UNC CHARLOTTE

Handbook of

Active Learning Patterns

University of North Carolina at Charlotte (UNCC)
College of Computing and Informatics

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Authors

Nasrin Dehbozorgi, Mary Lou Maher, Celine Latulipe, Harini Ramaprasad

For more information contact: Nasrin Dehbozorgi

Email**:** ndehbozo@uncc.edu

Website: innovationsteched.com

Published papers on Active Learning Patterns:

[1] Dehbozorgi, N., MacNeil, S. (2019, October). Semi-automated Analysis of Reflections as a Continuous Course Improvement Tool , In Frontiers in Education Conference (FIE). IEEE.

[2] Dehbozorgi N. Maher M.L., MacNeil S, Dorodchi M. (2018). An Object-Based Pedagogical Design Pattern Model for Collaborative Active Learning, Computer Science Education journal, (manuscript under review)

[3] Dehbozorgi, N., MacNeil, S.,Maher, M.M., & Dorodchi, M.(2018, October). A Comparison of Lecture-based and Active Learning Design Patterns in CS Education, In Frontiers in Education Conference (FIE). IEEE.

[4] Dehbozorgi, N. (2017, August). Active Learning Design Patterns for CS Education. In Proceedings of the 2017 ACM Conference on International Computing Education Research (pp. 291-292). ACM.

[5]Dehbozorgi, N. Maher, M. L., Dorodchi, M. (2017). "Development, Application and Evaluation of Activity-Based Learning (ABL) Design Patterns in CS Education", Poster at ICER 2017

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Team Based Approach to Active Learning

Collaboration and teamwork is an integrated part of active learning. Teamwork has been practiced for a long time in capstone courses (AKA heavyweight team). However, lightweight teams inside active learning classes has proved to be as effective while it has its own challenges. Over the past five years of practicing teamwork in active learning classes, we identified existing challenges in team-based active learning and possible solutions based on research about teamwork and empirical evidence of best practices of active learning. This led us to generate an active learning object-based pattern model and a set of patterns. The pattern model includes teamwork attributes and a set of values for each attribute which can be applied based on instructor's preference. Our pattern model two main components:

1- Meta-data: Provides information about high-level category of the problem the pattern addresses and its goal.

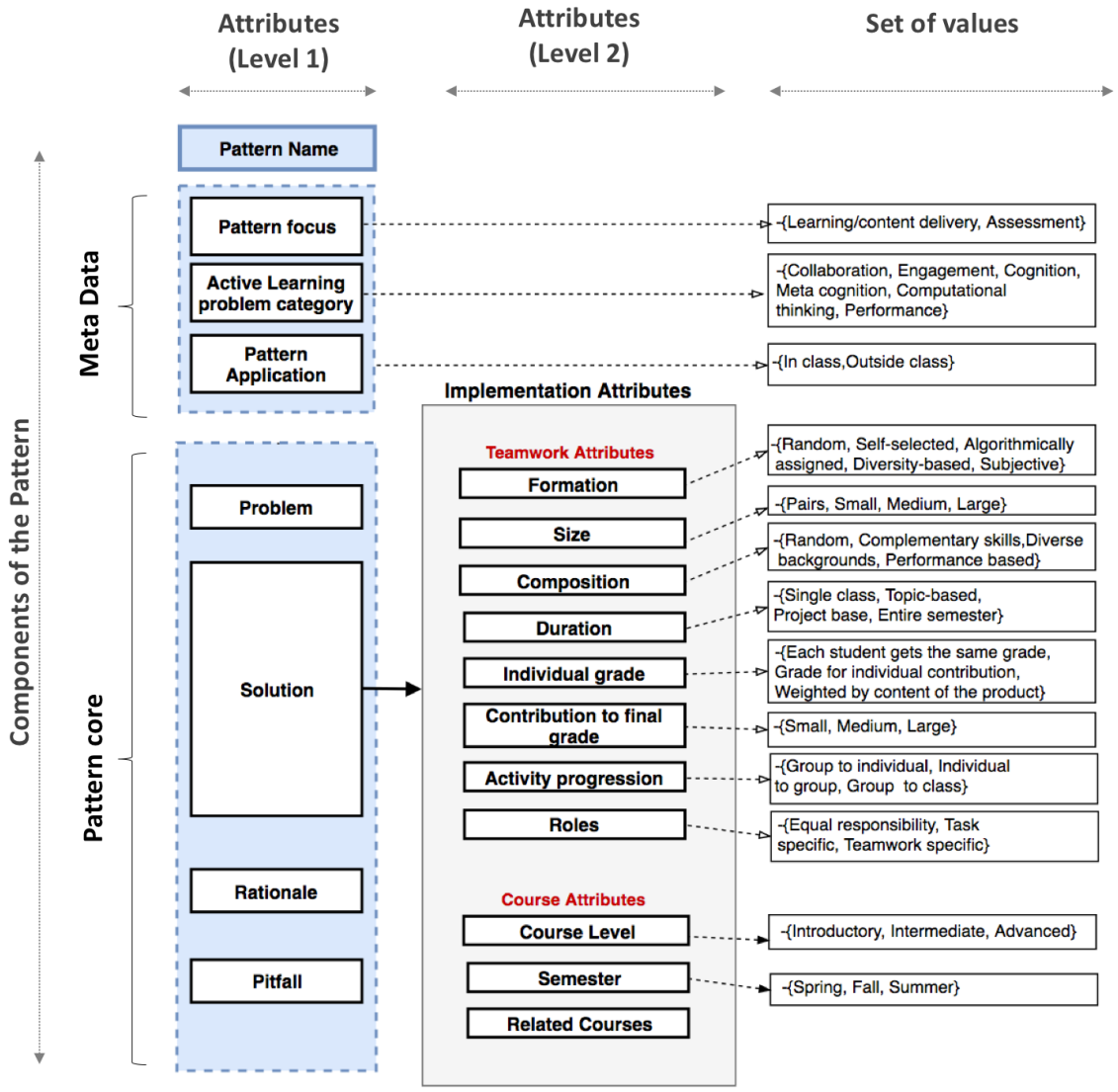
2- Pattern core: Includes four main attributes of: *problem, solution, rationale,* and *pitfall*. *solution* includes second level attributes which are 'teamwork' and 'course' attributes. The teamwork attributes are: *team formation, team size, duration of teamwork, individual grade in teams, teamwork product contribution to final grades, activity progression and roles in teams*. The course attributes provide insights about application of the pattern in a course or context specific domain. The course attributes are: *course level, semester and related courses*.

Depending on how the solution is going to be applied different values can be assigned to the second level attributes.

Successful active learning in the classroom requires systematic course design and practice. We believe other than teamwork, preparation work is an important aspect of active learning as well. Effective preparation work by students before attending the class allows them to deepen their understanding during the class and also allows optimum utilization of resources (i.e. professors, TAs, class time, problem solving with peers, etc.). We present our developed patterns in four main categories of: 1) Prep work patterns, 2) In-class activity patterns, 3) Teamwork patterns and 4) Reflection and feedback patterns.

This handbook includes the object-based model and a set of active learning patterns which offer the high-level and abstract solution for common problems in team-based active learning based on our experiment. However, different variations of teamwork and course attributes and incorporating them into *solution* is not mentioned to give the flexibility of extending solutions by instructors and course designers.

Object-Based Pattern Model



The second level attributes of the solution are optional and can have different values in each implementation depending on the course and instructors' preference.

Preparation Patterns

Short lectures before class	
Metadata	
Pattern focus	Learning/ Content delivery
Active Learning problem category	Engagement/ Cognition
Implementation	Outside class
Pattern Core	
Problem	Long lectures encourage passive learners and many students fall asleep in long lectures during class.
Solution	Create short video lectures and make them available online for students to watch before attending a scheduled class activity.
Rationale	Reduce passive learning during class time. Students have more time to ask their questions and get guidance from the instructor during the class.
Pitfalls	Breaking course content into chunks and the process of making a video may be a challenge for the instructor. Students may choose not to watch the lectures before class. Students may feel that watching videos online and alone is too passive. Watching videos is a passive learning that needs a follow up learning experience.

Online Textbook Studies before class	
Metadata	
Pattern focus	Learning, content delivery
Active Learning problem category	Cognition
Implementation	Outside class
Pattern Core	
Problem	Students are not prepared to learn from in class activities if they have not been exposed to the learning material before class.
Solution	Engage students by having them study online textbooks where they can study the material and do some activities in the book. Provide some reading assignments for them or have them practice the concepts in the tutorials.
Rationale	Students get exposed to diverse types of material for preparation work.
Pitfall	Finding the right resource might be a challenge for the instructor.

Requiring prep work	
Metadata	
Pattern focus	Learning/ assessment
Active Learning problem category	Cognition
Implementation	Outside class
Pattern Core	
Problem	Students might skip doing the prep work before attending the class.
Solution	Don't allow the students to access the in-class material until they have indicated that they have completed the prep work.
Rationale	Students take more responsibility in doing prep work timely.
Pitfalls	Students might acknowledge that they did the prep material while they have not completely finished the prep work.

Short quiz before class	
Metadata	
Pattern focus	Learning/ assessment
Active Learning problem category	Engagement/ Cognition
Implementation	Outside class
Pattern Core	
Problem	Students might not pay enough attention to the prep material or skip doing it. Instructors need to know the students' preparedness level before proceeding with the class activities.
Solution	Have students answer a short quiz after completing the prep work.
Rationale	This quiz can act as a forcing function to complete the prep material. The quiz provides a learning opportunity for students to learn from their mistakes. Based on the quiz grades instructors can monitor how many have done the prep work and also assessing their level of knowledge after finishing the prep work.
Pitfalls	Because of low grade contribution of prep-quizzes some students might skip doing them. Some students might need additional instruction to learn the content and do well in the quiz even if they have done the prep-work. Designing the pre-quiz with the right challenge level needs to be well thought.

Collaborative online activities before class	
Metadata	
Pattern focus	Learning/ Content delivery
Active Learning problem category	Collaboration/ Engagement
Implementation	Outside class
Pattern Core	
Problem	Students lack motivation to learn the material and be prepared before the class.
Solution	Design some activities related to the lecture video that students watch before coming to class and have them work collaboratively. Every badge that any individual earns by solving the problems can be rewarded to the whole group.
Rationale	Students are motivated by peer pressure and reward.
Pitfall	Some students might rely on their teammates and do not put much effort in solving the problems. Some students may feel that the reward does not have enough direct impact on their grade.

Collaborative online videos before class	
Metadata	
Pattern focus	Learning/ Content delivery
Active Learning problem category	Collaboration/ Engagement
Implementation	Outside class
Pattern Core	
Problem	Watching videos alone is passive and students may get distracted easily.
Solution	Use anchored collaboration techniques to embed forums into video watching sessions. Require that student groups submit a consensus on the most important points of the video lecture before class to get credit for preparation work.
Rationale	Students can interact with their peers and engage more actively as they consume content online.
Pitfall	Determining student's participation can be a challenge for the instructor.

Collaborative quiz before class	
Metadata	
Pattern focus	Learning, Assessment
Active Learning problem category	Collaboration, Engagement, Cognition
Implementation	Outside class
Pattern Core	
Problem	Students may not pay attention to the prep material unless they are graded on their understanding before class.
Solution	Before attending the class, students take a quiz and see the results. They discuss about the results in a forum or survey with other students.
Rationale	Students address their problems and misconceptions by getting help from their peers. It encourages collaboration between students.
Pitfall	Peers might unknowingly deliver incorrect information to the students.

In-Class Activity Patterns

Interactive real-time quiz in-class	
Metadata	
Pattern focus	Assessment
Active Learning problem category	Collaboration/ Engagement/ Performance
Implementation	In class
Pattern Core	
Problem	Students are not always motivated to study preparation materials for the class.
Solution	Develop interactive real-time quizzes that students take during the class. Engage students in answering individually or to discuss it with their team or both individually and together. The use of interactive quizzes makes the results visible anonymously to everyone and allows students to see their own and others mistakes instantly.
Rationale	Engages students in the material with feedback available to them instantly. Helps in learning with low stress. Interactive quizzes are the basis for peer learning, while the students are not dependent on their teammates to answer.
Pitfall	Designing quizzes requires a good amount of time and effort for the instructor. If a student did not do the preparation study, the learning benefit is diminished. Students may not have learned some of the concepts in the preparation study and need more instruction. Most real-time interactive quizzes are multiple choice questions and these kinds of questions only address recall, potentially missing application and synthesis learning.

Applied learning activity in-class	
Metadata	
Pattern focus	Learning/ Content delivery
Active Learning problem category	Collaboration/ Engagement/ Cognition
Implementation	In class
Pattern Core	
Problem	Students need to use the concepts from the lecture to learn in more depth and resolve their misunderstandings.
Solution	Expose students to in-class activities which are performed in small groups that require the knowledge in the preparation work to complete the activity.
Rationale	Students to go beyond memorizing generalizations and apply what they are learning. Students figure out if they really understand the material being presented. Students get motivated to do the prep-work before coming to class because of social pressure of working in teams.
Pitfall	Designing class activities and maintaining consistency in the preparation activities with class activities can be a challenge for the instructor. Determining the contribution of the class activities to final grades can also be a challenge for the instructor. Students may not know how to solve problems and will need more time to complete the activity.

Short lectures on demand in-class	
Metadata	
Pattern focus	Learning /Content delivery
Active Learning problem category	Cognition
Implementation	In class
Pattern Core	
Problem	Students are not able to connect the content of preparation work to a class activity.
Solution	Provide short (5-10 min) lectures during in-class activities that address emerging student misconceptions.
Rationale	Students learn more from mini-lectures since they are in demand of information and guidance.
Pitfall	Instructors should be careful that the mini-lectures do not exceed a certain time frame.

Active listening activity in-class	
Metadata	
Pattern focus	Learning /Content delivery
Active Learning problem category	Collaboration/ Engagement
Implementation	In class
Pattern Core	
Problem	Students need to practice and learn how to listen to other students.
Solution	Ask students in a team to respond to a prompt (why did you choose this major? How did you answer the quiz question?). Have each student take a turn to provide a response while the others listen. The listening students are not allowed to interrupt or speak. The student providing the response is given a fixed amount of time to answer. If the student speaking does not need the entire time allocating, then there is silence.
Rationale	Students will learn to listen if they are told not to ask questions or interrupt the student that is speaking.
Pitfall	Identifying the prompt and the amount of time for each student to speak may be difficult.

Teamwork and Collaboration Patterns

Think-pair-share in-class	
Metadata	
Pattern focus	Learning/Content delivery
Active Learning problem category	Collaboration/ Engagement/ Cognition
Implementation	In class
Pattern Core	
Problem	Group activity can reduce time for individual reflection.
Solution	Structure group activity so that there is time for individual reflection before the group discusses and submits a solution.
Rationale	By providing time for individual reflection and teamwork, different learning styles are accommodated.
Pitfall	Keeping teams on the same schedule is a challenge because students need different amounts of time for reflection.

High-stake teams in class	
Metadata	
Pattern focus	Learning/ content delivery
Active Learning problem category	Collaboration/ Engagement/ Cognition
Implementation	In class
Pattern core	
Problem	Students do not demonstrate enough collaborative and social skills to perform well in teams outside the class.
Solution	Assign students to teams during the class and have them work on activities together in senior course level classes.
Rationale	Students learn many concepts from their peers. Class time is more dynamic and students learn how to work in teams to prepare for being a computing professional.
Pitfall	Students need some time to reflect on concepts individually and not fully rely on teammates in solving problems. Teamwork can impose some grade stress on students (especially high achievers). Fair task distribution in teams and assessing individuals can be a challenge.

Medium stake teams	
Metadata	
Pattern focus	Learning, Assessment
Active Learning problem category	Collaboration, Engagement, Cognition
Implementation	In class
Pattern Core	
Problem	Students need to learn how to work in teams in which there is reasonable contribution towards their grade, while not having the stress of a large contribution to the grade.
Solution	Have students work on and submit assignments in groups. The contribution of the teamwork to their final grade is relatively higher than low-stake teams but less than high stake teams.
Rationale	Students learn how to collaborate in teams with assigned roles and work together towards creating a coherent submission without worrying about their grades.
Pitfall	High performing students may not see the value in collaborating. Some students may not contribute their fair share of work to the assignment.

Low-stake (lightweight) teams in-class	
Metadata	
Pattern focus	Learning/ content delivery
Active Learning problem category	Collaboration/ Engagement/Cognition
Implementation	In class
Pattern Core	
Problem	Students' performance in teams in negatively affected by the importance of the grade.
Solution	Create teams for in-class activities that do not have significant contribution to final grades and encourage students to learn from each other in introductory level classes.
Rationale	Reduces students' stress to perform well to get a good grade and encourages social learning.
Pitfall	Students may still worry about unequal contribution to teamwork. Students may get discouraged by low grade contribution.

Teamwork grade assignment	
Metadata	
Pattern focus	Assessment
Active Learning problem category	Collaboration, Engagement, Cognition
Implementation	In class or outside class
Pattern Core	
Problem	Evaluating teamwork and individuals in collaborative environments is a challenge.
Solution	In heavy stake teams assign grades based on the final product. In medium and low stake teams that the emphasis is more on students' learning assign grades based in individual's contribution to eliminate the grade stress with lower contribution to final grade.
Rationale	Diverse strategies for assessing teamwork gives the flexibility to focus on different aspects of team work such as cognition, collaboration and application of the knowledge.
Pitfall	Coming up with right strategies for grade assignment in team for each course requires instructor to be experienced in collaborative learning environment.

Reflection and Feedback Patterns

Reflection on teamwork	
Metadata	
Pattern focus	Assessment
Active Learning problem category	Collaboration, Engagement
Implementation	Inside/Outside class
Pattern Core	
Problem	Student reflection on their participation and interaction in teams does not happen unless it is requested.
Solution	Ask students to fill out a short survey (request for reflection) about their teamwork experience after each teamwork activity.
Rationale	Encouraging students to talk about collaborative/cooperative experience encourages learning through self-assessment. This is in contrast to the assessment made by the instructor.
Pitfall	Low performing students in groups may not provide the necessary details. Students may not appreciate the benefit of reflection and may need to see how it relates to their grade before they take it seriously.

Reflection on learning	
Metadata	
Pattern focus	Assessment
Active Learning problem category	Cognition, Meta cognition
Implementation	Inside
Pattern Core	
Problem	Students don't have many opportunities to reflect on learning in teams and it does not happen unless it is requested. Instructors are unaware of students' challenges in course content and teamwork submission may not reveal each individuals' gap in understanding the class material.
Solution	Have students fill out a short survey before leaving the class or at certain times during the semester. The survey can be open ended or Likert scaled.
Rationale	Developing meta-cognitive skills as it encourages students to think about their learning. Improves learning through self-assessment. This is in contrast to the assessment made by the instructor. Support the instructor in understanding what the students found challenging. Reflection is super short so students are more likely to do it.
Pitfall	Asking students directly about their learning may not always reveal valuable information. Some students may not answer the forms thoughtfully.

Feedback

Thanks for reviewing this handbook.

If you have any comments, suggested new patterns or examples of applying presented active learning patterns in this handbook, we are interested to hear from you.

To share your feedback please contact:

Nasrin Dehbozorgi

Email: ndehbozo@uncc.edu