



Handbook of

Active Learning Design Patterns

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**This work is supported by the National Science Foundation Award 1519160:
IUSE/PFE:RED: The Connected Learner: Design Patterns for Transforming Computing
and Informatics Education.**

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Published papers on Active Learning Design Patterns:

- [1]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.
- [2] 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.
- [3]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 heavy weight 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 researched on 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 design pattern model and a set patterns. The model includes teamwork attributes and set of values for each attribute which can be applied based on instructor's preference. Our developed design pattern model has four three 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 capture the teamwork aspect of the solution (when applicable).

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

3- Implementation: Provides insights about application of the pattern in a course or context specific domain. This includes three attributes of: *course level*, *semester* and *related courses*.

Successful active learning experiment 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.). For this goal we propose our developed design patterns in three main categories of: 1) prep work patterns, 2) In-class activity patterns and 3) Teamwork patterns.

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

Preparation Design Patterns

Pattern Name: 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. Have them take a short quiz on the videos and give credit based on quiz scores.
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.
Implementation	
Course level	Any
Semester	Any
Related CS courses	Any

Pattern Name: 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.
Implementation	
Course level	Any
Semester	Any
Related CS courses	Any

Pattern Name: 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.
Implementation	
Course level	Any
Semester	Any
Related CS courses	Any

In-Class Activity Design Patterns

Pattern name: Interactive real-time quiz questions activity 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.
Implementation	
Course level	Any
Semester	Any
Related CS courses	Any

Pattern name: 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.
Implementation	
Course level	Any
Semester	Any
Related CS courses	Any

Pattern name: 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.
Implementation	
Course level	Any
Semester	Any
Related CS courses	Any

Teamwork and Collaboration Design Patterns

Pattern name: Teamwork in-class	
Metadata	
Pattern focus	Learning/ content delivery
Active Learning problem category	Collaboration/ Engagement
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.
Rationale	Students learn many concepts from their peers. Class time is more dynamic and students learn social skills.
Pitfall	Students need some time to reflect on concepts individually and not fully rely on teammates in solving problems. Team work can impose some grade stress on students (especially high achievers). Fair task distribution in teams can be a challenge.
Implementation	
Course level	Any
Semester	Any
Related CS courses	Any

Pattern name: 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.
Implementation	
Course level	Any
Semester	Any
Related CS courses	Any

Pattern name: Lightweight teams in-class	
Metadata	
Pattern focus	Learning/ content delivery
Active Learning problem category	Collaboration/ Engagement
Implementation	In class
Pattern Core	
Problem	Students' performance in teams is 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.
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.
Implementation	
Course level	Any
Semester	Any
Related CS courses	Any

Pattern name: Lightweight team grade assignment	
Metadata	
Pattern focus	Assessment
Active Learning problem category	Collaboration/ Engagement/ Performance
Implementation	In class
Pattern Core	
Problem	Lightweight teams (Table 1) with the grade assigned based on team results disadvantages well prepared and high achieving students.
Solution	Assign grade for team activity as the average or the higher of the individual and group grade. This works best with clicker quizzes when you can re-poll each question.
Rationale	Encouraging students to come to class prepared.
Pitfall	Low performing students will continue to come unprepared.
Implementation	
Course level	Any
Semester	Any
Related CS courses	Any

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:

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