Towards a Pattern Language for Lecture Design: An inventory and categorization of existing lecture-relevant patterns

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Lectures are a common way of teaching in many universities, independent of the general effectiveness of this instructional method. Designing good lectures is a challenging task, and many lecturers struggle with the question how to improve the design of lectures and how to minimize the disadvantages of this instruction method. Educational patterns, as applied by successful lecturers, offer answers to these questions. But these patterns are described in multiple and unrelated publications, which makes finding and using them difficult.
In this paper we make an inventory of lecture-relevant patterns from the existing literature on pedagogical patterns and begin with their categorization. The goal of this work is to help lecturers finding relevant patterns that help them designing their lectures and to provide first steps towards a pattern language for lecture design.

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1. INTRODUCTION

We probably all remember situations when we nearly fell asleep during a lecture or felt the urge not to pay attention to the lecturer anymore. On the other hand, most of us had (hopefully) also experienced lecturers who were fascinating, attention attracting, and mind-opening. So there certainly is a difference in giving lectures, there are lecturers who do a better job than others. The interesting question is: What is it that makes some lecturers more successful and how can their knowledge and lecturing strategies be shared so that other people can benefit from it?

One could argument that the solution to this problem would be the abandonment of lectures. And indeed, the efficiency and effectiveness has been questioned and alternatives are discussed, e.g. in [Gunderman 2013; Grissom 2013; Christensen and Corry 2012]. But even though the disadvantages are well known, lectures are still a common method of instruction in computer science education and used by many universities. The main reason is probably that using lectures seems to offer a better knowledge transfer revenue per teacher, as the teacher-student ratio is more advantageous compared to other instruction methods. With a lecture, student groups of larger sizes can be instructed, sometimes even very large groups. Therefore, beside all discussion, lectures will very likely still be given over the next years and the challenge remains: how can we benefit from good lecturers in a way that helps others to improve the design of their lectures too?

One way of describing such looked-for good practices are educational design patterns. In the rich and growing body of literature on these patterns can be found answers to the previous question. Some of the published patterns are covering general didactic aspects like feedback, active learning, or how to handle different learning styles (e.g. [Larson et al. 2008; Pedagogical Patterns Editorial Board 2012]) . Others focus on more specific areas like making good use of technology (e.g. [Goodyear and Retalis 2010]), teaching specific CS topics (e.g. [Köppe 2013; Schmolitzky 2007], or assignment assessments (e.g. [van Heesch et al. 2012]).

Quite a few of the published patterns are applicable for lectures too. However, to our best knowledge there is no publication yet that explicitly covers the area of lecture design. Furthermore, even though there are some applicable patterns it is hard to identify the ones relevant for the specific problems that need to be solved. Reason for this is that there are only marginal categorizations and these differ in granularity and scope. In order to help lecturers with finding the relevant patterns, a common categorization system needs to be evolved.

In this paper we aim to make a first step towards helping lecturers to improve the design of their lectures by offering an inventory and an initial categorization of the already published educational patterns. More specific, in this paper we will:

—Elaborate on how lecture patterns could be structured (section 2),

—Propose first categories of a possible lecture design pattern, categorization system (section 3)

—Mine and summarize the pedagogical patterns relevant for lecture design, including references to the defined categories and a short “Where to start"-list (section 4 plus Appendix), and

—Outlook on what is necessary for further working towards the goal of a pattern language for lecture design (section 5).

Please note that many of the patterns are related to computer science education, as they were described by computer science educators. However, many of them are also applicable for lectures in other disciplines as well even though this is not indicated explicitly.

2. BRINGING STRUCTURE TO LECTURE DESIGN PATTERNS

Many people struggle with the categorization of patterns, it appears to be a non-trivial task. Different people see things in different ways, and often any individual pattern can fit into more than one category. Any strict categorization seems to help with pattern selection, but at the same time often limits the expressiveness and usability of a pattern language. We assume that this is because there is a difference between categories and the relations between patterns. Both help the pattern users, but especially the relations between patterns are essential for forming a language.

2.1 Known categorization systems

An often used system of categorizing patterns is *Tagging*. An example is the website planetspace[1]. The main issue with tags is that they typically have no relations and therefore do not allow a good representation of the pattern relations. Any number of tags can typically be assigned to a pattern.

Categories appear to be another common approach for bringing structure into pattern collections or pattern languages. These categories are often defined using some general criteria, e.g. at what moment in the design process is the pattern applicable, what sort of problem does the pattern address, or for what scope of design problems is the pattern applicable. These categories are therefore often grouped using the above mentioned criteria. The Pedagogical Patterns Project made use of such categories in the book *Pedagogical Patterns: Advice for Educators* [Pedagogical Patterns Editorial Board 2012]. Their categories were used as basis for our categorization and are described in the corresponding categories.

Typically, patterns can be placed in multiple categories, whereby the categories describe different aspects of the pattern domain. The Gang of Four [Gamma et al. 1994] used 2 categories for classifying the design patterns: scope (class/object) and purpose (creational/structural/behavioral).

[1] `http://planetspace.org.uk`

David Mundie et al. also explored how patterns of a language can be categorized [Mundie et al. 2012]. They applied a multi-dimensional approach that is supported by the facet map tool. The different dimensions can be seen as different categories which can be combined in different ways.

Most of the categories related to the same aspect (or the above mentioned criteria) are distinctive, which means that a pattern can belong to at most one of the categories. This requires a categorization that allows an unambiguous mapping which appears to be a problem in some cases, especially if only one group of distinctive categories is used. The solution is offered by a multi-dimensional approach which allows mapping to multiple categories. It also needs to be discussed if there are categories that could be organized in an hierarchical and inclusive way. In this case the mapping of a pattern to a category could implicitly include a mapping to all underlying categories.

2.2 The difference between categories and relations

Categories help with selecting individual patterns. They are usually related to the context of the patterns and the scope of the problem or the solution. Relations between patterns describe a sequence for their implementations. The implementation of the solution of pattern A might introduce a new problem that can be solved by applying pattern B. These two patterns then have a relation, whereby pattern B might be part of the resulting context of pattern A and pattern A might be part of the context of pattern B. These relations actually form the language aspect of a pattern language.

Even though two patterns are placed in the same categories, that does not necessarily mean that they are related. There are e.g. short scale patterns one can apply during a lecture for small groups that address different problems and require different solutions. However, many of the relations are also reflected in the categories, especially when they become more fine-grained.

3. CATEGORIZATION OF LECTURE PATTERNS

In this section we identify and describe some possible categorizations for the lecture-relevant patterns. This categorization is based on the categories used in the existing literature. The categories can form the basis for a multi-dimensional categorization and in consequence the implementation of a pattern selection tool. Most subcategories are distinctive, the patterns that are independent of a certain subcategory are grouped as “general". We are still exploring if it would make sense in some cases to also declare some subcategories as not distinctive and what influence that would have on the overall categorization. This is part of future work.

We also add references to patterns in the existing literature, which are summarized in the Appendix. This will help people looking for specific patterns belonging to certain categories. It also will help to identify possible gaps in the pattern literature if it shows that for some categories none or not many patterns, usable for lecture design, have been described (to the knowledge of the author). Please note that we did not include the pattern sources in the category tables, these can be found in Table VI in the Appendix.

All categories have a name and contain two or more subcategories. Each subcategory has a description, indicating its intention, and a code. This code is in most cases an acronym of the category name plus an ascending number. In some cases the subcategories have subcategories themselves, their code then consists of the category name acronym plus an hierarchical numbering.

3.1 Level of Educational Action

Peter Baumgartner proposes in his book *Taxonomie von Unterrichtsmethoden: Ein Plädoyer für didaktische Vielfalt* [Baumgartner 2011] a taxonomy that categorizes levels of educational actions based on their duration. These levels are also used as categories for grouping the patterns of the Pedagogical Patterns Project (PPP), as described in [Pedagogical Patterns Editorial Board 2012].

We placed the patterns according to the duration of the applied pattern solution, and not the duration it takes to implement the pattern. For example, CAREFULLY CRAFTED QUESTIONS [Larson et al. 2008] is placed in category LEA1, as asking the questions in class is a direct pedagogical interaction with a probable duration of several minutes. The

preparation of this pattern — the elaboration of the questions — might take (much) longer. This fact should be included in the pattern itself as one of the liabilities.

Table I shows the categories, their meanings and their corresponding level in Baumgartner's taxonomy (BG). We also added the mapping to the time scale as described by the Pedagogical Patterns Project (PPP).

code	description	patterns
LEA1	A direct (pedagogical) interaction, time frame of several seconds to minutes (BG: level A; PPP: scale of minutes)	BODY LANGUAGE; CAREFULLY CRAFTED QUESTIONS; COMMENTED ACTION; HONOR QUESTIONS; LANGUAGE ROLE MODEL; LINE OF REASONING; MINIMUM DISTANCE; NOBODY IS PERFECT; OPEN ENDED QUESTIONS; PIECE OF MIND; PREGNANT PAUSE; REFERENCE THE PLAN; SIMPLE ANSWER; STUDENT DRIVEN LECTURE; TEACHER'S LANGUAGE; UNINTERRUPTED LISTENING; WELCOME THE PARTICIPANTS
LEA2	A pedagogical unit, or a learning/teaching situation, time frame of several minutes to few hours (BG: level B; PPP: scale of hours)	ACQUAINTANCE EXAMPLES; BE THERE FIRST; BREAKS; BUFFERS; CHANGE MEDIA; COLORFUL ANALOGY; CONSISTENT METAPHOR (AKA ANALOGY); DIFFERENT APPROACHES; DIGESTABLE PACKETS; EXPOSE THE PROCESS; FEEDBACK; LET THE PLAN GO; LINKING OLD TO NEW; MAKE IT THEIR PROBLEM; MAKE THEM MAKE IT THEIR PROBLEM; MIX NEW AND OLD; ONE CONCEPT - SEVERAL IMPLEMENTATIONS; PHYSICAL ANALOGY; PITFALL DIAGNOSIS AND PREVENTION; RELEVANT EXAMPLES; REPEAT YOURSELF; SEE BEFORE HEAR; SHOW IT RUNNING; SHOW PROGRAMMING; SIMULATION GAMES; SOLUTION BEFORE ABSTRACTION; TAKE A RISK; TEACHER ENTHUSIASM; THINK..PAIR..SHARE; TRY IT YOURSELF; USE PARTICIPANTS' MEDIA
LEA3	A thematic unit, time frame of one to many hours (BG: level C; PPP: scale of days)	ABSTRACTION GRAVITY - FROM HIGH TO LOW; DISCUSSIONS WITH PEERS AND STAFF; EXPAND THE KNOWN WORLD; GENERAL CONCEPTS FIRST; MODULE'S STORY; MULTI PRONGED ATTACK; NAME IS LAST; PREPARE EQUIPMENT; PROBLEM ORIENTATION; SEPARATE SIMILAR CONTENT; SEVEN PARTS; SPIRAL; SUMMARY; WIDER PERSPECTIVE
LEA4	A part or unit of the curriculum as e.g. a course lasting one semester, time frame of all hours for that module (25 to 900 hours) (BG: level D; PPP: scale of weeks)	ACTIVE STUDENT; CHECK PREREQUISITES; EARLY BIRD; INTEGRATED F2F AND ONLINE ACTIVITIES; ITERATIVE COURSE DEVELOPMENT; LAY OF THE LAND; MANUSCRIPT; NEW PEDAGOGY FOR NEW PARADIGMS; SEMINAR PLAN; SET THE STAGE

Table I. : Subcategories - Levels of Educational Actions

3.2 Group Size related

There are patterns that are generally applicable for lectures, independent of the number of students attending the lecture. Some patterns are only applicable for smaller groups but do not work with large student groups. The latter leads to different problems and therefore requires other patterns.

In a first version of group size related subcategories we identified 4 groups: independent of size, small groups (up to 20), medium groups (20-40), and large groups. However, during the categorization of the collected patterns we found that most patterns are independent of the group size, meaning that they are applicable for large, medium, and small groups. Patterns that were not independent of the group size all belonged to small and medium sized groups. It became obvious that patterns that work for large groups also work for small groups (at least we couldn't find a counterexample). We therefore decided to simplify the subcategories into only two, as summarized in Table II: independent of size (therefore including large groups too) and applicable only for small to medium groups (up to 40 people).

One big difference between small and large groups is the difficulty of engaging the students actively during the lecture and making the lectures more interactive. An interesting observation is that nearly all collected patterns are applicable independent of the group size. Only a few patterns are only applicable for smaller groups. We believe that the reason for this can be found in the intention of the patterns. Most of them either support the selection of lecture content, the selection of delivery forms, or with structuring the lecture. These aspects are mainly independent of the group size, and therefore categorized as GS1. The aspect of making the lecture more interactive and engaging the students actively during lectures has not extensively been covered in the literature yet. This shows that there is a need for patterns

code	description	patterns
GS1	Independent of group size.	ABSTRACTION GRAVITY - FROM HIGH TO LOW; ACQUAINTANCE EXAMPLES; ACTIVE STUDENT; BE THERE FIRST; BODY LANGUAGE; BREAKS; BUFFERS; CAREFULLY CRAFTED QUESTIONS; CHANGE MEDIA; CHECK PREREQUISITES; COLORFUL ANALOGY; COMMENTED ACTION; CONSISTENT METAPHOR (AKA ANALOGY); DIFFERENT APPROACHES; DIGESTABLE PACKETS; DISCUSSIONS WITH PEERS AND STAFF; EARLY BIRD; EXPAND THE KNOWN WORLD; EXPOSE THE PROCESS; FEEDBACK; GENERAL CONCEPTS FIRST; HONOR QUESTIONS; INTEGRATED F2F AND ONLINE ACTIVITIES; ITERATIVE COURSE DEVELOPMENT; LANGUAGE ROLE MODEL; LAY OF THE LAND; LET THE PLAN GO; LINKING OLD TO NEW; MANUSCRIPT; MIX NEW AND OLD; MODULE'S STORY; MULTI PRONGED ATTACK; NAME IS LAST; NEW PEDAGOGY FOR NEW PARADIGMS; NOBODY IS PERFECT; ONE CONCEPT - SEVERAL IMPLEMENTATIONS; OPEN ENDED QUESTIONS; PHYSICAL ANALOGY; PITFALL DIAGNOSIS AND PREVENTION; PREGNANT PAUSE; PREPARE EQUIPMENT; PROBLEM ORIENTATION; REFERENCE THE PLAN; RELEVANT EXAMPLES; REPEAT YOURSELF; SEE BEFORE HEAR; SEMINAR PLAN; SEPARATE SIMILAR CONTENT; SET THE STAGE; SEVEN PARTS; SHOW IT RUNNING; SHOW PROGRAMMING; SIMPLE ANSWER; SOLUTION BEFORE ABSTRACTION; SPIRAL; SUMMARY; TAKE A RISK; TEACHER ENTHUSIASM; TEACHER'S LANGUAGE; UNINTERRUPTED LISTENING; USE PARTICIPANTS' MEDIA; WIDER PERSPECTIVE
GS2	Small to medium groups, up to 40 students.	LINE OF REASONING; MAKE IT THEIR PROBLEM; MAKE THEM MAKE IT THEIR PROBLEM; MINIMUM DISTANCE; PIECE OF MIND; SIMULATION GAMES; STUDENT DRIVEN LECTURE; THINK..PAIR..SHARE; TRY IT YOURSELF; WELCOME THE PARTICIPANTS

Table II. : Subcategories - Group Size

that help with making lectures more interactive. In [Köppe and Schalken-Pinkster 2013a] we started to collect these interactivity patterns.

3.3 Moment of Implementation

Patterns can also be categorized by the moment of solution application, which is related to but different from the scope of educational action they cover (as described in the Level of Educational Action category). The Pedagogical Patterns Project also defined scales as categories, these too are reflected in Table III.

As many of the already described patterns (see Appendix A) are related to selecting suitable content or suitable delivery forms, it is obvious that they have to be implemented before a course or a lecture (categories MoI1 and MoI2). These categories therefore contain the largest numbers of patterns. The small number (or absence?) of patterns in the other categories suggests that there might be more work to do in order to mine these patterns as well.

It is debatable in some cases if certain patterns indeed belong to the selected category. Especially patterns describing some interactive parts of lectures might be expected in category MoI3 or its subcategories. However, we decided to put most of them also into MoI1 or MoI2, as this is the moment where the actual activity is planned and included in the lecture structure. It is not common to think of implementing some interactivity patterns just-in-time during a lecture. So the main differentiation we made is: are the actions as described in the patterns based on *reacting* to something during the lecture or do they need to be *planned* in advance, and therefore applied before the lecture or course.

However, some of the patterns also can be applied ad-hoc during a lecture, e.g. when the teacher recognizes that students are drifting away he or she can try to use DIFFERENT APPROACHES [Pedagogical Patterns Editorial Board 2012]. Another example would be to think of another COLORFUL ANALOGY [Anthony 1996] if the chosen one does not seem to work well.

One conclusion of this table is that the important beginning of a lecture is not covered by many patterns yet. In [Köppe and Portier 2014] we address this issue by proposing patterns for beginning lectures.

code	description	patterns
MoI1	before whole course	ACTIVE STUDENT; CHECK PREREQUISITES; EARLY BIRD; GENERAL CONCEPTS FIRST; INTEGRATED F2F AND ONLINE ACTIVITIES; LAY OF THE LAND; MANUSCRIPT; NEW PEDAGOGY FOR NEW PARADIGMS; SEMINAR PLAN; SEPARATE SIMILAR CONTENT; SET THE STAGE; SPIRAL; WIDER PERSPECTIVE
MoI2	before (each or a specific) lecture	ABSTRACTION GRAVITY - FROM HIGH TO LOW; ACQUAINTANCE EXAMPLES; BREAKS; BUFFERS; CAREFULLY CRAFTED QUESTIONS; CHANGE MEDIA; COLORFUL ANALOGY; CONSISTENT METAPHOR (AKA ANALOGY); DIFFERENT APPROACHES; DIGESTABLE PACKETS; EXPAND THE KNOWN WORLD; LINKING OLD TO NEW; MAKE IT THEIR PROBLEM; MAKE THEM MAKE IT THEIR PROBLEM; MIX NEW AND OLD; MODULE'S STORY; MULTI PRONGED ATTACK; NAME IS LAST; ONE CONCEPT - SEVERAL IMPLEMENTATIONS; OPEN ENDED QUESTIONS; PHYSICAL ANALOGY; PREPARE EQUIPMENT; PROBLEM ORIENTATION; RELEVANT EXAMPLES; SEE BEFORE HEAR; SEVEN PARTS; SHOW IT RUNNING; SHOW PROGRAMMING; SIMPLE ANSWER; SIMULATION GAMES; SOLUTION BEFORE ABSTRACTION; STUDENT DRIVEN LECTURE; SUMMARY; TAKE A RISK; THINK..PAIR..SHARE; TRY IT YOURSELF; USE PARTICIPANTS' MEDIA
MoI3	during lecture in general	BODY LANGUAGE; COMMENTED ACTION; EXPOSE THE PROCESS; FEEDBACK; HONOR QUESTIONS; LANGUAGE ROLE MODEL; LET THE PLAN GO; LINE OF REASONING; MINIMUM DISTANCE; NOBODY IS PERFECT; PITFALL DIAGNOSIS AND PREVENTION; PREGNANT PAUSE; REFERENCE THE PLAN; REPEAT YOURSELF; TEACHER ENTHUSIASM; TEACHER'S LANGUAGE; UNINTERRUPTED LISTENING
MoI3.1	during lecture, at the begin	BE THERE FIRST; WELCOME THE PARTICIPANTS
MoI3.2	during lecture, in the middle	
MoI3.3	during lecture, at the end	PIECE OF MIND
MoI4	after lecture	DISCUSSIONS WITH PEERS AND STAFF
MoI5	after whole course	ITERATIVE COURSE DEVELOPMENT

Table III. : Subcategories - Moment of Implementation

3.4 Language related

When content and foreign language learning are integrated, then there are some design aspects that are specific for including the language aspect and integrating this with the content [Köppe and Nijsten 2012c]. This is actually independent of which second language is used. Table IV gives an overview of the language-related patterns.

code	description	patterns
Lang1	not language related	(all other patterns)
Lang2	language related	COMMENTED ACTION; LANGUAGE ROLE MODEL

Table IV. : Subcategories - Language related

3.5 Other categories

The previously described categories are based on descriptions in the existent literature. However, there are certainly more categories possible and potentially helpful when looking for specific patterns or identifying gaps in the pattern literature. Some suggestions for further categories that need to be evolved are described in the next sections.

3.5.1 *Educational Objectives.* It would be helpful to see which patterns could be applied to support certain educational objectives. One example in software engineering education, the MULTI-LEVEL ASSIGNMENT pattern (unpublished yet), demonstrates how this could be applied. In this case the revised Bloom's taxonomy [Anderson and Krathwohl 2001] was used for categorizing the educational objectives. The result is shown in Table V.

	Cognitive Process					
Knowledge	1. Remember	2. Understand	3. Apply	4. Analyze	5. Evaluate	6. Create
A. Factual	x	x		(x)		
B. Conceptual	x	x		(x)	x	x
C. Procedural	x	x	x			(x)
D. Metacognitive						

Table V. : Mapping of the educational objectives of the MULTI-LEVEL ASSIGNMENT pattern (unpublished yet) to the revised Bloom's taxonomy [Anderson and Krathwohl 2001]

In the shown example the revised Bloom's taxonomy seemed to be valuable. However, in that case it was used for assignments which are of a different nature than lectures. If the taxonomy is applicable for lecture design patterns too needs to be determined in future work.

3.5.2 *Content Domain Related.* Some patterns are specific for a certain content domain, while others are applicable independent of the content. This category therefore could distinguish between general and content specific aspects. The content-specific aspects form hereby a hierarchy that is dependent on the specific domain. These domain-specifics are often covered in taxonomies or classification systems. For the domain of computing, one example would be the ACM classification system[2]. If such mapping is valuable needs to be determined in future work.

However, educators of other domains are encouraged to describe their domain-specific lecture patterns and to include them in the language. They then should use a domain-specific categorization system that covers their domain.

3.5.3 *Technology related.* New technologies are evolving that also can be used in lectures, like smartboards, clickers, online voting systems, QR codes etc. There are patterns for effectively using these technologies in lectures, but these were not included in this work. Categorizing these patterns probably leads to categories that map with the technologies, this is part of future work.

3.5.4 *Culture.* One of the aspects that has not been taken into account yet is culture. None of the already described patterns looks at cultural issues like aspects of local, country-specific, regional, continental, religious, historical, political, gender, etc. We probably need research that either shows the culture-independence of educational patterns or includes the culture-specific aspects in the pattern contexts or categories.

4. INVENTORY OF EXISTING LECTURE PATTERNS

We reviewed existing pattern literature and judged all identified patterns if they are applicable for lecture design. One of the main sources was the work of the Pedagogical Patterns Project, summarized in the book *Pedagogical Patterns: Advice for Educators* [Pedagogical Patterns Editorial Board 2012]. Besides this book and the work referenced by the Pedagogical Patterns Project we also reviewed other literature. This has been selected using the following criteria:

—The paper was published in the proceedings of a conference that is part of the PLoP-conference series[3].

—Publications that were found with Google Scholar[4] using the search terms “pedagogical patterns" and “educational patterns".

It is likely that there are already more patterns for lecture design described than we are aware of at this moment. Our intention is to inventory these as well in future work.

Table VI in Appendix A shows the result of the pattern mining with their names in alphabetical order, a short summary per pattern, and the categories they belong to. All patterns are described in (much) more detail in the original publications.

[2] http://www.acm.org/about/class/2012

[3] PLoP, EuroPLoP, VikingPLoP, AsianPLoP etc., see http://www.hillside.net/conferences for more details.

[4] http://scholar.google.com

As we did not define subcategories for technology-related patterns yet, we also did not include these patterns in the inventory yet. This will be part of future work.

As you will see there is sometimes overlap between patterns, this will be mentioned in the remarks and/or references to the patterns. If a pattern is revised and published in a newer version, then this version is included together with references to the earlier versions of the patterns.

4.1 Where to start

As the collection of patterns is quite large it is hard to find some good entry points. To help hereby we present a list of what we think are the most important patterns one should begin with. The selection is purely based on our own experience and that of colleagues who also have applied these patterns. Another good way of beginning with lecture design patterns are the five essential patterns described in [Köppe and Schalken-Pinkster 2013b].

These are the patterns we suggest one should look at first:

—LINKING OLD TO NEW [Pedagogical Patterns Editorial Board 2012] - Linking new knowledge to already existing knowledge helps the students with learning, understanding, and remembering the new knowledge more easily.

—CAREFULLY CRAFTED QUESTIONS [Larson et al. 2008] - Questions asked to the students keep the students actively involved and motivate them to think about the presented content.

—HONOR QUESTIONS [Pedagogical Patterns Editorial Board 2012], also [Fricke and Völter 2000] - Students who ask questions are likely to be actively engaged, so asking questions should be encouraged and honored.

—DIFFERENT APPROACHES [Pedagogical Patterns Editorial Board 2012], also [Fricke and Völter 2000] - Only providing text slides is boring for students. Most often the content can be presented in different ways, and there are also ways of keeping the students actively engaged during a lecture. All these should be consciously taken into account.

—CHANGE MEDIA [Fricke and Völter 2000] - Alternating between different media exposes the students to a variety of delivery forms. This both helps to address different learning styles and helps to regain the attention of the students on a regular base.

—BUFFERS [Fricke and Völter 2000] - Don't fill the lecture with too much content, always ensure that you have time available if unexpected, but pedagogically valuable, events occur.

—CONSISTENT METAPHOR (AKA ANALOGY) [Pedagogical Patterns Editorial Board 2012] - Analogies or metaphors, especially if well known by the students, help tremendously with explaining concepts. This also can be combined with LINKING OLD TO NEW (see above).

—SEE BEFORE HEAR [Pedagogical Patterns Editorial Board 2012] - Spoken information is volatile and not easy to remember. Seeing something offers more time to internalize it and it triggers other senses.

—DIGESTIBLE PACKETS [Pedagogical Patterns Editorial Board 2012], also [Fricke and Völter 2000] - This helps you to take care of the problem with the attention span of students.

5. FUTURE WORK

This paper is intended as a first step in developing a useful body of knowledge regarding lecture design in the form of a pattern language. In order to reach this goal, some more work needs to be done which is described in the next sections.

5.1 Categorization Extension and Refinement

As mentioned before are there more possible and potentially useful categories. First ideas were given earlier in this paper and need to elaborated. These categories can be used for supporting the selection of certain patterns by the lecturers, which is important as the number of pattern is too large (and still growing) for easily keeping an overview of them.

5.2 Growing towards a Pattern Language

At this moment all the patterns form a collection, even though there are quite a lot of relations between them. But there are also some isolated subgroups of patterns. During the collection and categorization process we discovered that many of the patterns are addressing some parts of lecture design that are on a higher level. We believe that these higher level parts are actually some foundational patterns. In another paper we started with describing these higher level patterns [Köppe and Schalken-Pinkster 2013b]. The relations between these higher level patterns — SUITABLE CONTENT SELECTION, SUITABLE DELIVERY FORM SELECTION, REGULAR ATTENTION RECUPERATION, LECTURE STRUCTURING, and IMAGINATION STIMULATION — and their relations with the patterns collected in this paper form the base for defining a pattern language for lecture design in the sense of Christopher Alexander's *A Pattern Language* [Alexander et al. 1977]. Bringing all patterns together — the already described ones and the new ones — remains to be done in future work.

5.3 Pattern and Pattern Language Corroboration

Even though many educators feel the value of the patterns, it would be good to have some more evidence on their added value. Case studies or other ways of qualitative research could help here. Another interesting and important aspect is to determine which of the patterns are the "nuggets of wisdom" we are looking for. These are the ones that are essential, add the most value, and should form the core of the pattern language.

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Appendix A

The inventoried patterns were mined from the following publications. However, we reviewed more literature than presented here, but only included it if it contained patterns that were relevant for lecture design.

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The following table summarizes the identified patterns in alphabetical order and gives references per pattern to the appropriate categories as defined earlier.

No.	Pattern Name and origin	Patlet	Remarks	Categories
1	ABSTRACTION GRAVITY - FROM HIGH TO LOW [Pedagogical Patterns Editorial Board 2012]	Introduce concepts that must be understood at two levels of abstraction first at their highest level, then link this to the lower level abstraction by using reflection on the concept.	Similarities with GENERAL CONCEPTS FIRST.	LEA3, GS1, MoI2, Lang1
2	ACQUAINTANCE EXAMPLES [Anthony 1996]	Choose examples the students are familiar with, but which are not within the area of students' expertise.		LEA2, GS1, MoI2, Lang1
3	ACTIVE STUDENT [Pedagogical Patterns Editorial Board 2012]	Keep the students active, as passive students who only listen and read don't learn much.	This also counts for lectures. Questions are a good way of doing so, this is addressed by few patterns. Also related to WORK FORMS.	LEA4, GS1, MoI1, Lang1
4	BE THERE FIRST [Fricke and Völter 2000]	Being there before the students gives time for preparation of the lecture and personal communication with the arriving students.		LEA2, GS1, MoI3.1, Lang1
5	BODY LANGUAGE [Fricke and Völter 2000]	Support your spoken word with body language by using gestures and facial expressions intentionally.		LEA1, GS1, MoI3, Lang1
6	BREAKS [Fricke and Völter 2000]	Include (regular) breaks if sessions (or lectures) are very long and/or intense.	Another option for long lectures is REGULAR ATTENTION RECUPERATION [Köppe and Schalken-Pinkster 2013b]	LEA2, GS1, MoI2, Lang1

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No.	Pattern Name and origin	Patlet	Remarks	Categories
7	BUFFERS [Fricke and Völter 2000]	Inculde buffers in your planning for a lecture so that you have time for reacting on unforeseen problems, questions, and topics.	An alternative to directly answering questions would be to use a QUESTION PARKING SPACE [Köppe and Schalken-Pinkster 2013a].	LEA2, GS1, MoI2, Lang1
8	CAREFULLY CRAFTED QUESTIONS [Larson et al. 2008]	Spend time prior to class to construct questions that help to achieve the desired goals of the lesson.		LEA1, GS1, MoI2, Lang1
9	CHANGE MEDIA [Fricke and Völter 2000]	Diversify a lecture by using different media and changing them regularly without overdoing it.	The choice of available media might be externally determined (are the facilities available?). This is related to SUITABLE DELIVERY FORM SELECTION and LECTURE STRUCTURING [Köppe and Schalken-Pinkster 2013b].	LEA2, GS1, MoI2, Lang1
10	CHECK PREREQUISITES [Fricke and Völter 2000]	Ensure prior to class that everything you need for the lecture is present and works as needed.	Related to SUITABLE CONTENT SELECTION and SUITABLE DELIVERY FORM SELECTION [Köppe and Schalken-Pinkster 2013b]	LEA4, GS1, MoI1, Lang1
11	COLORFUL ANALOGY [Anthony 1996]	Use a colorful analogy to introduce a concept that has a lot of boring, detailed ramifications. This also provides a place to go back to to recall the details.	Related to IMAGINATION STIMULATION [Köppe and Schalken-Pinkster 2013b] and CONSISTENT METAPHOR.	LEA2, GS1, MoI2, Lang1
12	COMMENTED ACTION [Köppe and Nijsten 2012b]	Give a spoken description of the steps you are taking while showing or demonstrating complex abilities to expose the students to the language of the domain.	Mainly intended for when a foreign language is used as medium of instruction, but probably generally applicable or helpful.	LEA1, GS1, MoI3, Lang2
13	CONSISTENT METAPHOR (AKA ANALOGY) [Pedagogical Patterns Editorial Board 2012]	Use a metaphor that is consistent with the topic being taught, including the same basic elements and their interactions.	Related to COLORFUL ANALOGY.	LEA2, GS1, MoI2, Lang1
14	DIFFERENT APPROACHES [Pedagogical Patterns Editorial Board 2012], also [Fricke and Völter 2000]	Address various sensory modalities by providing different approaches to the same topic.	The approaches suitable for lectures are certainly only a subset of all existing ones. SELECT SUITABLE DELIVERY FORM [Köppe and Schalken-Pinkster 2013b] helps with making this selection.	LEA2, GS1, MoI2, Lang1
15	DIGESTABLE PACKETS [Pedagogical Patterns Editorial Board 2012], also [Fricke and Völter 2000]	Organize the topics of your lecture in such a way that they remain small and understandable and could be finished in a reasonable amount of time.	In lectures it is often not possible or desired to have multiple breaks. In this case REGULAR ATTENTION RECUPERATION [Köppe and Schalken-Pinkster 2013b] offers help.	LEA2, GS1, MoI2, Lang1
16	DISCUSSIONS WITH PEERS AND STAFF [TELL project output of WP3 2005]	Give the students opportunities to engage in discussions of the ideas they are encountering and let them know your expectations of how you want things to be discussed.	Although primarily intended for e-learning, this pattern could, if scoped down, also be applicable in lectures.	LEA3, GS1, MoI4, Lang1

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No.	Pattern Name and origin	Patlet	Remarks	Categories
17	EARLY BIRD [Pedagogical Patterns Editorial Board 2012]	Teach the most important topics first in a course, as students often remember best what they learn first.	Similar to GENERAL CONCEPTS FIRST.	LEA4, GS1, MoI1, Lang1
18	EXPAND THE KNOWN WORLD [Pedagogical Patterns Editorial Board 2012]	Explicitly link a new concept to experiences the students already have when introducing it.	Linking can be done with e.g. COLORFUL ANALOGY or CONSISTENT METAPHOR. Related to LINKING OLD TO NEW.	LEA3, GS1, MoI2, Lang1
19	EXPOSE THE PROCESS [Pedagogical Patterns Editorial Board 2012]	Do not show the results and correct solutions to exercises only, but also show and explain the process of getting there, including the critical decision points.		LEA2, GS1, MoI3, Lang1
20	FEEDBACK [Pedagogical Patterns Editorial Board 2012], also [Fricke and Völter 2000]	Give the students feedback on their performance, so that they know where they are at fault and learning becomes more complete.	Lectures can be used for giving feedback, but only if it is relevant for the whole group. There are several patterns on feedback published in [Pedagogical Patterns Editorial Board 2012].	LEA2, GS1, MoI3, Lang1
21	GENERAL CONCEPTS FIRST [Fricke and Völter 2000]	Start with teaching the general concepts, so that students can remember new, more detailed topics taught later more easy as they can associate these topics with the previously learned general concepts.	Similarities with ABSTRACTION GRAVITY - FROM HIGH TO LOW and EARLY BIRD. In some cases it's better to start with concrete examples.	LEA3, GS1, MoI1, Lang1
22	HONOR QUESTIONS [Pedagogical Patterns Editorial Board 2012], also [Fricke and Völter 2000]	Motivate the students to ask questions, show them that you value this and that there are no stupid questions.		LEA1, GS1, MoI3, Lang1
23	INTEGRATED F2F AND ONLINE ACTIVITIES [TELL project output of WP3 2005]	If you have online activities too, integrate them with the face-to-face activities so that they accompany and complement each other and support students' learning best.	Related to SUITABLE CONTENT SELECTION and SUITABLE DELIVERY FORM SELECTION. [Köppe and Schalken-Pinkster 2013b]	LEA4, GS1, MoI1, Lang1
24	ITERATIVE COURSE DEVELOPMENT [Anthony 1996]	Improve the course (and lectures) based on previous experiences in an iterative way.	Originally intended for a whole course. It is also applicable for lecture design, but needs to be scoped down.	LEA4, GS1, MoI5, Lang1
25	LANGUAGE ROLE MODEL [Köppe and Nijsten 2012a]	If you teach content in a foreign language, make sure that you can use it in a correct way as students are likely to imitate you.	Related to TEACHER LANGUAGE, but focused on the use of a foreign language as medium of instruction.	LEA1, GS1, MoI3, Lang2
26	LAY OF THE LAND [Pedagogical Patterns Editorial Board 2012]	Show students early in the course a large artifact that covers the major course themes, have them examine it so that they know where the course is heading to and can better place the details covered later.	The artifact can also be a large example or analogy.	LEA4, GS1, MoI1, Lang1
27	LET THE PLAN GO [Fricke and Völter 2000]	If a question arises that you haven't expected in your planning, but answering it would add nicely to your lecture, then take the time for this sidestep.	This requires that you have included BUFFERS in your planning.	LEA2, GS1, MoI3, Lang1
28	LINE OF REASONING [Larson et al. 2008]	When students' responses are unexpected, use this for learning. Ask the student to explain his or her thought process and take time to analyze the response.	This pattern supports STUDENT MINERS [Köppe and Schalken-Pinkster 2013a].	LEA1, GS2, MoI3, Lang1
29	LINKING OLD TO NEW [Pedagogical Patterns Editorial Board 2012]	Help the learner to make associations between new information and existing knowledge by using an old wrapper to introduce this new information.	Related to EXPAND THE KNOWN WORLD.	LEA2, GS1, MoI2, Lang1

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No.	Pattern Name and origin	Patlet	Remarks	Categories
30	MAKE IT THEIR PROBLEM [Schmolitzky 2007]	In order to get to know a live running system, have the students solve a problem, agree on a solution and then let them direct you to realize the solution using a single presentation computer connected to a projector.	Related to REMOTE HAND. [Köppe and Schalken-Pinkster 2013a]	LEA2, GS2, MoI2, Lang1
31	MAKE THEM MAKE IT THEIR PROBLEM [Schmolitzky 2007]	Let the students design teaching units where they also have to apply MAKE IT THEIR PROBLEM.		LEA2, GS2, MoI2, Lang1
32	MANUSCRIPT [Fricke and Völter 2000]	Provide a manuscript that complements the lectures by stating important goals, facts, or milestones explicitly.	Closely related to SUITABLE CONTENT SELECTION [Köppe and Schalken-Pinkster 2013b].	LEA4, GS1, MoI1, Lang1
33	MINIMUM DISTANCE [Larson et al. 2008]	Close the physical separation between you and the students by moving around in the room.		LEA1, GS2, MoI3, Lang1
34	MIX NEW AND OLD [Anthony 1996]	Combine reviewing old concepts with introducing new ones by mixing new with old material and presenting it in a different variation on learning styles..	This is also related to LINKING OLD TO NEW and MULTI-PRONGED ATTACK (both [Pedagogical Patterns Editorial Board 2012]).	LEA2, GS1, MoI2, Lang1
35	MODULE'S STORY [Anthony 1996]	Make the flow of a module (or lecture) into a story by using an example, exercise, or goal which makes use of most or all topics in the module.		LEA3, GS1, MoI2, Lang1
36	MULTI PRONGED ATTACK [Pedagogical Patterns Editorial Board 2012]	Choose examples and exercises that cover more than one idea or topic at the same time.		LEA3, GS1, MoI2, Lang1
37	NAME IS LAST [Fricke and Völter 2000]	Put the focus first on the students' understanding of a topic or a concept before presenting its name.		LEA3, GS1, MoI2, Lang1
38	NEW PEDAGOGY FOR NEW PARADIGMS [Pedagogical Patterns Editorial Board 2012]	Use pedagogy that matches the thinking modes required in the paradigm you're teaching.	Intended for programming, but probably generally applicable.	LEA4, GS1, MoI1, Lang1
39	NOBODY IS PERFECT [Pedagogical Patterns Editorial Board 2012], also [Fricke and Völter 2000]	Do not try to be perfect and admit your limitations with grace.		LEA1, GS1, MoI3, Lang1
40	ONE CONCEPT - SEVERAL IMPLEMENTATIONS [Pedagogical Patterns Editorial Board 2012]	Use different implementations as examples of one abstract concept and compare them afterwards to re-discover the abstract concept as essence.		LEA2, GS1, MoI2, Lang1
41	OPEN ENDED QUESTIONS [Larson et al. 2008]	Develop questions, prior to class, that require full and meaningful answers using the student's previously acquired knowledge.		LEA1, GS1, MoI2, Lang1
42	PHYSICAL ANALOGY [Pedagogical Patterns Editorial Board 2012]	Use, if possible, a concrete way for illustrating the dynamic properties of an abstract concept.	Related to COLORFUL ANALOGY.	LEA2, GS1, MoI2, Lang1
43	PIECE OF MIND [Larson et al. 2008]	At the end of class, let students anonymously write down whatever they want you to know, which is valuable information about their perceived progress and difficult parts.		LEA1, GS2, MoI3.3, Lang1
44	PITFALL DIAGNOSIS AND PREVENTION [Anthony 1996]	Pay special attention to vital concepts and emphasize them when it has shown that last time you taught the concept students had trouble with it.		LEA2, GS1, MoI3, Lang1
45	PREGNANT PAUSE [Larson et al. 2008]	Give all students enough time for formulating an answer to your question.		LEA1, GS1, MoI3, Lang1
46	PREPARE EQUIPMENT [Fricke and Völter 2000]	Make sure that when the session or lecture starts your equipment is working and ready to use.		LEA3, GS1, MoI2, Lang1

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No.	Pattern Name and origin	Patlet	Remarks	Categories
47	PROBLEM ORIENTATION [Fricke and Völter 2000]	Introduce a new topic by showing a problem it solves, that way the students know where you will lead them.	While using a problem as motivator for the content is certainly advisable, there are also some arguments for not combining this with a top-down approach as this might not fit well with varying learning styles of the students. A mix of both approaches (top-down and bottom-up) often seems to work good.	LEA3, GS1, MoI2, Lang1
48	REFERENCE THE PLAN [Fricke and Völter 2000]	Let the students know that you have a plan for the overall context and where the current session is located in it.		LEA1, GS1, MoI3, Lang1
49	RELEVANT EXAMPLES [Fricke and Völter 2000]	Use examples for illustrating abstract concepts that relate to the knowledge of the students, this way they are able to understand them and the underlying concepts more easily.	These examples could also be related to the daily life of the students, e.g. related to music or sports.	LEA2, GS1, MoI2, Lang1
50	REPEAT YOURSELF [Pedagogical Patterns Editorial Board 2012], also [Fricke and Völter 2000]	Repeat important topics, also by connecting them to new ones via cross linking. This will help students to remember things easier.		LEA2, GS1, MoI3, Lang1
51	SEE BEFORE HEAR [Pedagogical Patterns Editorial Board 2012]	Give learners the opportunity to see and experience a new concept before they her about it.		LEA2, GS1, MoI2, Lang1
52	SEMINAR PLAN [Fricke and Völter 2000]	Have a plan or an agenda for your seminar, which highlights important topics and goals and defines your strategy and order of covering them.	Rewritten for lectures as LECTURE STRUCTURING and SUITABLE CONTENT SELECTION [Köppe and Schalken-Pinkster 2013b].	LEA4, GS1, MoI1, Lang1
53	SEPARATE SIMILAR CONTENT [Fricke and Völter 2000]	If topics are different but seem similar, then separate their coverage in time and explain when which of them is used.		LEA3, GS1, MoI1, Lang1
54	SET THE STAGE [Pedagogical Patterns Editorial Board 2012]	Prepare students before introducing new material by reviewing prerequisites, showing the target and context, and providing an outline.		LEA4, GS1, MoI1, Lang1
55	SEVEN PARTS [Anthony 1996]	7 seems to be a good number for steps or sub-topics covered in a module.	This highly depends on the length of the lecture, and other interactivity possibilities. Not very strong.	LEA3, GS1, MoI2, Lang1
56	SHOW IT RUNNING [Schmolitzky 2007]	Do not just tell about the functionality of a software, but also use it during your presentation, as students remember better if they have seen it working and you can point to critical and important parts.	Relevant if you teach software tools or frameworks.	LEA2, GS1, MoI2, Lang1
57	SHOW PROGRAMMING [Schmolitzky 2007]	Show programming in action (and not only slides about programming), explain the code and concepts you apply, and show how you make use of useful features of the IDE.	Relevant when teaching software programming.	LEA2, GS1, MoI2, Lang1
58	SIMPLE ANSWER [Larson et al. 2008]	Engage students with simple, “close-ended" questions whose answers can be easily determined from material you already have covered in class.		LEA1, GS1, MoI2, Lang1

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No.	Pattern Name and origin	Patlet	Remarks	Categories
59	SIMULATION GAMES [Anthony 1996]	The simulation of a complex activity helps better with understanding of the underlying (tricky) concepts than a simple explanation would and additionally offers an opportunity for interaction.	Related to ROLE PLAY [Pedagogical Patterns Editorial Board 2012]. Only applicable in small groups and/or with good preparation.	LEA2, GS2, MoI2, Lang1
60	SOLUTION BEFORE ABSTRACTION [Pedagogical Patterns Editorial Board 2012]	Let the students first find solutions to specific concept-related problems, have them identify the common aspects of these solutions, and use these identified aspects to introduce the general, abstract concept.	It is somehow contrary to GENERAL CONCEPTS FIRST, but both address different learning styles (holistic vs. serialistic). They therefore should be used both and/or in combination.	LEA2, GS1, MoI2, Lang1
61	SPIRAL [Pedagogical Patterns Editorial Board 2012]	Start with introducing interrelated topics on a high level so that the students can use them for working on meaningful and interesting problems early. Iteratively cover the topics in more detail then.		LEA3, GS1, MoI1, Lang1
62	STUDENT DRIVEN LECTURE [Pedagogical Patterns Editorial Board 2012]	Select in the beginning of a lecture the questions students most want answered today and revise (parts of) your lecture accordingly.	The solution could be applied using social media or e-learning facilities. Earlier submitted homework could also form the base for a (indirectly) student driven lecture.	LEA1, GS2, MoI2, Lang1
63	SUMMARY [Fricke and Völter 2000]	Provide a summary at the end of each session or lecture that repeats the covered important topics and how they relate to the overall content.	In a lecture, also the learning objectives are often referred to in the summary.	LEA3, GS1, MoI2, Lang1
64	TAKE A RISK [Pedagogical Patterns Editorial Board 2012]	Try out new things in pedagogy, if you don't know that it works make sure to have a backup with alternative and working methods. Get feedback and use this for improvement.	The main message is that one should experiment with different delivery forms and evaluate afterwards their effectiveness.	LEA2, GS1, MoI2, Lang1
65	TEACHER ENTHUSIASM [Olson 2008]	Increase the enthusiasm of the students by showing enthusiasm yourself: towards the subject, towards the students, and towards the act of teaching.	This is of course generally applicable, but especially important in lectures, as the teacher plays a central role in these. Motivating the students to learn is one of the essential functions of lectures, and showing enthusiasm is a very important motivator.	LEA2, GS1, MoI3, Lang1
66	TEACHER'S LANGUAGE [Pedagogical Patterns Editorial Board 2012], also [Fricke and Völter 2000]	Speak with a loud voice and use language that suits the participants (or students), being expressive and fascinating at the same time.		LEA1, GS1, MoI3, Lang1
67	THINK..PAIR..SHARE [Larson et al. 2008]	Actively engage students by (1) have them answering a question on themselves, then (2) discuss this with another student, and (3) have randomly chosen students share with the class their partner's answer.	Does probably not work well with larger student groups.	LEA2, GS2, MoI2, Lang1
68	TRY IT YOURSELF [Pedagogical Patterns Editorial Board 2012]	After presenting a new concept, take a break in the presentation and have the students perform an exercise that makes use of the previously introduced concepts. Check if they understood it and give immediate feedback.	Only applicable in smaller classes, especially if you want to give feedback.	LEA2, GS2, MoI2, Lang1
69	UNINTERRUPTED LISTENING [Larson et al. 2008]	Let students complete their response when they are speaking, so that you understand the full thought of them and can react on this properly.		LEA1, GS1, MoI3, Lang1

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No.	Pattern Name and origin	Patlet	Remarks	Categories
70	USE PARTICIPANTS' MEDIA [Fricke and Völter 2000]	Support students' taking notes or copying things from your presentation by making use of media for your presentation that are of the same kind as the students' media.	Although the title is somewhat misleading in today's environment (as it might be interpreted as social media or gadgets), the content is surely applicable for lectures: If students are required to copy things manually, then write them down or paint them yourself manually too. Otherwise provide the material in another way.	LEA2, GS1, MoI2, Lang1
71	WELCOME THE PARTICIPANTS [Fricke and Völter 2000]	Welcome the participants of a seminar (or students in a lecture), talk to them informally in the beginning, hereby creating a suitable atmosphere.	This is more important for seminars, but one should also welcome students at the beginning of a course and apply some aspects of this pattern.	LEA1, GS2, MoI3.1, Lang1
72	WIDER PERSPECTIVE [Pedagogical Patterns Editorial Board 2012]	Give students an interdisciplinary understanding of the implications of technology — e.g. economical, social, or organizational — by teaching a technical topic from a wider perspective.		LEA3, GS1, MoI1, Lang1

Table VI. : Already described lecture patterns