HOW TO ORGANIZE EFFECTIVE AND EFFICIENT GROUP WORK IN TUTORIALS USING INDICATOR STRIPS

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Many lectures in Statistics are accompanied by weekly tutorials for which exercises are to be solved and possibly submitted. One way to get students actively involved in tutorials is to organize them into small groups of about 3 or 4 students, in which they are to compare and discuss their individual solutions. I describe a simple but efficient method for how such groups can rationally be formed at the beginning of each tutorial and individually be supported by the tutor. This concept is based mainly upon the idea of homogenization. It turns out that this way the learning outcomes are much more sustainable than in traditional "lecture style tutorials" provided that some important frame conditions are met. Longtime experiences in large class Statistics courses with small class tutorials directed by teaching assistants are very positive.

THE PROBLEM

"Learning takes place through the active behavior of the student: it is what he does that he learns, not what the teacher does" is an often-cited conclusion drawn by the American educator Ralph Tyler (1949). Yet it is frequently difficult to cope with this old finding and its well-known implications, specifically if we think of classical lectures. Tutorials on the other hand should really focus on an active learning behavior of all students.

Group work promotes active learning and collaborative skills among students. But it is also important to know that students feel much less inhibited to ask questions and to admit own problems when they talk to each other rather than to the instructor in front of class. Realizing that fellow students have similar problems can be an appeasing and encouraging experience. Yet, the big questions are how meaningful groups can be formed and what group work should look like.

The benefits from group work and cooperative learning as well as the concerns about it were surveyed for example by Garfield (1993). Roseth, Garfield and Ben-Zvi (2008) provide practical tips for implementing and organizing cooperative learning in groups. Similarly the present paper describes a concise framework developed and improved over several years. To the best of my knowledge, this concept, specifically the use of *indicator strips* (we call them this way), is new and has not been used anywhere else before.

GENERAL FRAMEWORK

In the following we assume the situation given in a compulsory Statistics course (typically some Basic Statistics course) comprising large class weekly lectures accompanied by small class tutorials directed by undergraduate or graduate teaching assistants (TAs). For such a setting I suggest the following framework:

1. Every week a new homework assignment is set up. Each assignment includes some *minimum requirement* to be fulfilled (minimum number or selection of exercises to be worked out by every student).
2. Each student needs to work out an individual *homework assignment paper*.
3. At the beginning of each tutorial all students need to submit so-called *indicator strips*, on which they indicate the exercises they actually have worked out and prepared for discussion. Upon this information, *homogeneous* groups of 2, 3 or 4 students are formed.
4. Now the students compare and discuss their individual solutions in groups. Meanwhile these groups are assisted and advised by the TAs. We call this phase *group phase*.
5. Each tutorial may end up with some lecture style phase, which the TAs might use to explain more complex problems or to point out general aspects of major importance. We call this phase *lecture phase*.
6. After the tutorial all participants receive a complete and detailed *sample solution* for the current assignment by email.

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Minimum Requirements

As far as our experience goes it is best to set the minimum requirements in such a way that they can easily be mastered by the average student and that the motivation for copying solutions from other students or from a sample solution is low.

Homework Assignment Papers

Homework assignment papers contain the solutions the students have individually worked out and written down. They need not to be submitted and will not be corrected. But they are the basis for group discussion. Sloppy and hardly legible papers should never be accepted. In general, homework solutions need not to be totally correct. But they should be worked out in a meaningful way.

Indicator Strips

Indicator strips are standardized segmented paper strips, where the segments of each strip correspond to the exercises (e.g. numbered from 1 to 10) of an assignment. The segments are marked by the students according to their individual amount of preparation. It might also be a good idea to distinguish between fully prepared and partly (superficially) prepared solutions. Thereby it is advisable to limit the latter ones to a maximum number (e.g. 1 or 2). By simply lining up all submitted strips *homogeneous* groups can easily be identified and called out by student names. "Homogeneous" means, that each group is formed by members who preferably have worked on the same number and selection of problems. In fact, it usually takes only about 2 or 3 minutes to form 5 or 6 groups out of 20 students.

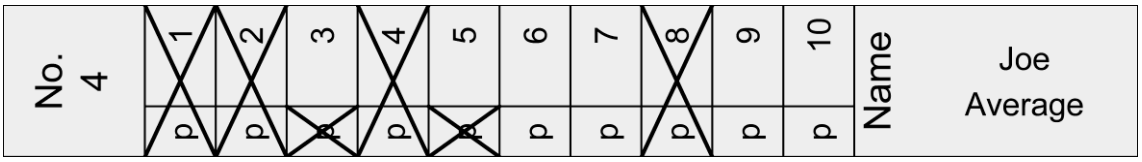

Figure 1. Indicator strip for assignment no. 4 with 4 fully and 2 partly prepared problems

It is important to "train" the students to have these indicator strips already prepared and to submit them at the beginning of each tutorial by themselves. Thus not too much time will be lost for group forming. By letting all TAs record the individual percentages of prepared solutions (call them *preparation degrees*) you may obtain individual performance profiles for all students and for all (parallel) tutorials which might be interesting for different kinds of (statistical) analyses. From time to time it should also be checked whether the indicator strips are correct. If students always claim to have done more than they actually did, this will deteriorate the quality of group work.

Group Phase and Lecture Phase

Since all groups are formed by the *principle of homogeneity*, there is automatically a basis for discussion in all groups. Students compare and discuss their individual solutions. They should usually start with those exercises all group members have worked out. After that they discuss the ones only some members of the group have prepared. In this case the prepared students explain their solutions to the unprepared students. Finally all group members try to solve together those exercises nobody has prepared or worked out.

According to our experience it is best to vary group sizes between 2 and 4, where a size of 3 is most recommendable with respect to a well-balanced discussion among all group members. Apart from that, 3 students may also sit side by side if you are in a lecture room with immobile seating. The group phase should cover at least 80% of the tutorial time. You may even waive the optional lecture phase and use it only if it seems to be absolutely necessary (e.g. if you do not want to explain the same problem to 6 groups individually). In general using too long lecture phases will render students passive. Too many students will tend to lean back during the group phase and just await the lecture phase.

HOW TO ASSIST GROUP WORK

It is highly advisable to provide all groups with *group sheets* which need to be filled out. Such group sheets mainly consist of empty spaces to be filled in and multiple choice boxes to be marked with crosses. All main results and solutions should continuously be transcribed to this sheet. In this way the TAs are permanently informed about the progress in each group and they can quickly check the results and give some feedback. These group sheets should be well designed and different from the original exercise sheets. You should not just ask for final arithmetical results but also include more detailed questions and intermediate data. Otherwise group discussion might tend to be too superficial.

The TA's main job now is to rotate among the groups continuously, to monitor progress, to check and tick results, to answer questions, to advise and to intervene when group discussion takes a wrong course. The main objective is to maximize the individual learning outcome for each group, where individual amount of preparation and ability needs to be taken into account. Students should be assisted according to the *principle of minimum support* (see for example Görts (2011)) meaning that they should work out and achieve as much as possible by themselves. Thus the learning outcome will be more sustainable as if just telling complete solutions all the time. Apart from that, this strategy will motivate and encourage students.

If any groups are finished before the end of the tutorial *additional exercise sheets* might be handed out to them. For example, I use former exam problems for that. But I do not provide any sample solutions for such additional exercises to point out that getting to them is neither important nor necessary. They just ensure that very well prepared and strong groups never idle.

IMPORTANT REQUIREMENTS

Possibly one of the most important requirements to make this concept work is to grade homework assignments, at least as long as you have to deal with compulsory courses where students' motivation is not a matter of course. For formal and organizational reasons the grading system should be chosen to be as simple as possible. Example: "*Each attendance will be graded with 1 full point provided that minimum requirements are fulfilled. Personal presence and active participation during the tutorial are required, too. There are 13 tutorials in total over the semester. The maximum total sum of tutorial points to score is 10. Thus, you may miss up to 3 tutorials without any loss of points. The total sum of tutorial points will be added to the total sum of points earned in the final exam.*" When using such a rule it does not play any role whether someone has fulfilled only minimum requirement or has prepared all exercises in a perfect way. This will additionally reduce motivation for copying solutions.

All tutors need to be introduced into the main ideas of this concept and be trained and prepared for their manifold job. Supporting several small groups at the same time, taking into account their different speeds and skills and finding an appropriate measure of assistance to their individual problems and needs should be quite challenging. Thus, you might collaborate with your university's center for teaching and ask for assistance. A customized tutor training is needed, where some basic didactic material is included as well as some basic psychology of group dynamics. *The principle of minimum support* could be trained best upon some case simulations, which involve typical types of questions and situations encountered in Statistics tutorials.

The *principle of homogeneity* which forms the basis of group building might be problematic from a psychological point of view if expressed the wrong way. Since the *preparation degrees* are usually strongly correlated with students' abilities and motivation (which are not necessarily the same!), group forming inevitably yields some kind of classification. In this regard it is extremely important to care for a positive atmosphere. The intention of homogenization should never be understood as classifying students into "good students" and "bad students" but as a "fair chance for everyone". High-performance students often need only short hints if problems occur whereas for weaker students more time of support might be invested now. It should be pointed out that homogeneity in this concept primarily refers to students' preparation and not to their ability. In fact, you still have enough heterogeneity even when forming seemingly homogeneous groups.

It goes without saying that homework assignments and tutorials need to be well coordinated both with the lecture and with the final written exam. Homework exercises need to be in accordance with typical exam problems. In this context the term *"constructive alignment"*

developed by John Biggs (2011) is frequently used. Thus the tutorials need to be constructively aligned to the exam in the sense of "What is learnt is what is tested".

Course material needs to be complete and easily accessible to all students. In general either lecture notes or a complete set of detailed lecture slides are needed, which the students are required to bring to the tutorials. Otherwise it would be much more difficult for the students in tutorials to work out exercises not yet prepared. For that purpose they need some uniform source of information.

Finally, sending complete and detailed sample solutions to all students after the tutorials ensures that everyone receives the same information. Nobody misses anything by using this concept and there is no need to hurry through all exercises of an assignment in order to get everything done in time.

MAIN EFFECTS

In this concept students soon realize that most part of what they get out of the tutorials depends on their own activity and commitment. Using this concept now for several years has revealed average preparation degrees which range from 70 to 90%. At this point it should be mentioned, that minimum requirements typically correspond to degrees of only 20 to 30%. Thus it really works well with respect to students' activity and motivation.

When offering two exam dates, one soon after the semester and the other one about 10 weeks after the semester, by far most students (80-90%) usually take part in the earlier exam. This proves this concept being really effective and sustainable. It keeps students working during the semester in such a way that they feel already prepared for taking the earlier exam dates. When using traditional "lecture style tutorials" in earlier days we never had such high participation rates for first exam dates. Instead many students usually used the lecture-free time to repeat all exercises and to deal with them more in detail for the first time.

In the teaching evaluations at the end of the semester most students rate these tutorials being very effective with respect to learning. Thus, the average score on the evaluation item "*Learning progress in comparison to other courses*" is usually far above average. Many students also explicitly tell this point in their written comments. Furthermore, the preparation degrees are quite strongly correlated with the final grades on the written exams.

Group forming is based on objective and comprehensible criteria in this concept rather than on randomization or sympathy. Most students entirely agree with this point. It also becomes truly visible for every student how their own commitment looks relatively to the others. This might have an additional motivating effect. Using randomized groups several years before revealed quite a large inefficiency. Well prepared students often complained about being put into the same group as much less or minimally prepared students.

Instead of acting as if all students were the same and had the same kind of problems, this concept takes students as individuals and responds to their individual needs. It is well suited for Statistics and might also work in other mathematically or technically oriented disciplines, where solutions for problems (at least for homework problems) are rather distinct than vague. Specifically the use of indicator strips turns out to be a simple but helpful idea.

REFERENCES

Biggs, J. and Catherine, T. (2011). *Teaching for Quality Learning at University*. Maidenhead : Open University Press.

Garfield, J. (1993). Teaching Statistics Using Small-Group Cooperative Learning. *Journal of Statistics Education, 1* (1).

Görts, W. (2011). *Tutoreneinsatz und Tutorenausbildung : Studierende als Tutoren, Übungsleiter, Mentoren, Trainer, Begleiter und Coaches - Analysen und Anleitung für die Praxis*. Bielefeld, Germany: UVW Univ.-Verl. Webler.

Roseth, C., Garfied, J., & Ben-Zvi, D. (2008). Collaboration in Learning and Teaching Statistics. *Journal of Statistics Education, 16* (1).

Tyler, R. W. (1949). *Basic Principles of Curriculum and Instruction*. Chicago: The University of Chicago Press.