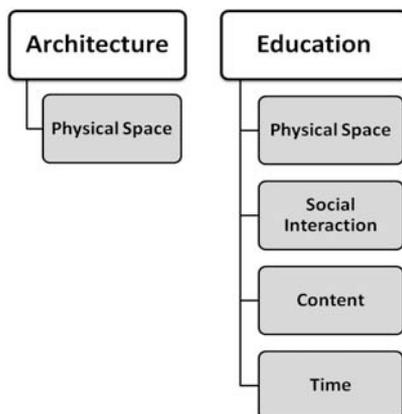


Figure 3. Four dimensions of educational scenarios

3.4 “Ball Bearing Method”: Three Possibilities to Describe One Method

In the following parts, we offer three different descriptions of the Ball Bearing method:

- **Description 1:** Ball Bearing as “pure” description of the method, i.e. without mentioning a specific context, without giving a reason using forces,
- **Description 2:** Ball Bearing in the pattern format, and
- **Description 3:** Ball Bearing as a reflection on the 15 properties.

Doing so, already the distinction between pattern and pattern description becomes very clear. Without doubt, the Ball Bearing method is a pattern, i.e. a recurrent form that fits for some reason (forces) with specific situations (contexts) and has been given a name. However, as shown in part 4, you do not have to describe the method in the pattern format. But the pattern described in part 5, raises a lot more light on the method as a whole. Finally, part 6 shows how Alexander’s 15 properties can be used to describe the Ball Bearing method.

The challenge is to describe the essence, the core of the Ball Bearing, without remaining in an isolated case, because the method should be transferable.

4. DESCRIPTION 1: CONTEXT-LESS DESCRIPTION

The “Ball Bearing method” (German: “Kugellager”) is very useful for structuring new content, exchanging information, views etc. It can be used to prevent an endless sequence of “presentations in front of an audience”. For instance, different students or groups one by one present different topics to the audience. These series of presentations tend to get boring for the audience. The activation of the students is low; many times they are just waiting for their turn to present.

To understand the specifics of the “Ball Bearing method”, this educational scenario can be explained by the following example:⁴ Students of a block inside the Educational Technology II course had to prepare and inform themselves about e-learning standards. For the implementation of the “Ball Bearing method”, at first they got informational material on ten different e-learning standards. Then, in small groups, the students investigated one of the e-learning standards. After their investigations, half the course participants formed an inner circle, while the other half formed an opposing outer circle (cf. Figure 4). The inner circle of students – and this is the reason for calling this educational scenario “Ball Bearing” – rotates one station clockwise each time a central signal is given. During a fixed time frame (e.g. five minutes), the members of the groups in the outer circle present their findings using posters, notes or even computer presentations. The outer circle remains fixed as the inner circle wanders by a central signal (e.g. a bell) to the next station. When the circle is thus completed, the participants change roles – the inner circle people switch with the outer circle people and the second half of the “Ball Bearing” process begins by repetition of the procedure just described.

⁴ “Educational Technology” was a former master’s programme at Danube University Krems. Since 2007 it is called “eEducation”.



Figure 4. Students at Danube University Krems performing the educational scenario "Ball Bearing"

5. DESCRIPTION 2: THE PATTERN FORMAT

In the following, to clarify the difference between a context-less perspective on an educational scenario, i.e. omitting the interrelated conditions in which the scenario exists or occurs, we have tried to describe the Ball Bearing scenario in form of an educational pattern.

5.1 Pattern Taxonomy/Dependencies

The following figure shows the Ball Bearing Pattern within the network of related patterns:

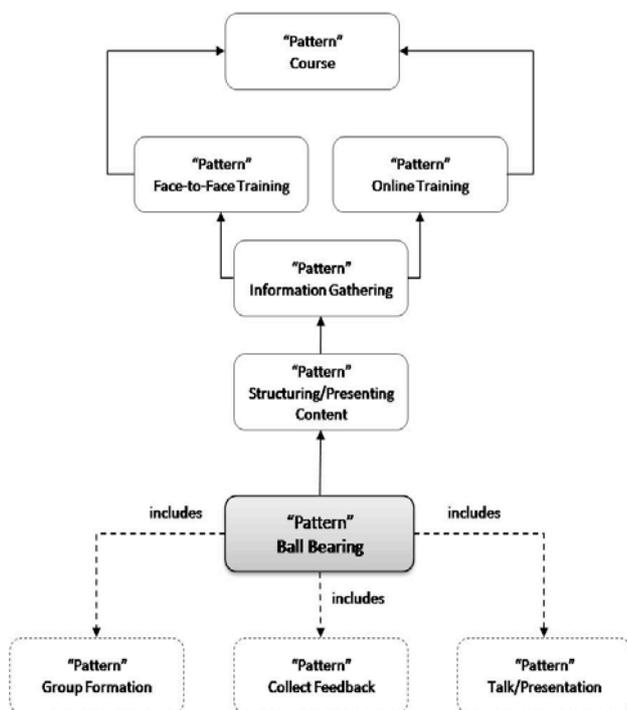


Figure 5. Current pattern embedded into a network of related patterns

5.2 Description of the Ball Bearing Pattern

For our description of the Ball Bearing Pattern we used an adopted version of the Alexandrian form, also used by other pattern subcollections [13, 14].

5.2.1 Pattern Name: **Ball Bearing**

Alias: *Double Circle, Onion, Zipper*

5.2.2 Thumbnail Picture



5.2.3 Context

In face-to-face trainings, especially there, where flexibility is required and group size oscillates between 10 and 30 students, there is a need to gather, structure, present, and learn new content.

5.2.4 Problem/Motivation

In a face-to-face training, the typical scenario includes, after an elaboration and preparing phase, an endless sequence of presentations. Normally, this causes a long period of "silence" until the last students or teams have finished their work.

Especially for teachers, such a scenario has advantages: They only have to think about special topics, to look for appropriate texts or documents if information texts are needed, to distribute them and to listen to the presentations.

The disadvantages, on the other hand, are perfectly obvious: This scenario results in a minimum of interaction, cooperation, personal experiences, observations, and exchange with peers. Frequently, there are left only a few minutes for verbal interactions when presentations are discussed. More extensive discussions are impossible. The main learning objective – from the teacher's point of view – seems to be a pure presentation of material selected by the teacher. Peer-to-peer learning is missing, i.e. learning from collaboration within the elaboration and presentation process is not an issue. The main learning objective – from the students' point of view – seems to be to find out how to fill in the time while waiting for their turn to present.

5.2.5 Forces

Time: There are not enough time resources for discussing the new information presented. Within a face-to-face training time resources for verbal interactions are strictly limited.

Feedback: Real feedback is missing because – due the lack of time – there is no way to ask questions or to express difficulties in understanding certain aspects with regard to the content.

Degree of interactivity: In the presentation phases students are only involved as active listeners. There are no possibilities either

to provide feedback on the different presentations or to discuss the content.

Output: An endless sequence of presentations in front of an audience tends to get boring. Finally, at the end of the training, most students know very well the content of their own presentation, but have not got the main information of the others, due to the monotonous chain of presentations.

5.2.6 Pattern Sequence/Solution

The Ball Bearing method is a student-centered and very economic way for structuring and presenting new content. The pattern addresses the shortcomings of conventional presentation phases within a face-to-face training described above.

Table 1 shows the sequence and the relation of the main phases of the pattern, and offers the corresponding description.

Table 1. Description of Pattern Sequence

Activity	Description
Elaboration Phase	
Create necessary space	Since the Ball Bearing session is conducted face-to-face, sufficient space has to be provided for moving in the classroom.
Provide general instructions	The teacher explains the Ball Bearing method (rotation rules etc.): There is an inner and an outer circle with two persons vis-à-vis (confronting one another) and exchanging information, views etc. After a predetermined period of time, the circles rotate in opposite directions so that different communication partners are facing one another.
Circle formation  Step 1  Step 2  Step 3	<p>First, the participants are divided into two equal groups which are provided with different texts of study. These texts are the basis for elaborating their presentations.</p> <p>After their investigations (reading the texts and structuring them by picking up the main information) the students take their notes into the circle and/or they hang their posters on the wall.</p> <p>Then the two groups form an inner and an outer circle so that they are facing each other (double circle).</p> <p>The form and the further movement bring to mind a Ball Bearing.</p>
Coffee Break	
The coffee break separates the two very different phases of elaboration and presentation from each other (boundary) and makes clear to the participants that the working mode will change. At the same time, the coffee break supports the property "positive space" (cf. Table 2).	
Presentation Phase	
Short talks 1, 2, ...	The teacher gives an acoustic signal (e.g. bell) for starting the work between inner and outer circle. Sometimes the teacher establishes conversation rules, e.g. in the opening round of the short talks only then members of the outer circle are allowed to speak and the members of the inner circle

	have to listen. After each round, the roles are changed. When the talk time is over, the teacher sounds the bell as a signal that the talks are finished. The talking time should always be the same.
Collect Feedback	
Summing up results  Step 1  Step 2  Step 3	After the completion of all rotations (the number of rotations depends on the number of texts), the activity ends and the students disband the two circles. The results and experiences can be compiled in a written form or in conversation.

5.2.7 Obstacles

Occasionally, there will arise the following situations that must be considered:

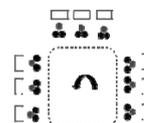
- **An odd number of participants**

Solution: More participants work together at one station.



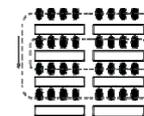
- **A great number of participants (30+)**

Solution: The large group is divided into small groups of three or four students who have to elaborate different topics and to present their results on posters. Afterwards, the small groups form one big circle. One person of each small group will stay at the poster. Now the other participants will go from station to station and listen to the presentation of the results of the other small groups. After a series of stations the members of each small group will change their role until everybody has run the whole Ball Bearing.



- **Not sufficient space**

Solution: Based on a determined seating arrangement two opposite seat rows are set. When rotating the students have to move further a certain number of places.



5.2.8 Benefits

The clear structure of this method gives the students a determined level of confidence, i.e. in a small group even quiet students have the heart to talk about a new topic. At the same time it provides extensive and varied contacts and exchanges within the pairs/group. Talking several times about the same topic will also contribute to the clarification of own thoughts. Furthermore, only changing the stations activates the students, again and again, and, in this way, active participation in an otherwise present-

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tation-centric face-to-face training will increase. The Ball Bearing is a useful method

- to overcome barriers
- to become active oneself
- to interact in the group
- to learn without a teacher (peer-to-peer learning)
- to give the students unfolding space
- to increase motivation
- to succeed together
- to have fun together.

5.2.9 Liabilities

- The teacher acts only as a facilitator and, therefore, does not always have the context control.
- This form of teaching requires intensive preparation, however, the learning success using the Ball Bearing method can be compared with 'usual' learning processes.
- By preparing the content of the lesson, it is essential to take care that contents vary and are not constantly repeated. Therefore, the teacher has to pay attention that students with the same task do not have to work together. Different contents have to be considered by forming the groups, i.e. each group has to summarize a different content.

5.2.10 Remarks for Implementation Purposes

- The number of rotations depends on the content and the students' level of concentration. Pure content-oriented impulses permit three to eight rotations/talking rounds.
- The Ball Bearing method may be used for getting to know each other (general), for making a lesson more interesting (theme-centered discussion according to rules, exchanging opinions on topics), for preparing communication (promotion and initiation). The main objective depends on the impulses by the teacher.

There exist variations of the method (cf. Obstacles).

5.2.11 Known Use

The following examples show several trainings which used the Ball Bearing for gathering, structuring, presenting, and learning new content:



Figure 6. Students at Danube University Krems performing the educational scenario "Ball Bearing" (cf. part 4)



Figure 7. YouTube-Video showing students at an Austrian higher-level secondary commercial college preparing a presentation for their Spanish conversation lesson (<http://www.youtube.com/user/RBauer65>)

5.2.12 Parameters⁵

- Primary pattern authors: Reinhard Bauer, Peter Baumgartner
- Primary pattern source: Department for Interactive Media and Educational Technology, Danube University Krems & Handelsakademie Gänserndorf (Austrian higher-level secondary commercial college)
- Pattern categories: Course type, composite, motivational
- Level of abstraction: Low
- Scope: Activity
- Primary presence type: Present
- Flexibility: High
- Level of confidence: 5/5 (The pattern has already been successfully applied in a number of circumstances.)
- Application effort: Low
- Level of expertise: Low
- Suggested assistance: none
- Target skills: Interpersonal skills, communication, collaboration
- Input: Copies of different (and complementary) texts of study
- Output: Presentation resources (e.g. posters)

5.2.13 References

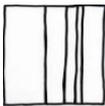
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6. DESCRIPTION 3: REFLECTION ON ALEXANDER'S 15 FUNDAMENTAL PROPERTIES

According to the four dimensions of educational scenarios (cf. Figure 3), in the following Table 2 we present our analysis results concerning the Ball Bearing method. Apart from their spatial analogy to Alexander's 15 properties we attempted to name their social, content-related and temporal dimensions as well.

⁵ For a general overview of a complete and commented list of parameters used in this pattern refer to [13, pp. 113-119].

Table 2. 15 fundamental properties of living centers and their implication for education exemplified by the Ball Bearing method [8]

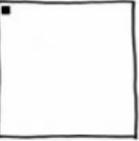
Alexander's 15 Fundamental Properties of Living Centers (TNO)		4 Dimensions of Educational Scenarios			
Name	Definition [with regard to space]	Social Interaction	Space	Content	Time
1. LEVELS OF SCALE ⁶ 	<i>is the way that a strong center is made stronger partly by smaller strong centers contained in it, and partly by its larger strong centers which contain it.</i>	Large group, Small groups ⁷	Large room, Small rooms	Poster, presentation	5 min per group, total time e.g. 60 min with 6 groups ⁸
2. STRONG CENTERS 	<i>defines the way that a strong center requires a special field-like effect, created by other centers, as the primary source of its strength.</i>	Peer-to-peer	Outer circle = Stations	Poster	5 min
3. BOUNDARIES 	<i>is the way in which the field-like effect of a center is strengthened by the creation of a ring-like center, made of smaller centers which surround and intensify the first. The boundary also unites the center with the centers beyond it, thus strengthening it further.</i>	Inner/Outer Student group	Inner/Outer circle	Headline, frame of graphs, (web-) pages	Bell = Signal for rotation
4. ALTERNATING REPETITION 	<i>is the way in which centers are strengthened when they repeat, by the insertion of other centers between the repeating ones.</i>	Presentation to all the other groups	Everybody part of outer/inner circle	Talking / Listening	5 min/5 min... 30 min/60 min ⁹
5. POSITIVE SPACE 	<i>is the way that a given center must draw its strength, in part, from the strength of other centers immediately adjacent to it in space.</i>	Peer-to-peer learning without teacher	Enough room for rotation	Intonation, white space around a graph	Coffee break

⁶ Diagrams by Helmut Leitner (GIVE Forschungsgesellschaft, Wien, Austria).

⁷ If 30 students are active in the large group during the Ball Bearing, during the phase of elaboration, the small groups should consist of more than two students. The larger is the total number of participants, the larger have to be the small groups, so that it does not become very boring. In our example there have to be six groups of five participants.

⁸ We know this is a problematic issue since, due to the jump of scale of 12 to 1. It does not do anything to bring life to the structure. This is a task on which, as a whole, we have to work and think about. The jumps between different scales must not be too great, "a center becomes most intensive in its life when other centers near it have a different size relation to it at a scale which is perhaps half its size, or twice its size – but not enormously bigger, or enormously smaller" (TNO, pp. 148 et seq.). With regard to our example, to intensify the dimension of time the jump of scale should be 2 to 1: Giving them 60 minutes of time, and forming six groups, each group of five participants will be active speakers (= teachers) for 30 minutes and learning listeners (= students) for the other 30 minutes.

⁹ Five minutes to five minutes could also be regarded as echoes. Alternating repetition may rather be perceived in the change between presentation and rotation within the Ball Bearing.

6. GOOD SHAPE 	<i>is the way that the strength of a given center depends on its actual shape, and the way this effect requires that even the shape, its boundary, and the space around it are made up of strong centers.</i>	Same group size	Sufficient room for necessary activities	Same level of difficulties and details	Adequate time frame for each round
7. LOCAL SYMMETRIES 	<i>is the way that the intensity of a given center is increased by the extent to which other smaller centers which it contains are arranged in locally symmetrical groups.</i>	Peer-to-peer work, twinning	Inner/Outer circle	1 Poster for every group	Every presentation same time frame
8. DEEP INTERLOCK AND AMBIGUITY 	<i>is the way in which the intensity of a given center can be increased when it is attached to nearby strong centers, through a third set of strong centers that ambiguously belong to both.</i>	Different roles: learner = teacher & vice versa	Circle rotation, part of inner/outer circle	Question focused on a problem (feedback/evaluation)	Fixed time schedules & personal presentation style
9. CONTRAST 	<i>is the way that a center is strengthened by the sharpness of the distinction between its character and the character of surrounding centers.</i>	Teacher vs. student groups	Inner/Outer circle	Group product vs. individual presentation, text vs. graph	60 min vs. 5 min
10. GRADIENTS 	<i>is the way in which a center is strengthened by a graded series of different sized centers which then "point" to the new center and intensify its field effect.</i>	Increasing confidence & responsibility	Different locations provide different perspectives for a general subject	Small variation of every presentation leads to growing knowledge	Sequenced repetition of learned material (e.g. forgetting curve of Ebbinghaus)
11. ROUGHNESS 	<i>is the way that the field-effect of a given center draws its strength, necessarily, from irregularities in the sizes, shapes and arrangements of other nearby centers.</i>	Individual characters of teachers/students	Every station has its individual properties	Short presentation provides rough summary	Within every time frame individual time management
12. ECHOES 	<i>is the way that the strength of a given center depends on similarities of angle and orientation and systems of centers forming larger centers, among the centers it contains.</i>	Socialization, incorporation of rules	Prototypes of a classroom adapted for specific method	Prior knowledge intensified and/or enhanced, redundancy	Repetition
13. THE VOID 	<i>is the way that the intensity of every center depends on the existence of a still place—an empty center—somewhere in its field.</i>	To concentrate/ to gather oneself	Way from one station to another	Starting the presentation with an empty poster	Recreational periods

<p>14. SIMPLICITY AND INNER CALM</p> 	<p><i>is the way the strength of a center depends on its simplicity—on the process of reducing the number of different centers which exist in it, while increasing the strength of these centers to make them weigh more.</i></p>	<p>No social distractions</p>	<p>Removing furniture</p>	<p>Simple & clear examples, to get directly to the point</p>	<p>Clear time structure</p>
<p>15. NOT-SEPARATENESS</p> 	<p><i>is the way the life and strength of a center depends on the extent to which that center is merged smoothly—sometimes even indistinguishably—with the centers that form its surroundings.</i></p>	<p>Awareness of being part of a group/a larger social system</p>	<p>Classroom as a part of larger spatial structure (e.g. school)</p>	<p>Embedded in a learning objective</p>	<p>Scenario as a part of curricula</p>

7. THEORY AND PRACTICE OF WHOLENESS: THREE PERSPECTIVES ON EDUCATIONAL SCENARIOS

Our aim is to contribute to the development of an educational taxonomy. Therefore, we argue strongly that Alexander's fifteen fundamental properties showing the vitality of centers are very helpful because they identify the character of living systems. In this context, speaking about liveliness has nothing to do with mysticism. In our language we are also used to say that a computer system is dead or alive. One is standing still, the other still reacts to its environment, it is in an exchange process with the environment, the computer system is agile. In some way, centers are the advancement of the pattern concept, i.e. a kind of theoretical superstructure. A center is basically a pattern which emphasizes a) the relation to the environment and b) the recursion, i.e. centers, which consist of centers (in the sense of inclusion, not just as a part of the whole). With regard to this, Alexander differentiates himself from his own pattern language, which is strictly hierarchical. His pattern theory was followed by a deeper theory which was looking for

"something more fundamental that was missing from the pattern language. [...] I began to notice a deeper level of structure and a small number (15) of geometric properties that appeared to exist recursively in space whenever buildings had life. These 15 properties seemed to define a more fundamental kind of stuff; similar to the patterns we had defined earlier, but more condensed, more essential – some kind of stuff that all good patterns were made of" [3, pp. 75 et seq.].

In the following we try to explain why the description of the Ball Bearing in the pattern format and as a reflection on the 15 properties are two complementary ways: the 15 properties are the substrate of all (educational) patterns and the main correlates of living structures like a teaching process. Therefore, the 15 properties must necessarily be included in the context (which requires a specific solution) and in the solution of a pattern.

There is no doubt that the description of the Ball Bearing without specification of an appropriate context is insufficient for its application, especially with regard to novices in the field of education. According to the five premises mentioned in the

introduction, only experts, i.e. experienced teachers, will "feel" intuitively whether a method is applicable in a specific teaching situation or not.

One might argue that – comparing the pattern form and the descriptions of the Ball Bearing scenario as a reflection on the 15 properties – there are no major differences. Just as Alexander's 15 properties are more than their (formal) description, the pattern form (name, context, problem, sequence/solution and forces) is much more too, namely a holistic form (solution) that fits into a holistic situation (context) which is influenced by forces (which constitute the problem). Therefore a pattern cannot be reduced only to its form. The center of attention is the pattern (the substance) and not its description. The identified pattern (e.g. the Ball Bearing) must be described somehow or other in order to provide cognition. The description of the Ball Bearing is nothing else than the "Solution", i.e. the description of a good form. The term Ball Bearing is simply the "Name". But what is a "good" form? The quality can be assessed only within a determined context because a form cannot be observed separated from the world.

The context is mandatory, since a form is only a good solution in a particular context – the Ball Bearing method is not adequate to any educational scenario. Therefore it is interesting to know in what circumstances and for what content it fits. This cannot be deduced from the 15 properties because they only describe the form, not the environment. The context is absolutely necessary for holistic views.

The problem is important because one wants to know why and for what the pattern can actually be used. The 15 properties do not give an answer to this.

The forces are important to understand why this way and not otherwise. What "forces" (what forces) a certain form of pattern for a certain situation?

Alexander's 15 structural properties help in perceiving the Ball Bearing as a balanced form. But they do not say anything about when, why and how. This is true, but therein lies the main difference: the description of the Ball Bearing method using a pattern form offers the non-expert an instruction, i.e. he or she may deduce the appropriate (practical) sequence of the Ball Bearing method for a certain context; the 15 properties help to understand the mutual relationship between the four educational dimensions (social interaction, space, content, time), and that way

they contribute to a more theoretical approach which attempts to capture the wholeness of any educational scenario.

The 15 properties could and should be reflected in the description of the pattern solution. A good staging of the Ball Bearing scenario requires

- **Levels of Scale:** a balanced group size, a balanced relation between the elaboration and presentation phase
- **Strong Centers:** there are clear phase parts and relationships between the participants
- **Boundaries:** the phases, the tasks, the groups are clearly distinguished from each other
- **Alternating Repetition:** listening and speaking phases
- **Positive Space:** personal space and freedom, e.g. for coffee breaks, time without the teacher
- **Good Shape:** the educational scenario is clearly recognizable as Ball Bearing scenario
- **Local Symmetries:** all groups and participants have equal rights, and the same time for presenting and listening
- **Deep Interlock and Ambiguity:** fluent transition between learning and teaching
- **Contrast:** clear differences in the phases: who is listening, does not present
- **Gradients:** without gradient, there could be no contrast, i.e. small variations concerning the rotation (the inner/outer circle moves on clockwise to the second/third/... position or the inner and outer circle move in opposite directions) keep the process interesting
- **Roughness:** teachers and students have their individual characters, so nothing can be forced, a certain looseness is necessary (e.g. simultaneous talks increase the noise level in the classroom)
- **Echoes:** similarity also means familiarity, i.e. the opportunity to join existing understanding or resonance, the students are able to join prior knowledge with new information
- **The Void:** combines stillness and motion, moving from one place to another the students can collect their thoughts and concentrate their mind on the next presentation
- **Simplicity & Inner Calm:** everything unnecessary has to be removed (e.g. furniture)
- **Not-Separateness:** the scenario has to be embedded in a learning objective, one of the primary characteristics of a teaching and learning situation (cf. Figure 1).

Many aspects of the 15 properties are crucial for a well-formed Ball Bearing, e.g. the coffee break or the specification of time units, etc. With regard to this, the 15 properties could be interpreted as indicators that show the difference between a failed and a lively staging of the Ball Bearing method. According to [3], by comparison to the power of the pattern language – “*patterns define relations which might be regarded as specific instances of recursive interaction of centers*” (p. 78), the overall

view of centers is helping us “*to understand what kinds of overall process can generate good structure, and which cannot*” (ib.).

To summarize, the 15 properties are that which makes up a good solution. The pattern structure is a path for telling the history of the solution. Alexander observes: “*Once we have the view of wholeness and centers, linked by the 15 deep properties, we have a general view of the type of whole which must occur as the end product of any successful design process*” (ib.).

8. CONCLUSION

Alexander is interested in design processes as much as in the end products of these processes, and he focuses on the people, and their feelings with regard to the end products, probably of the utmost interest and value for our purpose envisaged: developing an educational taxonomy, focused on the description of (already existing) educational scenarios with the aim of classifying them according to their complexity. When we transfer Alexander's concept of wholeness and living centers to pedagogy, it results in a new way of looking at educational scenarios: The important spatial, temporal, and social components used for defining an educational scenario are not separable components, but dependent aspects of a holistic teaching and learning situation.

In our point of view, the four dimensions *Space*, (*Learning*) *Time*, (*Social*) *Interaction*, and *Content* are similar to the recursive concept of centers of Alexander. The four dimensions are basically structures, repetitive and nested within themselves (cf. Figure 8), which are given regardless of the viewing scale of each didactic situation. Teaching processes are multidimensional and therefore they refuse all those attempts to isolate individual aspects. Teaching is *not a linear process*, it is a *circular* one: Teaching is made up of individual aspects, but it is a holistic event. In every single aspect each of the four dimensions is included.

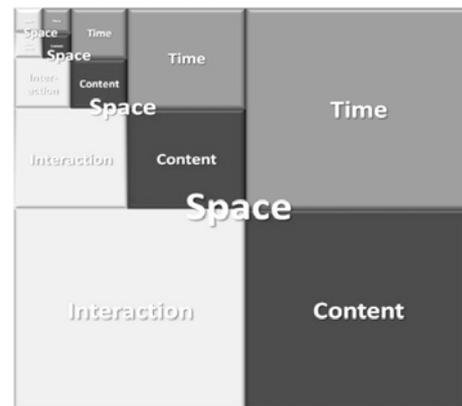


Figure 8. Recursion of the four dimensions *Space*, *Time*, *Interaction*, and *Content*

The novelty and the art of educational design, which we can learn from Alexander, are precisely to combine the different structural features in such a way that they form mutually supporting centers which allow emerging wholeness. This can lead to the following insights:

1. If we want to transfer Alexander's approach to another subject, we have to consider unquestioningly his 15 structural properties of living centers.

According to the five premises we mentioned in the introduction of this paper, there is a “sense of life”: we intuitively sense whether a design is harmonious and living, provided that we are trained to do so. The expert immediately recognizes good teaching situations, without being able to say directly (i.e. analyzing) what makes the liveliness of these situations. If we assume that a living form – a center that is a recurrent structure of a pattern – is perceived implicitly by an expert, then – in the transfer process of this knowledge – we have to pay special attention to the analytical dimensions we use. A verbal description is necessarily analytical and thus the challenge, despite the analysis and classification, is to communicate, to transfer the idea of wholeness.

We have criticized the pattern community for their – in our opinion – “sometimes hair-splitting discussions about description formalities” [8] instead of thinking about how to implement the 15 properties of life. Now we see that the discussion about how to transfer this knowledge is not a sideshow: the description fields or forces determine how much we learn about the form. Taking the Ball Bearing method: the information about for how many participants and for which content types it is useful, is included already in the form of the Ball Bearing. But this *in-form-ation* is not obvious. The description field “group size” (as a breakdown of the context) demands explicitly that this knowledge is given. The description field “context” demands more generally, that the knowledge about application scenarios is given. So, with regard to a specific pattern, the focus is primarily on issues of knowledge transfer. The 15 structural properties help us in perceiving whether the pattern is balanced and good or not.

2. A one-to-one transfer of these structural properties is not possible, because talking about space or time, for instance, we do not refer to physical space or physical time. We have to use these concepts on a meta-level. In higher education, for instance, we use the European Credit Transfer and Accumulation System (ECTS), a standard for comparing the study attainment and performance of students across the European Union. One credit stands for around 25 to 30 working hours.
3. Alexander's 15 structural properties always comprise four universal dimensions: *Space, Time, Social Interaction* and *Content*. Within this assumption the expression Content seems to fall out of alignment. What is meant by applying this concept? We guess that Content refers to the corresponding subject. In architecture, for instance, Content might refer to the special function of a building.

To sum up, we would like to point out that our first attempt to transfer Alexander's fifteen properties of living centers to educational/pedagogical theory needs to be validated, i.e. further educational scenarios must be analyzed in terms of their compatibility with the fifteen properties. The analysis of a typical educational scenario like the “Ball Bearing method” could be considered as starting point for further considerations and discussions.

9. ACKNOWLEDGMENTS

The authors want to thank their shepherd Christian Kohls for all his help and very thoughtful suggestions. We enjoyed working with Christian and we think we have not only improved our ideas for this paper but learned how to write our first pattern. We appreciate all the time Christian has invested in the shepherding process, particularly we would like to thank him for his exceptionally comprehensive written and oral feedbacks which he has provided to this paper.

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Final Version of a paper discussed at a writers' workshop at the 15th European Conference on Pattern Languages of Programs (EuroPLOP 2010), July 07 – 11, 2010, Irsee Monastery, Bavaria, Germany. This article is a preprint. It may differ slightly from the published version.

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