

The jigsaw puzzle method: A way to promote activating and student-centred teaching

Jakob HARDEN¹

¹Graz University of Technology (Graz, Austria)

Corresponding author email address: jakob.harden@tugraz.at

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Abstract

The jigsaw puzzle method is a teaching method from the field of group work. Particularly in university teaching the options, front-of-class teaching and individual assessment, are still preferred. Group work, on the other hand, is used relatively rarely. A fact often neglected is that the resulting teamwork can specifically promote key competencies that play a significant role in the professional life of graduates. This article aims to motivate teachers to use group work in their lessons and thus enrich the methodological diversity of their teaching. This article contains suggestions for the required materials and information on how to carry out the jigsaw puzzle method. That helps to get started with this teaching method and the didactic preparation. These suggestions and materials are a result of the repeated application of this teaching method in a course in the master's degree in civil engineering sciences.

Keywords: teaching method, jigsaw-puzzle, activating, student-centred

Categories: didactics, method

1 Introduction

Context: In university teaching, front-of-class teaching and individual assessment are used most frequently. That ignores the fact that university graduates usually have to perform their work in teams in professional life. In addition to faculty-specific competencies, key competencies play a significant role here. Thus, it makes sense to promote them as well, whereas well-prepared group work helps to achieve that goals. That is because the self-organized activity of the students, cooperation and communication in the team plays a significant role in group work.

Problem: Despite the benefits, group work is often rejected and associated with the following problems:

- (a) Free Riders
- (b) lack of opportunity to assess individual performance
- (c) expenditure time for little content

Approach: The presented application of the jigsaw puzzle method (JPM) shows how to successfully organize and conduct group work. That is made possible by good preparation and targeted use.

- **Free riders (a)** are widely impossible. Although students prepare the topics in the group, they must present them individually.
- Assigning group work and individual work to the students during the course counteracts the **lack of an opportunity to assess individual performance (b)**.
- The **expenditure of time for little content (c)** plays a subordinate role when using that teaching method for the necessary repetition and deepening of important learning content.

The JPM is well suited to give students an overview of an extensive topic. Individual topics can then be dealt with in detail subsequently. In addition, the JPM promotes key competencies needed in professional life.

Literature: Different variants of this teaching method are already well presented in the literature[1][2]. Reading the literature is recommended because only a brief introduction to the teaching method is provided here. This article is an addition to a conference talk held by the author at the teaching conference “In Love with Teaching” at Graz University of Technology in February 2023. The poster[3] presented during that talk contains a summary of the main features of the JPM. It is also made available under an open license at the Graz University of Technology repository.

Motivation and Target: This work aims to motivate teachers to use group work in the classroom. Therefore, this work offers suggestions for didactic preparation and information on applying this teaching method in a lecture. That helps to facilitate access and the implementation of this method. This work also contains suggestions for the didactic preparation and the teaching materials. They are a result of the author's experience from recurrent use in a course in the master's degree in civil engineering.

Special features: The JPM is student-centred and promotes the activation of the students through a high degree of self-organized, independent work guided by the teacher. Another feature of the JPM presented here is lengthening the initial Phase I and its holding in asynchronous form. That time extension allows for processing more extensive and complex topics. Furthermore, the asynchronous holding of Phase I makes this variant of the JPM become a “blended” teaching and learning scenario.

Applications: Due to the organizational structure of the JPM, it is applicable in courses with up to 30 participants. The methodology fits course types like exercises and lectures and is particularly viable for deepening and consolidating already known learning content. Appropriate preparation also makes this method applicable in online settings.

2 Materials and Methods

This section first introduces the workflow of the JPM. That serves to get an overview of the structure of that teaching method and makes it easier to get started. In particular for those who are not familiar with that teaching method. Then, the requirements for didactic preparation and the teaching materials are discussed. The provided explanations and examples should help to support teachers with the didactic preparation of a course and reduce the implementation time amount. Finally, the key competencies that are particularly encouraged by this teaching method are summarized.

2.1 Introduction to the teaching method

The implementation of the JPM consists of four consecutive phases. These four phases are preceded by didactic preparation. All necessary process steps are briefly described in Table 1. In addition, a graphical representation of the organizational structure is shown in Figure 1.

Element	Description
Preparation	create teaching materials, topic selection, group assignment, scheduling, assign topics to groups, work assignment
Phase I: core teams	The students work independently on the content of the subtopic and prepare a short presentation. This makes them experts in their subtopic.
Change of group	The members of the core teams are divided evenly among expert teams, such that each expert team has at least one expert for each subtopic.
Phase II: expert teams	The experts take turns presenting their subtopic and answering the questions of the other experts. The experts of the core teams thus also become experts for the subtopics of the other core teams.
Change of group	The experts are returning to their core teams. They are now experts on all subtopics.
Phase III: core teams	In the core teams, the topics of the other teams are presented and discussed together.
Break up groups	The core teams are dissolved and the discussion in the plenary follows.
Phase IV: discussion in plenum	Finally, all topics are discussed together with the teacher. Here questions can be asked and answered together. Any misunderstandings and incorrect representations can be clarified by the teacher. The teacher has the opportunity to obtain feedback from the students in order to recognize special challenges and to adapt the didactic preparation if necessary.

Table 1: Process description of the JPM

2.2 Didactic preparation

Good didactic preparation by the teacher is essential for successfully applying the JPM. First, cross-check whether that method is fitting to the overall didactic concept of the course in a meaningful way or not. In the didactic preparation, it is significant to ensure that the strengths of this method come into their own. That is not always the case. Therefore, it is reasonable to choose a different teaching method instead. That also fosters the desired methodical mixture within a course. The strengths of the JPM are:

- Get an overview of a complex or extensive topic
- Repetition and deepening of already-known teaching content
- Promotion of key-competencies

In order to use the method successfully, consider the following points.

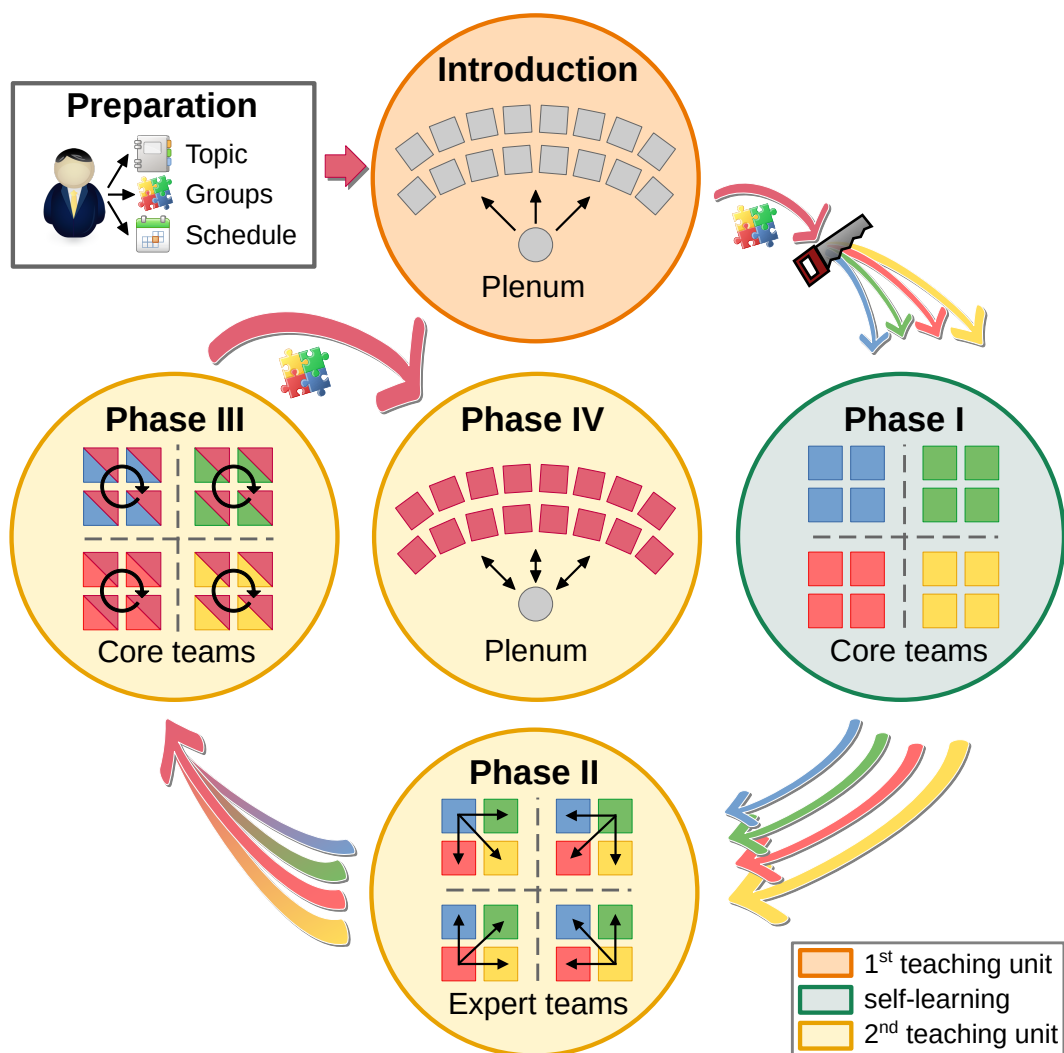


Figure 1: Organizational structure of the JPM with modification in the initial Phase I

Selection of topics: A requirement is to define the subtopics for the individual groups in a way that allows students to prepare, document and present them in a few minutes. All subtopics should be part of a higher-level topic and form a whole. Selecting an extensive topic and subdividing it into smaller subtopics is advisable. Choose the scope of that subtopic such that the time to present the respective subtopic does not exceed approximately five minutes.

Scheduling: Two appointment dates one to two weeks apart are required to carry out the teaching method. The first appointment is to introduce the students to the topics, the teaching method and the organization. The next step is Phase I, in which the students work through the content independently. The length of Phase I depends on the content and the effort involved in developing it and creating a short presentation from it. The second appointment includes the implementation of Phase II to IV. A suggestion for the schedule, based on empirical values, can be found in Table 3.

Group assignment: Existing or new group assignments can be used here. Nevertheless, the number of groups and subtopics has to be equal. Furthermore, the number of group members must also correspond at least to the number of subtopics. That ensures that sufficient experts are available for the expert teams in Phase II.

Introduction: The introduction of the students to the organization and process of the JPM in the first teaching unit requires some materials. These materials should contain the subtopics, the schedule, a description of the process, the work assignment and the assessment criteria. They are used in the first teaching unit and serve as a guideline for the students later. A checklist is presented in Table 2.

Work assignment: To support the students during the independent development of the content in Phase I, to promote a structured process and to communicate the expectations of the results, it makes sense to do this in the form of a work assignment. To convey the expectations of the teacher, it is helpful to supply students with key questions related to the individual subtopics. Further information on formal requirements, methods, materials, and available time provides additional clarity. A checklist for the work assignment is offered in Table 4.

Final discussion: The final discussion in Phase IV is the place to rejoin the subtopics again. Students and the teacher summarize and discuss the topic together. That discussion is also an opportunity to clear up any ambiguities and misunderstandings that might have come up. A dialogical classroom talk is a suitable form of teaching. That also promotes the activation of the students in the best possible way. In the course of the discussion or immediately afterwards, it makes sense to gather feedback from the students on the content and formal aspects of the teaching method.

Feedback: Collecting feedback at the end of Phase IV helps evaluate the learning outcomes and success of the learning scenario. That is particularly important when the teaching method is unknown to the students or used rarely. Therefore, questions used in the survey should address the teaching content and the teaching method. That enables the teacher to recognize

what was incomprehensible or particularly difficult for the students during the group work. It is recommended to conduct the evaluation anonymously because students rarely dare to criticize a teaching method in the plenum, and thus the teacher itself. For example, the audience response tool “feedbackr[4]” can be used for this. However, criticism should not be understood as a personal attack on the teacher. It represents a valuable opportunity for teachers to learn and further develop their teaching[5]. In this way, one can adapt the teaching method to any circumstances in the course. That also allows for further development of the teaching method (e.g. selection of topics, placement of the teaching method in the lecture, the content of the assignment, and time planning). An example questionnaire is given in Table 5.

Performance assessment: The results from the work assignment (short presentations) and the survey of the students at the end of the learning scenario can be used for the performance assessment. However, it is not possible to assess individual performance. Therefore, it makes sense to see the group work in the context of the entire course and to supplement it with other tasks with individual assessment.

2.3 Promotion of key competencies

While carrying out the group work, the students have to face different challenges. Besides expanding professional skills through the processed teaching content, the JPM also promotes a number of key competencies that will be needed later in professional life. Examples of this are organizational, communicational and decision-making skills. Below, please find a collection of the key competencies addressed within the student activities.

- **Capturing** the content in the initial Phase I and during the short presentations.
- **Summarizing** the content into a short, concise presentation.
- **Deciding** what is mandatory and has to be delivered and discussed in the presentation.
- **Communicating** the content of the subtopics. Discussion of the content within the group. Participation in the final discussion by asking questions and giving answers.
- **Organizing** the workload distribution within the group when creating the short presentation.
- **Presenting** the content during the short presentations.
- **Assessing** the presented content in terms of its priority and correctness. Critical questioning of the content.

Here is to mention that some competencies (e.g. making decisions, organizing, assessing) are usually solely assigned to the teacher. This form of group work also allows the students to strengthen those competencies.

3 Results and Discussion

In this section, the results of the implementation of the teaching method in a master's degree course in civil engineering are presented. The checklist for the didactic preparation, the modification of the initial Phase I, the schedule, the work assignment for the students and obtaining

feedback are discussed. The illustrations and descriptions serve as references and guidance for the didactic preparation. They should support teachers in implementing the JPM in their courses. Furthermore, it is necessary and encouraged to adapt those materials to specific thematic requirements of the lecture.

3.1 Checklist for the didactic preparation

The checklist in Table 2 lists the points of consideration for the didactic preparation. The experience has shown that one should plan for two to three working days to create the required teaching materials. It is also possible to conduct the JPM in online settings (see also point 9). In this case, safe handling of the chosen video conference tool is mandatory to ensure a smooth process. Therefore, it is strongly recommended to prepare appropriate breakout sessions for core teams and expert-teams breakout sessions beforehand.

#	Description
1	Study of the literature on the teaching method
2	Select main topic, subdivide it into coherent subtopics
3	Draw up dates and schedules for the teaching units
4	Create presentation for the introduction (slides, flipchart, whiteboard)
5	Compile worksheet for work assignment (SMART)
6	Create a feedback questionnaire or “feedbackr” survey (content and method)
7	Share all teaching materials with the students (e.g. TeachCenter, moodle)
8	Prepare submission options for short presentations (e.g. TeachCenter, moodle)
9	Online Hosting: Prepare breakout sessions for the groups

Table 2: Checklist for the didactic preparation

3.2 Modification of the initial Phase I

The modification of the initial Phase I was introduced to give the students more time to develop the content and create a short presentation. Especially in the engineering sciences, it is easier to present content through pictures. However, this requires more preparation time than summarizing a passage of text. If Phase I is held in asynchronous mode, the modified variant of the JPM becomes a “blended” teaching and learning scenario. Experience has shown that one to two weeks of preparation time (depending on the content) is appropriate and also favoured by the students. The schema in Figure 2 illustrates the modification of the teaching method in Phase I.

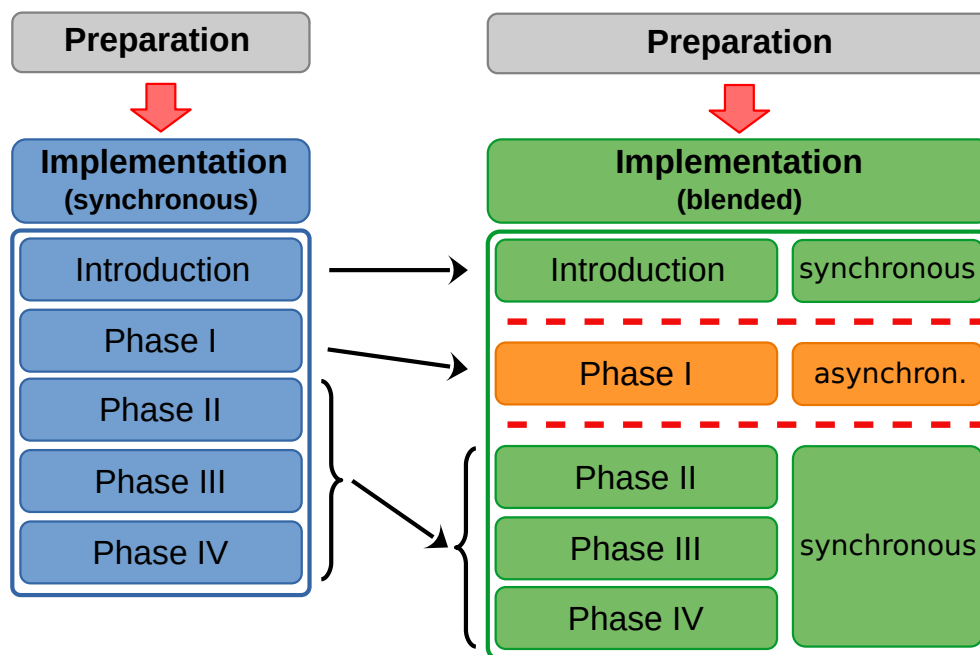


Figure 2: Comparison, the JPM without (left) and with (right) modification of the initial Phase I

3.3 Scheduling the preparation and implementation

The times given in Table 3 for the individual steps are proposed guide values based on empirical values. Attention has to be paid to limiting the presentations in time and content. Otherwise, it will become increasingly difficult for the students to grasp and retain the contents of all subtopics. This kind of group work mainly aims to allow the students to quickly get an overview of an extensive topic or to deepen their knowledge of topics they have learned before.

U	Duration	Description	Materials
—	2-3 wd	didactic preparation	teaching materials
1	2 min	welcoming	—
	5 min	presentation of the content/topics	slides, flipchart, whiteboard
	5 min	introduction to the teaching method	slides, flipchart, whiteboard
	3 min	group assignment	list of participants
	5 min	work assignment	worksheet
	5 min	summary, repetition	slides, flipchart, whiteboard
	25 min	Sum, teaching unit 1	—
—	1-2 wk	working out the topics (Phase I)	e.g. slides
2	5 min	welcoming, repeat the teaching method	slides, flipchart, whiteboard
	5 min	assemble expert teams	list of participants
	5 min p.t.	presentations in expert teams (Phase II)	documents of the students
	5 min	change of groups	—
	5 min p.t.	presentations in core teams (Phase III)	documents of the students
	5 min	break up groups	—
	25 min	discussion in plenum (Phase IV)	slides, flipchart, whiteboard
	10 min	survey and feedback	e.g. “feedbackr”
	≈ 90 min	Sum, teaching unit 2	—

Table 3: Scheduling for preparation and holding. Legend: U ... teaching unit, wd ... working days, wk ... weeks, p.t. ... per topic

3.4 Work assignment

The checklist for the work assignment contains a proposal for the definition of the goal of the work assignment handed over to the students for Phase I. On this behalf, it makes sense to apply the SMART principles[6]. Based on these principles, the worksheet can be created and handed over to the students. Experience even turned out that providing key questions on the subtopics makes the tasks more specific and supports the students in creating their presentations. A list of the SMART principles, including examples, is shown in Table 4.

Principle	Description, Example
S specific	Define and clearly delimit subtopics. Determine the materials and methods to be used. Example: Materials: reference to text passage, book or website Methods: create a short PowerPoint presentation
M measurable	Define formal and content-related criteria for the work creation and assessment. Example: formally: max. 3 DIN A4 pages, preferably graphics, less text, clear presentation, submission as PDF file in terms of content: the key questions must be answered in full, the following aspects of the topic are to be presented: ...
A attractive	Motivate the purpose of the topic and show the benefit of the work. Example: The result of the work supports the subsequent presentation and is helpful in preparing for the exam.
R realistic	Coordinate workload and processing time. Example: 1-2 weeks (depends on content)
T timely	Submission deadline Example: Submit your work as PDF file using the TeachCenter until ...

Table 4: Application of the SMART principles to create the work assignment

3.5 Feedback

The questions shown in Table 5 contain suggestions for creating a feedback questionnaire. The questionnaire consists of three question blocks. Question Block 1 is to be adapted to the lecture topics and is not explained in more detail here. Question blocks 2 and 3 deal with the implementation and personal experience of the students with the JPM.

When using anonymous audience response tools, such as “feedbackr”, it makes sense to use single-choice and multiple-choice questions for the most part. Students usually use that tool on their smartphones, which makes it hard to answer free-text questions. Each block of questions should not contain more than five questions. Always keep in mind, that the attention paid to answering the questions decreases with the effort to answer them.

Experience has also shown that making the answers immediately visible to all students (e.g. live presentation using a video projector) should be avoided. In rare cases, students have used the free text questions, combined with anonymity, as an opportunity to vent their anger and personally unpleasantly attack the teacher.

Questionnaire

Question block 1: content, topics

1 - 5 (adapt to course content)

Question block 2: implementation

- 1 I was already familiar with the jigsaw puzzle method before the course
☐ Yes ☐ No
- 2 The explanations of the process were sufficient
☐ Yes, I got along well
☐ more or less
☐ No, I had no plan what to do
- 3 The information about what the presentation slides should contain was sufficient ...
☐ sure, I knew what to do
☐ reasonably clear, I got by
☐ rather unclear, I needed help
☐ totally unclear, I didn't know what was happening to me right now
- 4 During the presentations the prepared slides were ...
☐ very helpful ☐ helpful ☐ rather unnecessary ☐ totally superfluous

Question block 3: personal impressions of the students

- 1 In terms of content, for me this group work was ...
☐ easy ☐ rather easy ☐ difficult ☐ very difficult
- 2 Emotionally, for me this group work was ...
☐ nice, i want to do it again
☐ ok, you can do it again
☐ rather uncomfortable, I don't have to have it
☐ very uncomfortable, pure stress
- 3 I think that my overview of the edited topics ...
☐ has increased ☐ stays the same
- 4 What was problematic for me?
 Free text: ...
- 5 What did I like?
 Free text: ...

Table 5: Example, feedback questionnaire

4 Conclusions

Finally, the essential findings and experiences in the classroom with the JPM are summarized here. These are a result of the repeated and successful implementation of that method in a course in the master's degree in civil engineering.

Good preparation is the most significant prerequisite for a successful implementation. The students, who are usually unfamiliar with this teaching method, need good informative and formal

support.

The teaching method is very well received by the students. That was observable in the students' presentations and, ultimately, in the learning success.

The teaching method promotes the activation of the students. In particular, the short presentations in the expert teams do not allow for free riders. The visibly lively participation of the students confirmed that as well.

The teaching method is student-centred. In large parts, the students work independently. The teacher takes a back seat and only has a supporting function. Here, too, experience showed that the students clearly enjoyed the self-organized and independent work. On average, they were very motivated. Support from the teacher was occasionally requested and gladly accepted.

The final survey on the teaching method showed that students would like greater variety in the design of the lessons. That is one of the reasons why the teaching method was so well received. The students found the teaching method challenging and strenuous. They also described it as helpful and instructive. That also aligns with the principles of learning psychology - learning does not happen in the personal comfort zone.

By obtaining feedback, the teacher has the opportunity to continuously adapt and improve the application of the teaching method. Through targeted questions about the teaching method and the student's personal experiences, the teacher can research and improve their teaching (Scholarship of Teaching and Learning - SoTL[5]). The highest potential for adjustments lies in the topic selection and the time planning.

Experience, based on repeated implementation, has shown that the number of participants should not be much larger than 30 people. That ensures that the number of groups and subtopics remain within a manageable framework and students can still grasp all of them. Therefore, the method is more suitable for small-scale courses.

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