Lecture Design Patterns: More Interactivity Improvement Patterns

CHRISTIAN KÖPPE, MICHEL PORTIER, RENÉ BAKKER, STIJN HOPPENBROUWERS
HAN University of Applied Sciences, Arnhem, the Netherlands

Designing lectures that are inspiring and help students with learning instead of boring them is not an easy task. One of the important aspects hereby is the interactivity during the lecture, as students learn more when they are actively involved.
In earlier work we presented patterns foundational patterns for lecture design and patterns that help with making lectures more interactive. In this paper we present six more patterns which can be used for increasing the interactivity in lectures in an efficient way.

Categories and Subject Descriptors: K.3.2 [**Computers and Education**]: Computer and Information Science Education —*Computer science education*

General Terms: Design, Languages, Education

Additional Key Words and Phrases: Educational Patterns, Design Patterns

ACM Reference Format:

Köppe, C., Portier, M., Bakker, R., Hoppenbrouwers, S. 2015. Lecture Design Patterns: More Interactivity Improvement Patterns – L(July 2015), 11 pages.

PLEASE NOTE: this is the version presented in a writer's workshop at the PLoP'15 conference.

1. INTRODUCTION

Lectures are still a commonly used way of teaching in education, even though their effectiveness is regularly questioned and alternatives are discussed (see eg. [McCartney and Tenenberg 2013]). But lectures certainly can be of value if they are designed carefully and if they show properties that support learning. The foundational patterns for lecture design presented in [Köppe and Schalken-Pinkster 2013b] describe some of the essential solutions for designing valuable lectures. However, these patterns are on a higher abstraction level and require lower level patterns for the implementations of various aspects and properties.

One of these properties is the interactivity between students and lecturer. Students who are actively involved during the lectures and motivated to participate are likely to learn more than when they are only passively consuming (see also ACTIVE STUDENT). This interactivity does not come naturally, it needs to be designed into the lectures, ideally in a variety of alternating ways.

In an earlier paper we introduced five patterns that help to improve interactivity during lectures [Köppe and Schalken-Pinkster 2013a]. These patterns (and all other referenced patterns in this paper) are summarized in the appendix.

In this paper we describe six more patterns that help with making lectures more interactive and therefore keeping the students more active, an important aspect in learning as also described in ACTIVE STUDENT. An overview of these patterns is given in Table I.

The patterns use an adapted version of the Alexandrian pattern format, as described in [Alexander et al. 1977]. The first part of each pattern is a short description of the context, followed by three diamonds. In the second part, the problem (in bold) and the forces are described, followed by another three diamonds. The third part offers the core of the solution

Author's address: {christian.koppe,michel.portier,rene.bakker,stijn.hoppenbrouwers}@han.nl

Pattern Name	SUMMARY
ACTIVATING DELIVERY FORMS	Select and use delivery forms that require the students to actively participate.
CONSIDERATE LECTURER	Pro-actively ask students on their progress, observe how they perform and react on what you observe in a constructive manner.
COLLABORATIVE EDITING	Use a tool which offers access to the same content for you and the students and collaboratively edit this content with the tool.
THUMBS UP	Make every student choose one option of a two-answer question by keeping their choice exposed via thumbs up or down.
DISCUSSION STATEMENTS	Organize group discussions in which a small number of students reacts to some provocative statements given by the teacher, and actively encourage the students to engage in discussion or even debate.
STUDENT DEBATE	Give a small number of diverse or even contradicting statements to students, have them prepare and present a plea for their statement and use these presentations as starting point for deeper discussions of the topic.

Table I. : x additional patterns that help improving interactivity during lectures

(again in bold), the solution in more detail, the positive and negative consequences of the pattern application — which are part of the resulting context — and a discussion of possible implementations. This is followed by examples of the pattern implementation, shown in *italics*.

PATTERN: ACTIVATING DELIVERY FORMS

You're busy with SUITABLE DELIVERY FORM SELECTION and also want to apply ACTIVE STUDENT.

❖ ❖ ❖

Students can easily stay passive during the lecture and are not triggered to think.

Learning costs some energy and effort, while staying passive is easier. Furthermore, students (especially beginning ones) often see themselves in the role of a knowledge consumer and the teacher as knowledge provider.

But even if students want to actively engage during lectures, it is sometimes not possible for them because of the non-interactive design made by the lecturer.

❖ ❖ ❖

Therefore: select and use delivery forms that require the students to actively participate.

According to ACTIVE STUDENT, students should be active in class too. This requires that the lecturer consciously makes use of delivery forms that encourage or even enforce students to become actively involved with the topic at hand.

Such delivery forms could be of collaborative nature, as in COLLABORATIVE EDITING, COLLABORATIVE SUMMARY, CO-DESIGN, or STUDENT MINERS. It could also be simpler forms like asking questions, having students ask questions or proposing a problem the students have to solve. Using examples where the students can connect with is also likely to increase their active participation with the topic. Another option is a SURPRISE BEGINNING, where you start the lecture with an interesting picture or story that attracts the interest of the students. Using this story as starting point for introducing a new topic will have the effect of more actively involved students.

Applying this pattern makes the lecture more valuable for the students, as because of their active participation they are likely to learn more. Furthermore, if the delivery forms are carefully chosen and applied, then each student will participate and therefore get the feeling that her contribution to the group is valued. This makes it also more fun for the students to attend the lectures.

Preparing such lectures might cost a bit more preparation time. Also, due to the often unpredictable character of some of these delivery forms, one needs to be able to handle unexpected responses and situations.

*The lectures for the course "Patterns and Frameworks" were designed using a variety of activating delivery forms. These were also documented in a detailed lesson plan, an example is shown in Figure 1. Here it can be seen that these activating delivery forms (*STUDENT DESIGN SPRINT*,* SHOTGUN SEMINAR*, and* PEER FEEDBACK*) are also combined with some more principle-oriented patterns (such as* PRINCIPLES ARE LEADING*,* KEEP IT SIMPLE*, and* FEEL THE PAIN *for teaching design patterns [Köppe 2013a] and* METATALK *[Köppe and Nijsten 2012] for addressing the usage of a foreign language (English instead of Dutch) for teaching).*

Needed material for 2nd lecture: large paper-sheets and markers, tape.	
Here we form groups of 4 (2x2) which have to discuss both solutions and make a best-of version (STUDENT DESIGN SPRINT). This had to be painted on a large paper sheet and is then to be presented to the class by a randomly chosen student (SHOTGUN SEMINAR). The students give feedback (PEER FEEDBACK) on their solutions and discuss the best aspects of all solutions. Here the teacher should lead the discussion in the direction of the characteristics of the Strategy pattern and should also discuss the consequences of bad designs (FEEL THE PAIN).	STUDENT DESIGN SPRINT, SHOTGUN SEMINAR, PEER FEEDBACK, PRINCIPLES ARE LEADING, KEEP IT SIMPLE, FEEL THE PAIN English: METATALK

Fig. 1: Part of a lesson plan including activating delivery forms.

PATTERN: CONSIDERATE LECTURER

You are teaching a subject using lectures and have defined the LEARNING OUTCOMES you want the students to achieve.

❖ ❖ ❖

You can't be sure what the students really have understood well and therefore it's often not clear until the end if the learning objectives have completely been achieved.

Between lectures, there's often not much time for individual questions by students, either because the lecturer or the student has other obligations.

Admitting that something not has been understood (completely) is often difficult for students. Even more, they sometimes simply don't know if they understood it correctly. It also can be that they think they have understood the concept, but actually have not (completely).

❖ ❖ ❖

Therefore: Pro-actively ask students on their progress, but also observe how they perform and react on what you observe in a constructive manner.

When asked on their progress, some students will answer that they are doing fine without doing so. So in order to be sure about their progress, the lecturer has to observe directly how they perform. If e.g. a small assignment can be given during the lecture (as a MISCONCEPTION ASSESSMENT), then you should walk around and look over the students' shoulders at what they are doing and how they perform. Actively ask them to show you the results of earlier assignments, so that you can check if these really were solved properly. If misconceptions are detected that way, you can either discuss them with the student (or the small group of students) directly or, in case these misconceptions become present more often, adjust your lecture and discuss them with the whole class.

It is not sufficient to rely on that students become active when they don't understand a topic completely. Some students are too shy to ask or might feel embarrassed when doing so in front of the whole class.

In the flipped classroom course "Object-Oriented Program Development" at HAN University of Applied Sciences, the students have to make assignments as parts of the preparation and to hand them in via mail. The lecturers scan some of these in order to get an overview of the whole class. However, there might be students with difficulties whose solutions have not been examined (and used in class as suggested in USE STUDENT SOLUTIONS *[Köppe et al. 2015]) so you don't know about their shortcomings. For this reason, the lecturers use the time when students work on assignments in class to walk around and ask students to show them some of the older assignment results. This way, the lecturer gets an even better grip on the overall and individual students' progress. If it becomes clear that certain parts of the assignments are not solved correctly by more students, then a mini-lecture on that topic was held or the classical instruction was adjusted so that the difficult topic was addressed again.*

PATTERN: COLLABORATIVE EDITING

You want to show students how they can apply new knowledge, e.g. with SHOW PROGRAMMING or SHOW IT RUNNING using a tool or editor.

❖ ❖ ❖

Showing content in a tool using a projector makes you as teacher the only one who is actively working with the content, the students can easily slip back to their passive role.

REMOTE HAND does not work well with longer content parts (like whole functions in programming) as they time needed for dictating might be too long. Furthermore, complex content (like source code expressions) can easily lead to the "chinese whispers"[1]-effect: the message is understood differently by the lecturer than originally communicated by the student.

Furthermore, if the lecturer does enter all the code into a tool, then the students are more or less forced to be passive and wait until the lecturer is done.

❖ ❖ ❖

Therefore: Use a tool where both you and the students can edit the document and which everybody can access using their own computer. Have students also add, edit, or delete parts of the document instead of doing it for them.

This way the students can actively participate in collaboratively editing the content and they can copy&paste the results to their own environment.

This pattern is a variant of REMOTE HAND. The biggest difference is that students partly add parts to the document themselves through the collaborative editing tool.

Beware of the group dynamics when you apply this pattern for the first time in a group, as the students are likely to test how it works and will heavily edit and change the document. In order to handle this, allow them to do so for a short period of time (announcing that they now can try the tool and write/change whatever they want as long as it is over-the-top). After this period you as lecturer decide who is allowed to edit the content.

Using a text-based tool for e.g. collaboratively editing source code has some advantages and disadvantages. On the one hand, it is great to just run a program and use the observable results (error messages, console print-outs, compiler messages etc.) for discussing the issues related to them. On the other hand, it can be good to not being able to compile and run the program, but rather discussing how it will behave if compiled or run. This encourages the students to think and reason about if the program is working and doing what it is supposed to be doing, a much more active approach that helps students with more deep learning.

In an introductory programming course at the HAN University of Applied Sciences, students have to write short programs which solve given problems, e.g. a robot who can guided along the screen and can pick up and drop small packets. After the students had worked on that assignment for some time, the lecturer opened the online collaborative editing tool Collabedit[2] and started to build up the solution together with all students. Step by step he asked students to copy a small part of their program to the tool, which was then discussed with the rest of the class. In some cases other students had solved parts differently. These were asked to copy their implementation into the same document, so that two solutions were seen side-by-side. Examining and discussing the differences was of great value for the students, and many copied the alternative solution too.

[1] http://en.wikipedia.org/wiki/Chinese_whispers
[2] http://collabedit.com

PATTERN: EVERYBODY'S THUMBS VISIBLE

You're asking a question during a lecture which allows two answers and want all students to choose one of them.

❖ ❖ ❖

Asking for who chooses the first answer by raising their hands and who chooses the second answer by raising their hands nearly always has the effect that a third big group is left: the ones who didn't raise their hands at all.

It is easy to hide in a group if no one really knows what and if you have voted at all for one of the answers. So students can be passive during such activity.

On the other hand, students sometimes are not sure about the answer and therefore do not vote, even though the main goal of the question is often not to count the correct answers but to make the students think about it.

❖ ❖ ❖

Therefore: Make the group of the first answer keep their thumbs up and the group of the second answer thumbs down. This way you see who has not decided on an answer and you can encourage them to do so or ask why they didn't choose.

It should be clear which answer belongs to thumbs up and which to thumbs down. Drawing up and down arrows with a short hint on the answer on a visible board will help to remember this and also show the students what to do when they decided on their answer. Forcing the students to decide on one answer requires them to think about it more thoroughly.

One positive consequence is that in case you want to count the answers, you only have to count once and it is (often) easy to determine visually which choice was taken less often, so counting goes faster. If it's not easy to determine the bigger group, then the likely result is that both groups are more or less equal.

Applying this pattern does not solve the problem issue that students who are not sure about the correct answer often follow the majority of the group. Address this by having students discussing their choice with their neighbor/s. This increases the chance that students who did vote without really knowing get an explanation for the vote of a peer student, which might help them to get a better understanding themselves.

It might be a bit turbulent when applying this pattern, as often the effect is that students start to discuss their choice with peers without being asked to do so. So one should try to apply EVERYBODY'S THUMBS UP in a quick manner and make clear upfront that the result of the vote will be discussed immediately after. Also one should not over-apply this pattern but only use it occasionally.

In a course on software design, I asked the students the question: does the application of software design patterns automatically lead to better designs? The goal of this question was to trigger a discussion about the advantages of patterns and they way they are applied best. When I asked for the yes-vote, a few students raised their hands. When asked for the no-vote, again a few students raised their hands. However, most of the students haven't voted neither yes or no. So asked the question again, but this time required that the yes-voters use their thumbs upwards and leave them that way. The same went for the no-voters and it became obvious who hasn't voted at all. I asked these students to think about a possible answer, based on their prior knowledge and reasons they could think of which support their decision. Afterwards, I asked randomly selected students why they had chosen for yes and no, and the given reasons formed the basis for a lively groups discussion.

PATTERN: DISCUSSION STATEMENTS

You want to engage students in active, independent thinking on some topic, beyond reproduction of what has been handed to them; you want them to practice tight argumentation and come up with original, solid points of view.

❖ ❖ ❖

Students often reproduce the opinions or choices as presented by the lecturer or in a book without thinking deeper about it.

Regular lecturing does not provide students with much head-on exercise in thinking for themselves, phrasing their own standpoints, and arguing for them.

But It is also not realistic to expect all students to engage in serious discussions on core topics outside the classroom.

❖ ❖ ❖

Therefore: Organize group discussions in which a small number of students reacts to some provocative statements given by the teacher, and actively encourage the students to engage in discussion or even debate. Also encourage them to nurture their stronger points of view as fuel for later work (e.g. a research essay or a thesis).

If you want to develop students into independent thinkers, experts and professionals in their field, they have to learn to think for themselves and phrase their standpoints and argue for them. Using discussion statements is a good way of supporting the students with acquiring these skills.

The statements given should allow multiple opinions and they should not be trivial (“the air is blue") or common sense (“we all breath"). The statements should address issues of the lecture domain in order to trigger discussions which are also held by experts in the field. The discussion will be more lively if the statements are provocative or even taking an opposite stance as the majority.

In case all students follow one argumentation then you a s lecturer can provoke a better discussion by taking an opposite stance or asking questions that trigger thinking in a different direction. It is good to combine DISCUSSION STATEMENTS with SHOTGUN SEMINAR, as selecting the presenting students randomly requires everyone to be prepared.

Sometimes students only give shallow or minimal comments. This can be addressed by having more than one student presenting their thoughts on the same statement, hereby increasing the chance that there will be substantial comments presented. In that case, the ones with shallow or minimal comments will see how others have approached the task in more detail and can learn from this.

This way the students are not only pushed to do some active, original thinking of their own, but to do so seriously and passionately. Most students can very much do with some practice in argumentation, both logically and rhetorically. Kindling and nurturing their ideas may even lead to the beginnings of new research or enterprises. Too often students feel insecure about their own ideas, they need encouragement and practice to speak out their own thoughts more loudly and clearly.

However, there might be students who will have difficulties with expressing an opinion that differs from the lecturer’s one because of cultural or other reasons. In that case it should be emphasized that each individual opinion is good and valuable, even though it might be different from others opinions. This requires a positive attitude during the discussion, but should also be communicated upfront, e.g. when presenting the statements.

It can happen that when students are randomly chosen, that they all have the same opinions and they have don’t have to add much after the first stance or start to repeat the already said. In that case it might be better to ask who of the students has a different opinion and let this student present.

In order to encourage a discussion with a variety of different or even contradicting opinions, one can apply STUDENT DEBATE.

In a master's course in the Radboud University curriculum in Information Science, two 'Discussion Lectures' are regularly planned. Three statements, of a somewhat provocative nature, are mailed to the students some days before the discussion lecture. The statements concern some key, unresolved or debatable issues in the field concerned in the course. Examples are "Visual representation of formal rules is an excellent way of lowering the threshold for business people to create and manage their own business rules" or "As long as organisations have no full control over the formulation and management of their (existing) regulations, large scale introduction and support of business rules should be postponed for those organizations".

All students are told they may be asked to publicly comment on one of the statements, so they have to prepare a stance on each of the statements in advance. During the lecture, three students are asked to stand up and give their comment on a particular statement. This usually takes 1-3 minutes per student. After their initial three comments, group discussion ensues (involving as many students as possible, from all of the class), guided and encouraged by the teacher who acts mostly as a discussion leader. The goal is to enthuse students in coming up with new and possibly 'wild' or 'rebellious' ideas in view of the subjects taught in the course. The discussion is allowed to go on as long as it remains sufficiently lively and interesting. The actual length may vary; the teacher decides when it is time to quit. A discussion usually lasts 10-30 minutes. Another statement may be up next. Discussion lectures are much appreciated by the students and are felt by all involved to be a useful preparation to the research essay the students have to write as part of the course examination. Often, topics chosen for the essay originate in the discussion lectures.

PATTERN: STUDENT DEBATE

You want to teach students how they can support the choices they made, e.g. when designing, and also want to expose them to a variety of aspects of a topic to be covered. You decided to use DISCUSSION STATEMENTS.

❖ ❖ ❖

Students tend to look for the one good way or the one correct interpretation. When they apply it, they often cannot give sound support for why they've chosen this way or why their interpretation is correct.

Many students tend to follow the strategy "when it works, it works" without evaluating if the working solution is indeed a good (or the best) solution. Being able to execute such evaluation requires knowledge of possible alternatives, which does not come naturally to students.

On the other hand, if students have evaluated different ways and made a well-supported choice, they often find it hard to describe and document *how* they evaluated and *why* their choice indeed is a good one.

❖ ❖ ❖

Therefore: Give a small number of diverse or even contradicting statements to students, have them prepare and present a plea for their statement and use these presentations as starting point for deeper discussions of the topic.

Having to present and defend a statement requires the students to dig deeper into the topic and to look at it from different perspectives for finding a good support of their defense. Defending a statement usually includes a discussion of why other alternatives are less good, which is also part of DISCUSSION STATEMENTS. However, by having various and even contradicting statements, the arguments will likely clash and the students have to discuss which of them is more important or why actually both statements are correct with respect to some identified criteria. Being able to coming to such conclusion (and learning how to do this) is one of the students' competences and learning objectives in many fields, and such STUDENT DEBATEs can help with realizing it.

The biggest issue are statements that actually *are* wrong, but the students are required to still argue in favor of them and find support for it. Even this is very helpful, as such argumentation likely is of some naïve character and hereby shows that not all explanations and arguments should be followed blindly.

In the course software design (part of the master Software Engineering) at the University of Amsterdam, 2 contradicting statements addressing various aspects of software design are given to two pairs of students. The students then have to prepare pleas for defending their statement which include well supported arguments, and have to present these to the whole class. After that a discussion is held about which arguments were the strongest and most convincing. By looking much deeper at these aspects and discussing their pro's and con's, the students learned to evaluate the applicability of a variety of styles and techniques and to make well supported choices for of against them in future projects.

2. CONCLUSION

Improving the interactivity is important for involving the students more actively during lectures. It makes lectures more fun for both students and lecturers and is likely to have a positive impact on the students' learning.

In this paper we proposed six patterns that help with designing more interactive lectures. They are part of larger work on a pattern language for lecture design.

REFERENCES

ALEXANDER, C., ISHIKAWA, S., AND SILVERSTEIN, M. 1977. *A Pattern Language: Towns, Buildings, Construction*. Oxford University Press.

ANTHONY, D. L. G. 1996. Patterns for classroom education. In *Pattern Languages of Program Design 2*, J. Vlissides, J. Coplien, and N. Kerth, Eds. Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA, 391–406.

BERGIN, J., KOHLS, C., KÖPPE, C., MOR, Y., PORTIER, M., SCHÜMMER, T., AND WARBURTON, S. 2015. Assessment-Driven Course Design - Foundational Patterns. In *Preprints of the 20th European Conference on Pattern Languages of Programs, EuroPLoP'15*. Irsee, Germany.

FRICKE, A. AND VÖLTER, M. 2000. Seminars - A Pedagogical Pattern Language about teaching seminars effectively. In *Proceedings of the 5th European Conference on Pattern Languages of Programs, EuroPLoP 2000*. Number Dec 12, 2002. Irsee, Germany.

KÖPPE, C. 2013a. A Pattern Language for Teaching Design Patterns. *Transactions on Pattern Languages of Programs 3*, 24–54.

KÖPPE, C. 2013b. Towards a Pattern Language for Lecture Design: An inventory and categorization of existing lecture-relevant patterns. In *Proceedings of the 18th European Conference on Pattern Languages of Programs, EuroPLoP'13*. Irsee, Germany.

KÖPPE, C., NIELS, R., HOLWERDA, R., TIJSMA, L., VAN DIEPEN, N., VAN TURNHOUT, K., AND BAKKER, R. 2015. Flipped Classroom Patterns - Designing Valuable In-Class Meetings. In *Preprints of the 20th European Conference on Pattern Languages of Programs, EuroPLoP'15*. Irsee, Germany.

KÖPPE, C. AND NIJSTEN, M. 2012. A pattern language for teaching in a foreign language - part 1. In *Proceedings of the 17th European Conference on Pattern Languages of Programs - EuroPLoP '12*. ACM Press, New York, New York, USA, 1–14.

KÖPPE, C. AND PORTIER, M. 2014. Lecture Design Patterns: Improving the Beginning of a Lecture. In *Proceedings of the 19th European Conference on Pattern Languages of Programs, EuroPLoP 2014*. ACM, Irsee, Germany.

KÖPPE, C. AND SCHALKEN-PINKSTER, J. 2013a. Lecture Design Patterns: Improving Interactivity. In *Proceedings of the 20th Pattern Languages of Programs conference, PLoP'13*. Hillside Group, Monticello, Illinois, USA.

KÖPPE, C. AND SCHALKEN-PINKSTER, J. 2013b. Lecture Design Patterns: Laying the Foundation. In *Proceedings of the 18th European Conference on Pattern Languages of Programs, EuroPLoP'13*. Irsee, Germany.

MCCARTNEY, R. AND TENENBERG, J., Eds. 2013. *ACM Transactions on Computing Education (TOCE) - Special Issue on Alternatives to Lecture in the Computer Science Classroom*. Vol. 13. ACM.

PEDAGOGICAL PATTERNS EDITORIAL BOARD. 2012. *Pedagogical Patterns: Advice for Educators*. Joseph Bergin Software Tools, New York, NY, USA.

APPENDIX

Summary of Existing Patterns

In an earlier paper we already described five patterns the help with improving interactivity in lectures [Köppe and Schalken-Pinkster 2013a]. Table II gives a summary of these patterns.

Pattern Name	SUMMARY
REMOTE HAND	When demonstrating a tool, let the students tell you what to do and then execute it so that everyone can see it. Combine the tool's feedback with your own.
QUESTION BOOMERANG	Send a question back to the students like a boomerang. Let them try to answer it themselves as group or to think of possible answers. Do this repeatedly until they found the answer themselves or the question requires the introduction of new material.
STUDENT MINERS	Introduce the concept through questions that are related to existing knowledge and lead towards the new concept; don't present the concept yourself directly. Let multiple students provide a variety of answers to these questions and lead the group through follow-up questions towards the new concept. Mine the new concept from all answers together with all students.
QUESTION PARKING SPACE	If a question comes up during a lecture that cannot be answered directly —either because you don't know the answer or because you don't have the time or possibilities to answer it—put it in a parking space and provide an answer at a more suitable time or in a more suitable way.
COLLABORATIVE SUMMARY	Create a list of covered content interactively with the help of the students. Write everything down where it is visible to all students. In case you've prepared such summary in advance, e.g. on a slide, show it after this collaborative activity and use it only as control if something was missing.

Table II. : Summaries of referenced patterns

Table III contains summaries of all other referenced patterns (in alphabetical order), adapted from [Köppe and Schalken-Pinkster 2013b; Köppe and Portier 2014; Köppe 2013b].

Pattern Name	SUMMARY
ACTIVE STUDENT[Pedagogical Patterns Editorial Board 2012]	Keep the students active, in class and out of class..
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.
EXPAND THE KNOWN WORLD [Pedagogical Patterns Editorial Board 2012]	Explicitly link a new concept to experiences the students already have when introducing it.
IMAGINATION STIMULATION [Köppe and Schalken-Pinkster 2013b]	Add activities to a lecture and use delivery forms and contents that stimulate the students' imagination.
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.
LEARNING OUTCOMES [Bergin et al. 2015]	State the goals of your teaching in a clear, active, and measurable manner and make these visible at the start of the course or lesson.
LECTURE STRUCTURING [Köppe and Schalken-Pinkster 2013b]	Investigate and design the optimal flow of the contents and delivery forms of a lecture.
MISCONCEPTION ASSESSMENT (to be published)	Explicitly assess the students for common misconceptions of threshold concepts in order to identifying necessary corrective actions.
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.
REGULAR ATTENTION RECUPERATION [Köppe and Schalken-Pinkster 2013b]	Add activities to a lecture and vary in delivery forms to allow students to recuperate their attention.
SEE BEFORE HEAR [Pedagogical Patterns Editorial Board 2012]	Give learners the opportunity to see and experience a new concept before they her about it.
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.
SHOTGUN SEMINAR [Pedagogical Patterns Editorial Board 2012]	When student groups research a topic, encourage them all to work on the topic by choosing the presenter randomly right before the presentation.
SUITABLE CONTENT SELECTION [Köppe and Schalken-Pinkster 2013b]	Ensure that mainly content is selected and delivered that fits lectures as form of content delivery for the learning goals.
SUITABLE DELIVERY FORM SELECTION [Köppe and Schalken-Pinkster 2013b]	Explore different delivery forms and select the valuable ones for your lecture design so that the students are engaged and that the delivery forms fit the content.

Table III. : Summaries of referenced patterns