Designing lively learning scenarios

How to adapt Alexander's 15 spatial properties to learning design?

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In this paper we delve from an educational perspective into the theory of Christopher Alexander as presented in "The Nature of Order". In this ground-breaking four volume work, Alexander tried to develop a vision of a more humane world by exploring the phenomenon of life and its underlying processes. Inspecting natural processes, Alexander draws on his experiences in architecture and the art of buildings and finally comes up with 15 fundamental spatial properties, which – in his view – are necessary for wholeness in all living structures and processes.
From here we derive our research question: Can we use these 15 properties for lively learning structures as well? We think so, but one has to adopt theses properties to education because geometric issues do not play the same essential role in education as they do in architecture. We believe that the spatial qualities of these properties have to be converted into chronological characteristics, seeing as learning is a process over time. This paper discusses the rationale for this assumption and shows how this transformation can be done.

1. Wholeness as the central notion

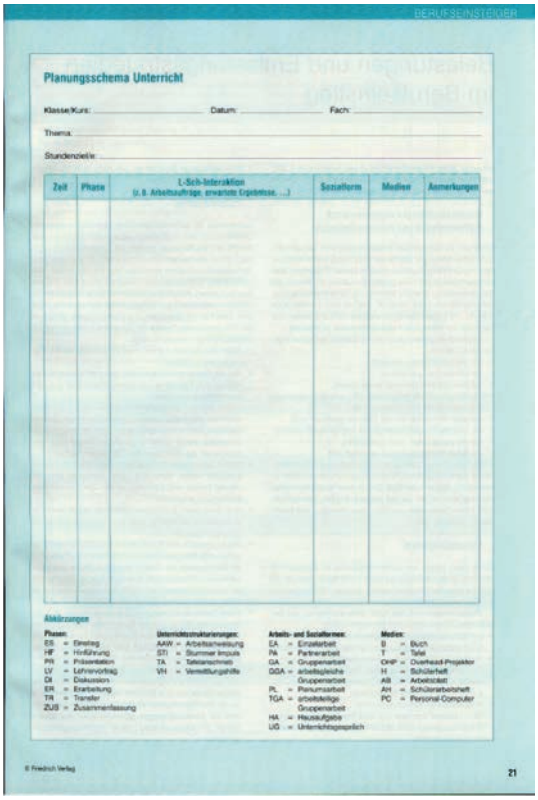
1.1. Unity: Wholeness as a relational configuration of parts

The concept of "wholeness" in Alexander's term is a central notion that he uses to understand the beauty of buildings, their degree of life and their capacity to support lively interactions between humans. Wholeness means that all parts of an architectonical structure in question (its walls, roof, garden, trees, street, other buildings etc.) are not isolated fragments but rather relate to the whole configuration. It is not the different parts that are essential but the rather the wholeness important.

From this perspective, interdependency does not only exist between parts but also to the whole structure. Parts and whole have a dynamic interplay consisting of a special kind of reciprocation of their meanings and significance: "... the local parts exist chiefly in relation to the whole, and their behavior and character and structure are determined by the larger whole in which they exist and which they create" (Alexander, 2004, p. 80).

Examples that illustrate the concept of interrelatedness between whole and part in nature abound. Many science authors discuss these holistic relationships. Here we will just mention a few works in (gestalt) psychology (Haken & Schiepek, 2010; Köhler, 1970; Koffka, 2014), physics (Bohm, 1981; Capra, 2010; Zukav, 2009) and biology (Carroll, 2005). The concept of wholeness is a central tenet in chaos and complexity theory where it takes the mathematical forms of iterations and recursions (J. Holland, 2000; J. H. Holland, 1996; Mitchell, 2009; Strogatz, 2003).

In spite of plenty scientific references, the holistic paradigm is not yet mainstream in education. In pedagogy a mode still dominates in which students have to reproduce different isolated facts and pre-service teachers are often trained to design courses in terms of serial additions of various pedagogical components. A typical example is the following (German) form sheet where teachers-in-training have to plan their lessons in a serial timeline, adding different educational components one after the other. There is no instrument or tool to help pre-service teachers to plan a holistic design, e.g. to relate the different building blocks to each other and to the special class with their varieties of students, to their overall learning goals respective to the framework curriculum and vice versa.



Planungsschema Unterricht

Klasse/Kurs: Datum: Fach:

Thema:

Stundenziel/e:

Zeit	Phase	L-Sch-Interaktion (z. B. Arbeitsaufträge, erwartete Ergebnisse, ...)	Sozialform	Medien	Anmerkungen

Abkürzungen

Phasen:
EE = Einstieg
HF = Hinführung
PR = Präsentation
LV = Lehrervortrag
DI = Diskussion
ER = Erarbeitung
TR = Transfer
ZUS = Zusammenfassung

Unterrichtsstrukturierungen:
AAW = Arbeitsanweisung
(ST) = Stummer Impuls
TA = Tafelanschrieb
VH = Vermittlungshilfe

Arbeits- und Sozialformen:
EA = Einzelarbeit
PA = Partnerarbeit
GA = Gruppenarbeit
GGA = arbeitsgleiche Gruppenarbeit
PL = Plenumsarbeit
TGA = arbeitsteilige Gruppenarbeit
HA = Hausaufgabe
UG = Unterrichtsgespräch

Medien:
B = Buch
T = Tafel
OHP = Overhead-Projektor
H = Schülerheft
AB = Arbeitsblatt
AH = Schülerarbeitsheft
PC = Personal Computer

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Fig.1: Form sheet for pre-service teachers (Böhmann & Klaffke, 2010, p. 21)

1.2. Unity: Wholeness as a different mode of consciousness

In the above example, wholeness is still thought in the traditional analytical way: different parts are connected and interrelated to each other to form a unity. Wholeness is formed by a bunch of (formerly) isolated elements. As the order, structure and characteristics of these relationships are not embedded in the parts themselves the famous quote ascribed to Aristotle gains its significance: "The whole is more than the sum of its parts".

But it is important to see that an analytical mode of consciousness constructs this kind of wholeness: wholeness still consists of different parts or components held together by likewise different elements of connections which function as a kind of glue in order to create unity. Both building blocks and relationships are just elements to support the whole unified structure. "But the unity of this 'unity in multiplicity' has the quality of uniformity, and hence it is static and inflexible. In this mode of consciousness we refer to *reducing* multiplicity to

unity. This is the mechanical unity of a pile of bricks, and not the organic unity of life." (Bortoft, 1996, p.83f.)

An holistic (educational) scenario should not be understood as extensively consisting simply of different building blocks "glued" together, but rather as a unique situation which cannot be divided into different isolated pieces or elements. The variety of situations unfolding from each other has to be understood intensively as an inseparable 'multiplicity in unity'. Bortoft explains the different modes of seeing, referring to the distinctions between photographs and holograms. Dividing a conventional photo results in two different objects each containing a different part of the original picture. Whereas dividing a hologram also results in two different material objects but the whole picture is optically reconstructed through each part; "there is One hologram optically (the One which is many) because each is the very same One" (Bortoft, 1996, p.86).

The wholeness of the photo is 'unity in multiplicity' as it exists after the divi-sion of different pictures. The different parts put together (correctly) generalize the various parts to one whole. In contrast, the wholeness of the hologram is 'multiplicity in unity' because even after the division, the One whole picture exists throughout all the parts and is universal to all the different parts.

Coming back to the design of educational situations: We cannot trust that wholeness unfolds with the accumulation and integration of different pedagogical or didactical elements in the way that a lively architectural structure is built just from diverse elements. To support lively interactions between humans in architecture as well in education we need a change of consciousness. Instead of assembling building blocks to achieve general goals we need to strive for universal principles of liveliness. But what are those universals and how can we work with them?

2. The paramount importance of centers

2.1. Centers as geometrical structures in space

Alexander calls the entities from which wholeness originates "centers". It is im-portant to understand that these centers are not just given entities or parts but are created by the wholeness themselves (Alexander, 2004, p. 83/84). With a single dot in an otherwise empty sheet of paper Alexander gives us a proto-typical example of wholeness and how it creates centers. The dot divides the empty space in the rectangular sheet of paper into 20 different overlapping segments, zones or entities like the sheet itself, the dot, the halo around the dot, different rectangles trapped by the dot, the corners, a system of relationships (imagined "rays") to all these different configurations. The rectangles and rays are not really

drawn by a pencil in the way that the dot is plotted, but they are created by the wholeness, by the relation between dot and sheet of paper (Alexander, 2004, p. 81/82). For Alexander, the "center" is not only one of the 15 properties but the most important one. Wholeness originates from centers and centers are therefore of paramount significance.

For Alexander and his purpose of architectural design, centers are – on an abstract level – mainly geometrical structures in space created and supported by the wholeness of the complete "arrangement" of their parts (shape and pattern of buildings, rooms, streets, furniture etc.). But what are centers in education? This is a crucial question, as all the other 14 properties are dependent on this starting point.

When we inspect the learning scenario in the photograph (figure 2: next page left) we will note different centers. We can overlay the photograph with a sketch outlining these centers and how they relate to each other (figure 2: next page right). But these are just geometrical drawings overlaid on a photograph in order to outline the spatial centers in this picture. Similar to the famous drawing of the Belgian surrealist painter René Magritte ("Ceci n'est pas une pipe"), which presents not a pipe but a *picture* of a pipe, the above photograph is not a learning situation but a photograph of a learning situation. The sketched elements capture the center and their relationships of spatial configuration in the picture but not the forces of the social situation.

But centers created in space from geometrical structures are for Alexander only the explicit and obvious *visible* centers. Others – like biological or social centers – are latent or hidden but nevertheless influence human behavior (cf. Alexander, 2004, p. 90).

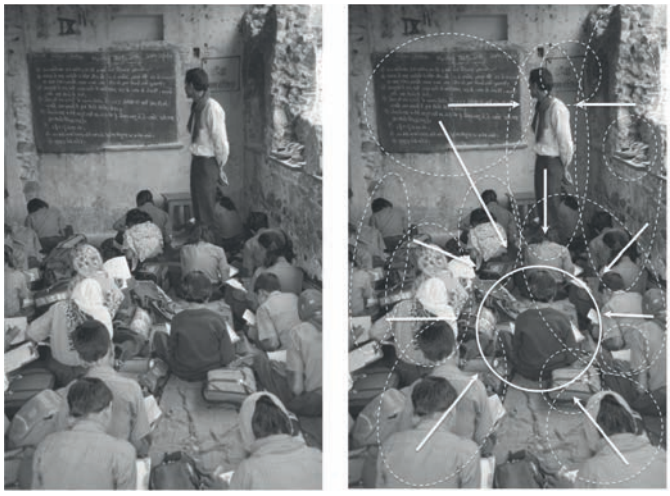

Fig 2: Field of forces in the photograph of a learning scenario (Bauer 2014, p.225)

2.2. Centers as social structures in time

When we take the form sheet for pre-service teachers and fill in the necessary categories to describe the learning situation captured by the photograph, we get in the far-left column a time span (let us say for instance 20 minutes), "lecture" as the characteristic phase, "silent input" for the teacher-student interaction, "plenary assembly for the social form and "black-board" for the used media. We could add some remarks in the last column like the subject of the lecture for example.

But this description would be a very static one, as we would not have expressed the whole-ness of the arrangement of the situation and their parts (teacher, students, room, technical equipment etc.). It freezes the dynamic situation into one specified schema that would be better presented by the above photograph or by a sketched configuration of the planned learning situation. And if we continue this line of reasoning, then a video or a sequence of sketches like a comic book would be even better for representing the dynamic and different relationships between all the elements that may be relevant for lively learning situation.

But even if we capture all the mentioned relationships we are only scratching the surface, as these are only the eye-catching centers. There are other centers which are more latent or hidden, such as students' and teachers' prior knowledge, skills and competences, and their know-how to shoulder responsibility for their own learning experience etc. In "Taxonomie von Unterrichtsmethoden" (taxonomy of teaching methods) Baumgartner (2011) listed 26 educational dimensions that can be – in the light of Alexander's theory – understood as possible centers for education. Most of them are obvious (like subject [of study], cognitive process, feedback modus, learning challenge, number of learners) but some, for instance the type of relation between teacher and student (dominant, critical, impersonal, faithful, trusting...) are only implicitly existent but nonetheless have an impact on learning outcomes.

As a consequence of this line of thought, we not only lack a vocabulary of cen-ters to descri-be lively and dynamic learning situations but also lack a mode for representing them and working with them. Language – as Susanne Langer (1957) noted – has some disadvantages to other forms of presentation: Verbal speech is inherently sequential as one word or sen-tence follows the other like clothes on a laundry line. Therefore we can only verbalize those thoughts that we can confine to this limitation. For synchronicity of concurrency we need other means of expression. A famous example of the restriction of language is described by Gregory Bateson when he quotes how the famous dancer Isadora Duncan answered the question of what one of her performances meant: "If I could tell you what it meant, there would be no point in dancing it." (Bateson, 2000, p.137 and 464)

For the purpose of educational design we propose defining centers as learning activities in time, created and supported by the wholeness of the arrangement of their parts (shape and pattern of learning activities, teacher, student, room, technical equipment etc.). To communicate the art of learning design we would need not only a special (technical) vocabulary but also a mode to capture chronological dynamics. Our point of view is that we would need to elaborate a special notation similar to a musical score in order to better support ourselves to teach (and learn) how to design lively learning scenarios.

2.3. About the relationship of centers and properties

In observing the processes of nature, Alexander came up with 15 properties essential to creating liveliness. "... [T]hey make things have life, *because* they are the ways in which centers can help each other in space" (2004, p. 145) The properties in education can also foster liveliness in learning activities. Centers are of paramount importance whereas properties are subordinate to them and serve to help centers create life.

Alexander's 15 properties are not a rigid and fixed set of characteristics. "The precise number fifteen is not significant. But I do believe that the order of magnitude of the number is significant. Throughout my efforts to define these properties, it was always clear that there were not five, and not a hundred, but *about* fifteen of these properties. ... There is no certainty that this list is exhaus-tive." (2004, p. 242)

In the same way that the educational dimensions in the "Taxonomy" (Baumgartner 2011) are important "... the fifteen properties are not essential in themselves. What matters in the end is the life of the centers. The importance of the properties is simply that they help you to understand the way that centers come to life." (Alexander, 2004, p. 242, footnote)

3. Teaching as a design science

3.1. Learning design situated in the no man's land between science and art

Historically seen, these 15 properties did not come out all of a sudden with the publication of "The Nature of Order" but are in an embryonic form implicitly embedded in the former work of Christopher Alexander. The "Nature of Order" is just the consequential continuation of his earlier work. If this assumption is right, then the "quality without a name" (QWAN) as well as the pattern language idea are linked to the 15 properties (Alexander, 1978, 1980). As it has turned out, pattern languages are of value not only for architecture but also for software development, human-computer interface design, organisational development, and

project management. Given this, we draw the conclusion that they could also be valuable for education if we see teaching as a design science as well.

As different as they are, the various fields mentioned above all have in common that they are situated in the no man's land between science and art. Even if there are some important rules to follow, these are not sufficient to guarantee the creation of liveliness of wholeness in the Alexandrian sense. All of the above-mentioned applications try to design something in their environment: space (architecture), programme structures (software development), interaction (human-computer interface design), communication (organisational development), collaboration (project management), and learning (education). To use a concept of mathematics: Design is the least common denominator of all of these different application fields.

If teaching is essentially learning design, then it can indeed be understood as kind of design science: "Teaching is changing. It is no longer simply about passing on knowledge to the next generation. Teachers in the 21st century, in all educational sectors, have to cope with an ever-changing cultural and technological environment. Teaching is now a design science. Like other design professionals - architects, engineers, town planners, programmers - teachers have to work out creative and evidence-based ways of improving what they do." (Laurillard, 2012)

3.2. Chronological versus spatial configuration

In the work of Christopher Alexander, geometry and its relation to space are of paramount importance. In order to transfer the 15 properties to education one has to find an analogy that is theoretically justified and provides a coherent way of designing for the very different domain of education. We believe that "time" (instead of space) could be this central concept for learning design, e.g. for the design of learning scenarios. This assumption is on the one hand supported by the space-time continuum hypotheses of the theory of relativity. The design of educational scenarios is on the other hand closely related with the time flow of learning activities.

In educational theory, the planning and designing of different learning activities following each other in a methodologically sound way is called the choreography of teaching. In that sense, teachers have to orchestrate educational variety in order to achieve a planned learning outcome. Planning chronological sequences of learning activities is the central aspect of educational design. The paramount importance of the notion of the "center" in the theory of Alexander can be translated to address the crucial impact of learning activities. In our approach to education, the notion of the"living center" in the Alexandrian sense is

translated into the "living learning activity" and the design of spatial configurations to create liveliness and wholeness for buildings is translated into education design focused on the temporal configuration of learning activities.

4. Proposal for 15 teaching principles

The following table names and describes in column [A] and [B] the 15 prop-erties that Christopher Alexander found in nature and applied to architecture. In column [C] we try to interpret how these properties could be translated to teaching.

Our interpretation should be understood with two restrictions:

1. Our focus is oriented toward teaching as a design science, which is just a small part of education at large. It does not concentrate on the self-determined learner, as it does not zero in on informal learning.
2. We try to provide some ideas for a livelier teaching scenario and do not try to promote any critical alternatives to our educational system.

Our aim in this article is therefore a limited one: Instead of a revolutionary ap-proach to promoting change of the whole educational system, we settle for a more modest approach of outlining some teaching strategies for better learning design at an intermediate level to help teachers in designing livelier (and we believe: therefore better) learning scenarios.

Tab.1: Overview of the translation of the 15 space-properties to time-properties

[A] Name	**[B] Quotation**	**[C] Interpretation: teaching principle**
[01] Strong Center	[D]efines the way that a strong center requires a special field-like effect, cre-ated by other centers, as the primary source of its strength.	Strong centers in architectural design are learning activities in educa-tional design. The recursive definiti-on of strong centers in education is realised through the field-like effect of learning activities: Each learn-ing activity influences the semantic of the chronologically following one but at the same time draws its own me-aning from the previous one. Learning activities have a time related field-like effect.

[02] Level of Scales	[A] 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.	There is an inclusive hierarchy of different levels of educational de-sign. Different time scales of learning activities sort these layers. **Example**: At the "lowest" level, we can define "educational interac-tion" which covers the learning time span of seconds to minutes. The next level is "educational scenarios" with learning activities from a few minutes to about an hour. A "higher" level (e.g. layer with a longer time frame) includes all the "lower" levels. Every level has its own rules and laws which must be taken into account (cf. Baumgartner, 2011, p. 64pp.) – More in the next (concluding) chapter of this paper. From these observations follows the design **rule**: Observe the appro-priate level of scale for the chosen time-frame of the learning activity. Choose coherent properties in group sizes, content material, complexi-ty of tasks – Vygotsky's zone of proximal development (Vygotsky, 1978) – time lag, as well as details and elaborateness of feedback etc
[03] Boundaries	[A] way in which the field-like effect of a center is strengthened by the creation of a ring-like center, made of a smaller center which surround and intensify the first. The boundary also unites the center with the centers beyond it, thus strengthening it further.	Teachers should design boundaries between different learning activi-ties in such a way that they provide additional surplus value for learn-ing opportunities and help the teachers to strengthen their adjacent (before and after) learning activities. **Example**: If you are changing from one learning activity to another explain the significance and congruity of the fact that these two learn-ing activities follow each other. The boundary itself becomes a transi-tional phase with educational value of its own because it does not only limit one activity and start the next one but links the two consecutive phases together. **Rule**: Design boundaries in way that they are centers themselves so that they can provide additional learning opportunities and/or strengthen the chronologically surrounding learning activities.

[04] Alternating Repetition	[A] way in which centers are strength-ened when they re-peat, by the insertion of other centers be-tween the repeating ones.	Repetition is a very important learning and teaching strategy. But in order to provide diversion, do not repe-at the same activities many times. Always to rerun the same type of exercise over a long period gets boring. Insert other activities between the repetitive sequences in such a way that they strengthen the replication as well as each other. **Example**: In mathematics, for instance, let learner solve the same type of equation not only with different parameters but also asking for different parts of the equation as unknown variables. (cf. „Roughness" and „Echoes"). At a meta level this principle could also be interpreted as an alternat-ing repetition of different cognitive levels, e.g. an alternating repetition between reception and self-determined activities. **Rule**: Design repetitive sequences in more complex ways, such that the same type and modus of repetition do not follow each other but alternate with a different kind or modus of activity.
[05] Positive Space	[A] way that a given center must draw strength, in part, from the strength of other centers immediately adjacent to it in space.	Positive Space is translated to Positive Time. Design consecutive ac-tivities in a way that they support each other. Change or add some elements to the later learning activity so that they can support the learning effect of the previous one. **Rule**: Think about the following learning activity not only in its own right but also as a way of supporting and strengthening the effect of the previous activities. And vice versa: Think about an activity not only in its own rights but also as foreshadowing and introducing the next one.
[06] Good Shape	[A] way that the strength of a given center depends on its actual shape, and the way this effect re-quires that even the shape, its boundary, and the space around it are made up of strong centers.	Design all activities with an appropriate time frame at an appropriate time in the learning sequence with respect to different levels of time scales (interactions, scenarios, modules, courses) but also with respect to their assessments and proven learning outcomes. **Rule**: Design timely coherent learning activities in such a way that they fit to their overall learning goal and intended learning outcome. Plan a coherent fit between all learning activities including testing and assessment phases in order to reach the intended learning outcome.

[07] Local Symmetries	[A] way that the intensity of a given center is increased by the extent to which other smaller centers which it contains are themselves arranged in locally symmet-rical groups.	Design learning activities with local symmetries. A more time-consuming activity (an activity of a "higher" time frame) is supported and strengthened by shorter similar activities. **Example**: The learning outcome of a relatively long keynote in the morning of a conference can be supported and fostered with a series of shorter talks in different tracks of the conference in the afternoon. **Rule**: Design learning activities such that they form local symmetries as a strategy to understand better the overall learning design and to help learners to develop their own rhythm.
[08] Deep Interlock and Ambiguity	[A] way in which the intensity of a given center can be in-creased when it is attached to nearby strong centers, through a third set of strong centers that ambiguously belong to both.	The effect of two learning activities that follow each other can be increased with a third activity which is included between them in such a way that it belongs ambiguously to the other two. **Rule**: Link two consecutive learning activities with a third one in such a way that there is a smooth transition and crossover of the different learning activities. (cf. the difference to "Boundaries")
[09] Contrast	[A] way that a center is strengthened by the sharpness of the distinction between its character and the character of sur-rounding centers.	Design appreciable contrasts for different kinds of educational dimen-sions. This does not only mean different subjects or different ap-proaches to certain subjects, but also a contrast of number of learners (plenum assembly, group work, single person working) seatwork vs. working in motion (mobile learning), type of tasks, type of learning mode (receptive, imitating, resolving, exploring, constructing...), type of supporting tools etc.). **Rule**: Design learning activities in such a way that their underlying learning targets are strengthened by the sharpness of the distinction between their different types.

[10] Gradients	[A] way in which a center is strengthened by a graded series of diffe-rent-sized cen-ters which then "point" to the new center and intensify its field effect.	Employ educational interventions of gradually different effect sizes. **Example**: Delegate for instance step-by-step res-ponsibility to the learner in their consecutive learning activities and follow the strategy of phased withdrawal of your own interventions ("fading"). Let novice teacher students give part of a lesson for a class, intermedi-ate students the full lesson and ad-vanced students complete responsi-bility for the whole semester including grades. This is the concept of "legiti-mate peripheral participation" (Lave & Wenger, 1991). **Rule**: Design learning activities in such a way that they approach the planned learning outcome in a step by step, systematic and construc-tive manner.
[11] Roughness	[A] way that the field effect of a given center draws its strength, necessarily, from irregularities in the size, shapes and arrangements of other nearby centers.	Include small changes, or vary slightly different educa-tional dimen-sions (cf. "Alternating Repetition" and "Echoes"). **Example**: In mathematics, for instance, let the learner solve the same type of equation not only with different parameters but hide the prob-lem with different text statements (cf. „Alternating Repetition" and „Echoes"). **Rule**: Design repeated learning activities in such a way that they are never exactly the same.
[12] Echoes	[A] way that the strength of a given center depends on similarities of angle and orientation and sys-tems of centers forming characteristic angles thus forming larger centers, among the centers it contains.	In repeating activities, emphasize different aspects or accentuate different educational dimensions. **Example**: In mathematics, for instance, in a series of calculations change not only the resolving variable of an equation (cf. "Alternating Repetition" und "Echoes") but request different solution strategies (cf. "Alternating Repetition" and "Echoes"). **Rule**: Emphasize variation of the same learning activity in such a way that they still have the same outcomes but need different angles and orientations for their solution.

[13] The Void	[A] way that the intensity of every center depends on the existence of a still place - an empty center - somewhere in its field.	Breaks are themselves a special kind of learning activity: People come together and talk informally about their last learning activities. But not only breaks are meant here: Provide opportunities for "cogni-tive breathing" so learner can think trough a problem individually at his or her own pace. **Rule**: Design cognitive breaks in such a way that they support the other learning activities.
[14] Simplicity and Inner Calm	[A] way the strength of a center depends on its simplicity – on the process of reduc-ing the number of different centers which exist in it, while increasing the strength of these centers to make the weigh more.	Avoid distractions and diversion in the learning path. Design basic learning activities which are easy to carry out and elementary in their learning outcome. Prevent distraction just to activate students. **Example**: Playing a bingo game with essential concepts during a talk encourages the learner to focus just on the words or notions on their papers and not on understanding the essence of the lecture. **Rule**: Aim at the intended learning outcome in a simple manner and prevent overly complex and distracting learning arrangements.
[15] Not-Separateness	[A] way the life and strength of a center depends on the extent to which that center is merged smoothly - sometimes even in-distinguishably - with the centers that form its surroundings.	Design the flow of learning activities methodologically to be sound and smooth without edges, wrinkles and interruption. (cf. „Bounda-ries" and „Contrast") in such a way that the separation between learn-ing situation can be overcome easily. Avoid artificial learning situa-tions which are difficult to translate into real life ones. **Rule**: Choose learning activities which are natural and fit into life (long learning).

5. Concluding remarks

5.1. Properties are important but only as long as they support centers come to life

From the significance of the number and gestalt of the system of properties in relation to the much more important centers and the wholeness of a lively learning situation, all properties have to be revised critically. For instance on the one hand it seems to us that the properties of "alternating repetition", "roughness" and "echoes" describe almost identical ways in which centers can be supported in order to embody more life. Perhaps we could merge them into one property called "variety" or "diversity". On the other hand some im-

portant other properties are missing, such as other ways to strengthen educational centers such as "rhythm" (= variation of the length and accentuation of the series of events in such a manner that a regular recurrence or pattern in time develops cyclical phenomena having a periodicity or frequency). Another missing property could be "progression" (= an individual's movement from unknown to known through the stages of education and/or training).

But here we will not go into the details of an educational discussion of every property. For us it was important to show that we can transform principally space-dominated characteristics from process that are based in architecture and natural processes into time-dominated characteristics of learning processes. But we have to caution the usefulness of our work, as "the fifteen properties are not essential in themselves. What matters in the end is the life of the centers. The importance of the properties is simply that they help you to understand the way that centers come to life." (Alexander, 2004, p. 242, footnote)

5.2. Level of scale: Exploring one of the properties for learning design

Even if do not go into the details of every property, we want to show using one example what can be said of one Alexandrian property after we have adapted it to teaching. Here, we have chosen the property "levels of scale" and will compare its appearance in education with how it appears in architecture and nature, hoping to generate some ideas of the mode and manner of this translation.

A good introduction into the natural occurrence of levels of scale is given by Jenny Quillien (2008):

"All life tends to form multi-leveled structures of systems within systems. At one level, say, in an animal or plant, there are cells which obey certain laws, then there are aggregations of cells obeying different laws and creating new wholes, and then aggregations themselves form larger aggregations, again with new laws. From cells to tissues to organs to organisms to social systems to ecosystems – new properties emerge with each new level of complexity. The different nested levels 'help' each other, perform different tasks, and are necessary to the functioning of the whole. The characteristics of the whole come from the organizing relations of the parts" (Quillien, 2008, p. 16).

In Alexander's view, spatial structures "exist at a series of well-marked levels, with definite jumps between them" (2004, p. 145). In our conviction the ques-tion is not **if** there are levels of scale but if there is an **appropriate range** of levels of scale to support the centers. It is necessary that "the jumps between different scales are not be *too* great", that they have a certain proportion which – according to Alexander – lies around the ratio 2:1 or 3:1 (2004, p. 147f.).

Fig. 3: Entry doors with different levels of scale. Left door: The levels of scale do not really work, their propor-tions seem not be adequate. Right door: Here the levels of scale seem to work because of different propor-tions. (Internet photos from public relations material of door manufacturers.)

In education we have the idea of action levels where for each different strata rule there is a different kind of social law. This – as already hinted at in the quote by Jenny Quillien – is motivated by the philosophical premise that the real world is structured hierarchically into different layers. Philosophers like Nicolai Hartmann and Michael Polanyi have argued that each of these distinctive strata follow characteristic laws (Hartmann, 1964; Polanyi, 1974).

A water molecule, for instance, contains one oxygen atom and two hydrogen atoms and behaves completely different as their individual atomic components. Water as a chemical substance form an even higher-level stratum as H_2O molecules has properties (like liquidity), which cannot be found on the molecule tier. You cannot take out just one molecule and describe it as liquid The philosopher John Searle uses the vocabulary "caused by" and "realized in" to address these different levels (1983, p. 269f.; cf. the detailed resume in the context of the ontological aspect of tacit knowledge by Baumgartner, 1993, pp. 185–193). It is the specific relation of their (lower-level) parts which generates the new attributes of the (higher-level) compound chemical substance, a process designated with the philosophical notion of "emergence" (Bedau, 2008; J. Holland, 2000; Johnson, 2002; Stephan, 2005, 2006).

In a holistic or monistic worldview, the same idea, which is valid for physical objects, has to be applied to the realm of the humanities and social sciences as well. It follows that there is also a hierarchy of (educational) interaction level in which the specific laws of each of theses

tiers can be observed. This is especially important for planning and designing (learning) interactions because many teachers mix these different levels inadvertently:

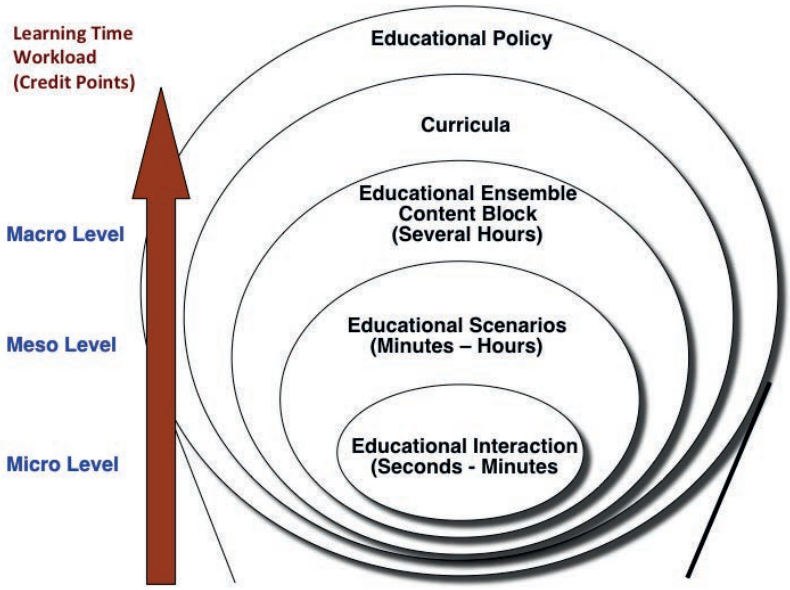

Fig. 4: Inclusive hierarchy of different levels of scale of educational interactions (Baumgartner, 2004).

Figure 4 not only shows the different levels but also their distinguishing "learning time", which is generally very different to physical time. It means "learner workload" in EU parlance and is measured in ECTS (European Credit Transfer and Accumulation System) or ECVET (European Credit System for Vocational Education and Training). It functions as a standard for comparing the achievement and performance of learners.

The policy layer clearly has a completely different set of laws to observe, most of them not even belonging to the educational domain. The curriculum layer is important for planning and designing curricula for formal education, which underlies special laws in combining different courses to build up certified competences. For educational design purposes in particular, the levels of the "educational scenario" and the "educational ensemble" are especially interesting and theoretically rewarding. The laws that govern these two levels are still debated in educational discussions. As these two layers are educationally very important, most of the books on teaching methods are dedicated to explaining their laws and how to designing situations which are pedagogically sound and effective (z.B. Becker et.al., 2007, Grell & Grell, 2010, Meyer, 1984 und 1997). According to our definition, these two levels of scale are defined as follows:

A **Scenario** is defined as an educational setting with a time frame of several minutes to about one hour of learning time. It describes an educational arrangement designed or set up to provide a methodological educational unit. This action level creates didactic driven units under the aspects of time, space and social configuration.

An **Ensemble** is defined as an educational setting with a time frame of about one hour to several hours of learning time. It describes the learning goals for a specific subject and the formation of different scenarios for reaching the specified learning target. This action layer creates thematic driven units under the aspects of scenario configurations.

Comparing these two definitions, you will find a special relationship between them: The "higher" educational action layer contains the "lower" layer. All the proposed action levels therefore form an inclusive hierarchy; the "lower" layers are included in the "higher" ones.

It is important to understand that the proportions in teaching scenarios between the layers are very different (bigger) than they are in spatial configurations. But keep in mind that levels of scale also operate inside the above-mentioned layers: One does not have to take into account just the separated building blocks but their relationship to the wholeness of the educational goal, learning outcome or teaching strategy. The obvious and clearly discriminable teaching methods form chronological sequences (progressions), and cyclical rhythms (temporal patterns) which themselves support centers and develop the whole but are also created by it. In a similar way there are different levels of scale in the pattern language by Christopher Alexander: region, town, community and neighborhood, public land inside the community, private land inside the neighborhood, configurations of buildings, buildings and their rooms, garden and paths between buildings, small rooms and closets inside rooms, configurations of construction material, detailed construction, details of color and ornaments (Alexander, 1978). All of these different levels of scale consist of different levels of scale in themselves in a recursive manner. For instance, each ornament contains different appropriately proportioned levels of scale to form a lively ornament which itself supports other centers on a higher level of scale (e.g. a wall or a door).

Here you can see a different way of judging a lively structure: One does not fo-cus on the design of isolated entities but on the interactive relationship between them as well as with their collectivity, their total configuration or wholeness. This is a very different approach in training of teachers than is implemented when using the form sheet shown in Fig.1. And here we can see the importance of the properties:

"It takes years – perhaps three, five, ten years – to learn the process of making centers, and to know what it means to make a center come to life [e.g. to become a good teacher; our insertion]. In the meantime, the properties are a very useful tool; they are a way of focusing our attention on the centers. By following the properties, even if blindly, like a mechanical tool, we gradually come to know more and more and more about the life of centers – we appreciate the way that centers interact, we learn to make the life of one center more intense, by adding, or providing other centers – and the property thus teaches us, concretely, more and more about how we can make centers come to life. That is the whole ball game in the end" (Alexander, 2004, p. 242, footnote).

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