Open Virtual Mobility

O3-A2.5: Matching tool
Final prototype and report

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Imprint

Imprint: This publication is O3-A2.5 of the Open Virtual Mobility Erasmus+ strategic partnership founded by the European Commission 2017 - 2020 under **2017-1-DE01-KA203-003494,** URL: https://www.openvirtualmobility.eu/

This technical white paper describes the functionality of the Moodle plugin mod_groupformation based on the matching criteria discussed in O3-A2.1. The goal is to use the plugin in the Open Virtual Mobility Learning Hub to form groups of learners. This plugin is based on formerly released mod_groupformation by the author and his team. It is part of Outcome O3 *Competency Directory and Matching Tool.*

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Executive summary

Essential parts of the competencies defined as Open Virtual Mobility include inter-cultural and interpersonal competencies. Thus, for the provided learning courses (MOOCs) on intermediate and advanced level, peer activities were designed, for which the participants need to be put into learning groups. This is not done manually, but by an optimization algorithm which is extended with a user-interface as a Moodle plugin, called mod_groupformation.
After a brief repetition about learning group formation theory, the requirements are listed and explained which are derived from earlier documents and the transnational partner meetings. Afterwards, the functionality of the plugin is explained from a user perspective referring back to the requirements. It will be explained in the document why a matching criterion based on country-of-origin is currently out of scope, even though it was desired (as non-critical) by partner organizations (see section 3.1 in this document for details). The functionality of the underlying GroupAL algorithm is described to make clear why, at certain deadlines, the group formation needs to take place (instead of continuously adding participants to groups). Finally, the installation process and requirements for proper use of the plugin are provided. The document closes with a conclusion.
Note: This document is a revised and updated version of the former publication O3.A2.3 Matching tool: Functional prototype of matching tool and O3-A2.4: Matching tool: Connected to VM Learning Hub.

What are the objectives of this paper?

- goal of learning group formation and algorithmic optimization
- requirement list
- functionalities described
- final state of the Moodle plugin mod_groupformation

Who is this paper for?

- Pedagogues and instructional designers interested in optimized learning group formation
- Researchers of computer-supported learning group formation to be introduced to mod_groupformation features
- users of openVM learning hub to read background information about the group formation plugin used

What topics are addressed in this paper?

Requirements, optimization algorithm, plugin installation, plugin usage in three steps, teacher perspective, learner perspective, optimization criteria used, multi-language support, Moodle cron, challenge of nominal values for optimization

Contributors

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Acknowledgements

mod_groupformation[1] is an open source code release under GPL license. We acknowledge the work of all involved researchers, developers, testers, translators, and end-users.

[1] https://moodle.org/plugins/mod_groupformation

1. Aims and Scope

The scope of the current document is about the definition of the functionality provided to the project consortium with the plugin mod_groupformation and how it can be used within the sub-MOOCs about open virtual mobility skills.
The text will:

A. define and explain the requirements of the group formation plugin
B. state the matching criteria used
C. explain the user interface (course coordinator and learner perspective)
D. deliver insight into the functionality of the group formation algorithm
E. describe the installation process and requirements for the plugin to run properly

2. Learning group formation

When learning groups are formed to work together towards a solution of one or several tasks, the learning situation is designed to require a certain combination of prerequisite traits, skills or competencies to be present to successfully solve the task as a team (Dillenbourg 1999). If all prerequisites are met by one person, they might solve the task alone without any group work (Michaelsen et al. 1997). If essential prerequisites are missing in the group, the task might not be solvable.
Thus, the goal of optimized learning group formation is to find the best combination of learners per group that they individually can maximize their learning improvements towards the learning goal and all learners have the same quality of learning group (Konert et al. 2014).
For further details about the theoretical and practical background from pedagogical psychology and computer science, please refer to the detailed former *O3-A2.1 Matching tool: Definite set of relevant matching criteria*, which is available on the project website[2].

3. Group formation plugin

3.1 Requirements definition

The state-of-the-art analysis and discussion from publication O3-A2.1 (Konert, 2018) was amended by decisions made during transnational partner meetings in Rome (31.05.2018) and Timisoara (27.09.2018). Originally, as mentioned in former document O3-A2.1, it was planned to collect written statements by each partner about the following questions (cf. Konert, 2018, p. 10): “

A. *Which literature about relevant criteria for collaborative group work do you want to add to be considered in the project?*
B. *Which literature or study or source about relevant criteria to be represented in groups for learning VM skills do you want to add?*
C. *In your opinion, by which criteria should the learning groups be built for the open VM learning tasks? Please indicate for each proposal, whether the criterion should rather be*

[2] http://openvirtualmobility.eu

heterogeneous (different) or rather similar (homogeneous) or rather something else (e.g. one of each kind) within the groups.

Partners are encouraged to invite external experts, like their organizations didactics center or pedagogical advisors to contribute to the discussion."

During the transnational partner meeting in Rome (31.05.2018) these questions were directly discussed. None of the partners saw substantial necessity to add literature (A, B) to the already existing research background of the O3 output leader. Based on the limited literature about positive effects of certain matching criteria on learning group performance, all partners agreed on building upon the reported findings of O3-A2.1 and use the same criteria as already set in mod_groupformation. The discussion led as well to the amendment of requirement R7 (described below) to mix participants from different countries.

The major requirements for the group formation plugin are:

R1 Moodle compatibility
R2 Multi-language support (at least English and all partner organizations languages)
R3 Can be restricted to build groups only with participants of a certain sub-MOOC
R4 Flexible group size settable per group formation
R5 Using the matching criteria conscientiousness, extraversion, team orientation, and motivation for course which were used before by mod_groupformation
R6 Course coordinators can set up deadlines
R7 Additional matching criterion: country of origin (desired)

Non-requirements (exclusions):

- No integration of Moodle passed pre-tests as prior knowledge criteria vectors
- No group formation based on existing prior competencies in the field of openVM competency framework (defined by Output O1)
- No continuous group formation (asynchronously adding participants)

R1: Moodle compatibility

The group formation tool is meant to be used for assisting in learning group creation within the MOOCs created by the partnership to enhance the update of open virtual mobility skills in Europe. As the learning hub and MOOCs are technically realized using Moodle, the group formation should be a plugin to be integrated into Moodle as an activity. Recent Moodle version updates should be supported.

R2: Multi-language support

A declared goal of the partnership is to provide all resources in as many languages of the project partners as possible. While certain content-intensive parts will be provided in English only (due to heavy translation efforts needed), guidelines, user prompts etc. are envisioned to be available in multi-language. The group formation activity will provide the interface language in all of the languages provided by the MOOCs of Open Virtual Mobility (at maximum all the languages of the partner organizations). English will be the fallback default language.

R3: Can be restricted to build groups only with participants of certain sub-MOOCs

As the group formation activity will be used within certain sub-MOOCs (covering e.g. level 3 of one of the competency areas of O1), it is necessary that the course coordinator in Moodle can adjust the group of participants used for creating learning groups. The set of relevant participants is either designed by Moodle groupings and/or assignment of the relevant participants to a certain course within Moodle.

R4: Flexible group size, settable per group formation

At the date of this document release the partnership has decided to use the group formation plugin for activities on the highest level of sub-MOOCs only (which is level 3). The activities for group work are expected to vary from peer assessment to discussions via forum[3]. Thus, it is desirable that the group formation plugin allows a flexible setting of a maximum group size per instance, e.g. forming groups of two (2) for mutual feedback or forming groups of 5 for discussions.

R5: Using the matching criteria *conscientiousness, extraversion, team orientation, and motivation for course* which were used before by mod_groupformation

During the transnational partner meeting in Rome (31.05.2018) all partners agreed that for group formation the formerly investigated and effective criteria, as used by mod_groupformation in other contexts, should be used for group formation within the open virtual mobility scenario, too. While it would have been technically possible to implement different questionnaires for other personality-related matching criteria or solely rely on matching based on the competency areas defined in O1, the uncertainty how well this might work and how much individual learners then profit from their group lead to decline such changes. (Note: R7 adds one more criterion)

R6: Course coordinators can set up deadlines

While participants take the self-learning activities of the sub-MOOCs at their own pace and starting times, it is a needed requirement (based on mod_groupformation) that from the set of learners at a certain time learning groups are formed. Thus, for the activity “learning group formation” offered by the plugin here, deadlines need to be available to allow course coordinators to configure when the activity opens for filling the questionnaires and when it closes that course coordinators can afterwards create the groups. These deadlines will allow creation of several activities in parallel where participants can choose for which start date of group work they want to fill out the questionnaire. Manual work by course coordinators is acceptable to create new instances of the activity and/or start the algorithmic creation of groups based on the participant’s answers.

R7: Additional matching criterion: country of origin (desired)

During the transnational partner meeting in Timisoara (27.09.2018) the possible integration of the matching tool was discussed. As the competency areas (O1), covered by open virtual mobility, were defined it became clear that for some areas, e.g. intercultural skills and attitude, it would be beneficial to match learners in one group from different cultural backgrounds. It was decided to achieve this by using the country of origin as an additional criterion (to be matched

[3] Currently the independent sub-MOOCs activities and assessment activities are not fully designed and subject to change.

heterogeneously within a group). This request causes a major change in the interface and algorithm as it is a set of nominal values to be used for group formation. Currently, all criteria used are interval scales. For nominal scales a drop-down list needs to be presented and the calculation of the quality of matching needs to be extended. Thus, this requirement seems out of scope of the possibilities funded by this Erasmus+ project. The functionality was added during the project period (mainly finished until February 2020), but due to the fact that pilot phase 2 was already running, the partnership decided not to update the Moodle plugin during the pilot due to high risk of failure (errors, losing database entries with settings, etc.). Thus, the final state is: the underlying optimization algorithm has been extended by the capability to consider nominal optimization criteria, called bin-based criteria based on (Craig, Horton, Pitt, 2010), but this functionality was not yet activated within the learning hub. Interested readers can find the functional plugin in the code repository[4].

3.2 Process of application in three (3) steps

The group formation is synchronous, thus collects data of all participants, which should be matched, and then, at a certain date, from this set of participants the groups are formed. From setup through data collection until final group formation there are three steps, described here and illustrated in Figure 1.

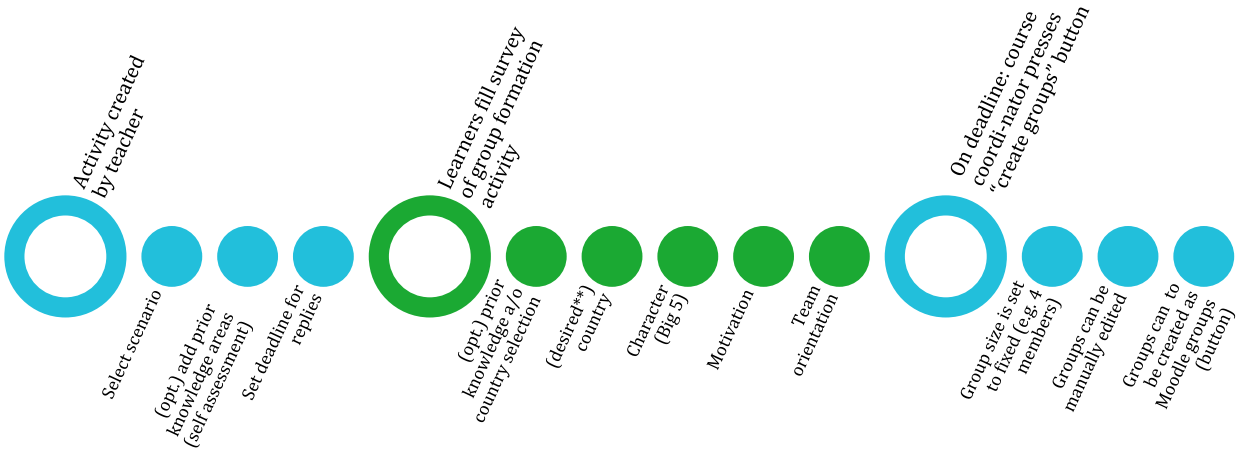

Figure 1: Three phases of using group formation

First step is a setup by a course coordinator, who adds the activity to the Moodle course. The plugin supports three different scenarios which influence the way each criterion is respected in the group formation algorithm (more details later in this document, Appendix Figure 8, p. 16). The activity can be restricted to be available from and until a certain date (R6). Additionally, the access can be restricted to a certain group and grouping of Moodle, in case not all participants of the Moodle course should be used for group formation (R3). Likewise, a setting is offered to consider only those participants, which answered at least one question of the group formation questionnaire. This helps to avoid grouping of participants that are inactive in the course.

[4] https://github.com/openVirtualMobility/moodle-mod_groupformation/tree/one-of-bin-criterion branch one-of-bin

Second step is the availability to participants (i.e. the learners), who are guided through the questionnaires, which are as well responsively designed to be usable on smartphone and desktop resolutions. Participants can skip single questions, return later and finally submit the questionnaire.

Third step is the deactivation of the questionnaire availability, either by the set date or manually by a course coordinator. The group formation is not started automatically but needs a click on 'star group formation' by a course coordinator. This is necessary as in teaching situations sometimes deadlines are extended, or settings are adjusted, before groups are built. The calculated groups are presented after 1-5 minutes runtime to the course coordinator. A drag & drop interface allows manual correction of the group membership before the groups are either dropped (to be re-calculated) or transferred into Moodle groups.

A more detailed description with screenshots is provided in Attachment *A1 Detailed description of the plugin usage*.

3.3 Final set of criteria

As described in section 3.1 Requirements definition, the consortium decided to use the criteria set, found as relevant for better group performance before in scientific literature. Additionally, the questionnaires for personality traits (Big5), team orientation and motivation can be considered as culturally stable to a certain degree (R5). Especially the Big5 are widely accepted internationally and have been translated and evaluated for reliability. As listed in Table 1 the desired additional criterion of country-of-origin has been added to the set of criteria ideally used for the open virtual mobility group formation (R7). The latest version of the plugin supports this nominal value criterion (which is created and presented as a selection-list), but it was not part of the optimization during project pilot phases, as explained in section 3.1 Requirements definition.

Table 1: List of criteria used for openVM learning group matching

Criterion	Scale	Optimization goal	Data source
extraversion	Interval	heterogeneous	questionnaire (big 5 items)
conscientiousness	Interval	heterogeneous	questionnaire (big 5 items)
Team orientation	Interval	homogeneous	questionnaire
Motivation for course	Interval	homogeneous	questionnaire
cultural background/country of origin (optional)	Nominal	Diverse set of values	List of countries

3.4 Multi-language support

While the requirement for Moodle support (R1) is given by the fact that the group formation is implemented as a Moodle plugin, the requirement (R2) for multi-language support is respected in the design of the plugin, too. The presented questionnaires to participants (character, team orientation, motivation) are stored in XML-files delivered with the plugin. Currently, these questionnaire items are shipped in English and German[5]. Likewise, the web frontend interface texts of the plugin are stored in Moodle language files which are automatically switched by the selected language of the Moodle user. With the assistance of all project partners these texts were translated and are available now in Dutch, English, French, German, Italian, Romanian, and Spanish. Default is set to English in case a user has selected a different language.

3.6 Group formation algorithm (brief summary)

After data collection for each participant and each question, the answers are stored in the database. For the questionnaires of character traits, motivation and team orientation, the items are summed up into one value each (one for characteristic conscientiousness, one for extraversion, one for motivation, and one for team orientation). These values are normalized to the interval [0,1]. Thus, for each criterion the vector value has only one dimension (the one value).
The algorithm itself supports for each criterion a weight and a type. Weight is set for all equally. Type is either heterogeneous or homogeneous or one-of-bin depending on whether it should be as similar as possible between group members or different or one of each nominal value (bin) (cf. Table 1).
From the underlying GroupAL algorithm (Konert, Burlak & Steinmetz 2014) the group-centric matcher strategy is used. For the desired group size, the number of final groups is calculated based on the number of participants (e.g. groups of 3 from 24 participants results in 8 groups). For each empty group a pivot element is selected. Then for each group the next best fitting participant is added until the group reaches its maximum number of participants.
The next best fitting participant is decided by pairwise comparison with each member of the intermediate group. Each pairwise comparison calculates how similar the two participants are for criteria, which should be homogeneous. The smaller the distance value, the better the pair fits. For heterogeneous criteria the distance should be maximized. Here, the Manhattan distance metric is used instead of Euclidean as Manhattan delivers for multi-dimensional criteria more intuitive distance values[6]. For the one-dimensional criteria vectors in the context of open virtual mobility this is irrelevant. In case criteria are of type one-of-bin, the distance metric from scientific literature is used (Craig, Horton, Pitt, 2010). The mean value of all pairwise calculated fitting of the intermediate group with the possible next candidate is then divided by the standard deviation of all these pairwise fittings. This is necessary to lower the suitability for next participants that are only suitable with some of the existing group members and with some others are extremely unsuitable. Such a

[5] The psychometric standardized and internationally as reliable proven questionnaires for personality traits are not that easy to translate as other languages need to be validated to measure exactly the same dimension as the original questionnaire. This effort is far beyond the scope of this project. As the questionnaire from scientific literature is available in English and German only, to the best of our knowledge, the support remains for these two languages.
[6] E.g. for vectors (1,0) and (0,1) the distance in Manhattan is 2, but in Euclidean is $\sqrt{2}$. For Vectors (0.5, 0) and (0, 0.5) compared to (1,1) and (1,0) the distance should be the same, but is for Euclidean $\sqrt{0.5}$ and $\sqrt{1}$. For Manhattan in both cases the distance is 1.

situation would lead to low group coherence. The participant with the highest remaining fitness value will be added to the group.
The set of groups is then returned to the Moodle plugin instance and can be revised by the course coordinator.

4 Installation and technical setup by administrators

The plugin can be installed by either retrieval from the plugin repository of Moodle or by manual ZIP upload of the whole plugin data. Minimum required Moodle version is v2.9. Moodle then prompts for installation on the next login of a Moodle administrator account. Screenshots are provided in attachment *A2 Details about plugin installation*.
For the plugin to work properly the Moodle `cron` needs to be set up correctly[7]. The group formation is a calculation intensive process and thus done in an extra PHP process by Moodle `cron`. Depending on the interval of `cron` job starting, the results are available within 1 to 15 minutes (usually Moodle `cron` starts each minute).
The plugin has system wide settings which can be edited by administrators. The number of days can be set after which automatically all personal data (answers to questionnaires for group formation) are deleted (default is 365 days). If the plugin data is used for scientific evaluation studies, the participants can be asked for a participant code in the opt-in dialog presented on first click to the group formation activity in Moodle (default is set empty). This participant code is then added to the export/download of the formation data. See Attachment *A2 Details about plugin installation* for details.
The repository of the current master code state is available on Github (see Figure 2)
https://github.com/openVirtualMobility/moodle-mod_groupformation

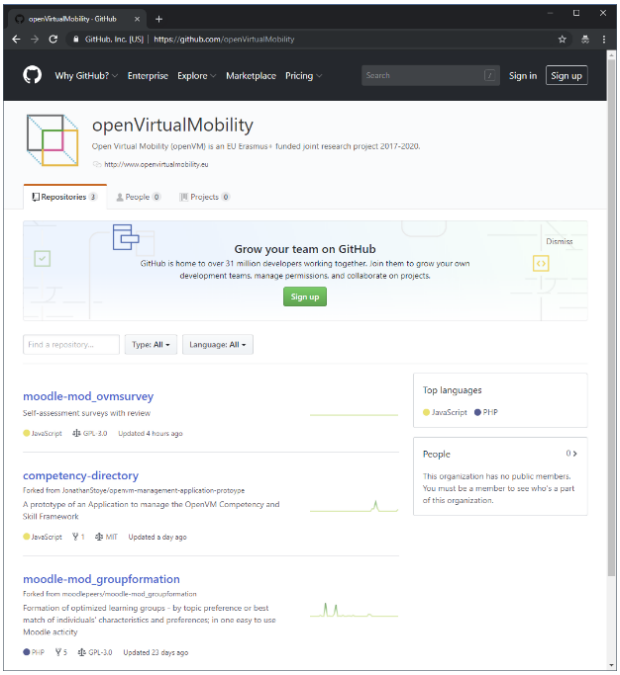

Figure 2: Screenshot of Github repositories of Open Virtual Mobility organization.

[7] Cf. https://docs.moodle.org/36/de/Cron-Job, last accessed 01.03.2019

5. Conclusion and outlook

The document presented the Moodle plugin for group formation to be used in the MOOCs of the Open Virtual Mobility platform. As the higher levels of competency and skills to achieve include inter-personal and social skills, peer activities are part of the MOOCs on the *intermediate* and *advanced* levels. For this, synchronized deadlines are needed and communicated to learners to match and optimize them for learning group activities, e.g. peer feedback or discussions. For details see Output 6 about MOOC design. The plugin provides the flexibility to be set up in several instances and only match a certain subset of participants (e.g. only those belonging to a certain grouping or course in Moodle). Likewise, desired group size is changeable per instance. The plugin currently provides the standardized international personality traits questionnaires in English and German due to the limited availability of validated translations. The frontend interface itself is available in all languages of the partner organizations (7 languages).
The plugin is currently installed and running. Criteria used for group formation are the same as used in the original mod_groupformation plugin. This has been decided after literature review and discussions during transnational partner meetings. One additional criterion was desired by project partners (as non-essential but nice to have), which is the heterogeneous criterion of country-of-origin. Based on this, intercultural mixture within a group could be optimized. The current interface provides flexible configuration of prior knowledge (self-assessment) and included by the end of the project as well the interface and algorithmic parts for the drop-down question of nominal 'one-of-bin' values (here: countries as a list). Additionally, the fitness value calculation of the participants per group was adjusted, because nominal values need to be respected in similarity/distance calculation differently (see references) than interval scales (which are all the other criteria).
In summary, the plugin is finalized and stable and was successfully integrated and used for peer learning group formation within the sub-MOOCs of the open virtual mobility courses (levels advanced and intermediate). The partnership decided to add group/peer activities on these two higher level courses where the participants need to fill the group formation questionnaires for certain deadline dates and then the group activity will start (e.g. for 2 days or 1 week). This scenario suits the three-step process of the plugin, where after setup by course coordinators (with deadlines), participants can provide their answers to the questionnaires, and finally, as a last step, a course coordinator creates groups based on the provided data. Then the participants can start their group activities and continue to progress in the course.

7. References

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Michaelsen, L. K., Fink, L. D., & Knight, A. (1997). Designing Effective Group Activities : Lessons for Classroom Teaching and Faculty Development. To Improve the Academy, 385, 373–397.

Attachments

A1 Detailed description of the plugin usage

Step 1: Setup (course coordinator view)

Figure 3: In the Moodle course a plugin instance can be added as activity

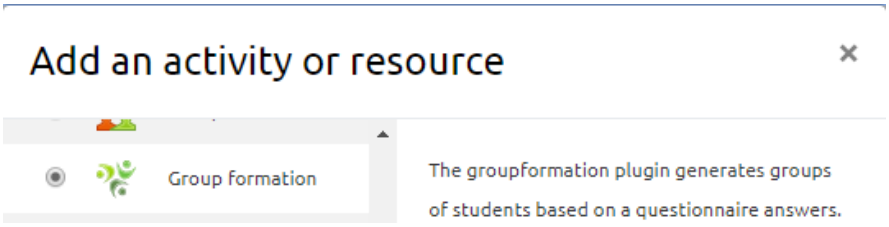

Figure 4: Select the group formation from the list

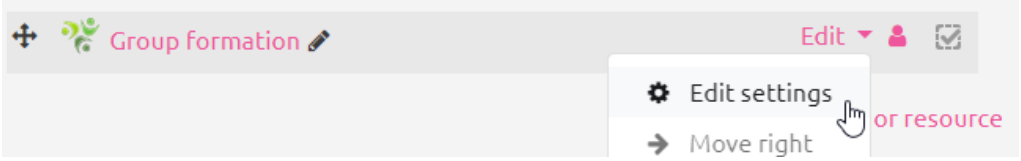

Figure 5: On creation you are directly forwarded to settings. Later on, open settings via the Edit-menu

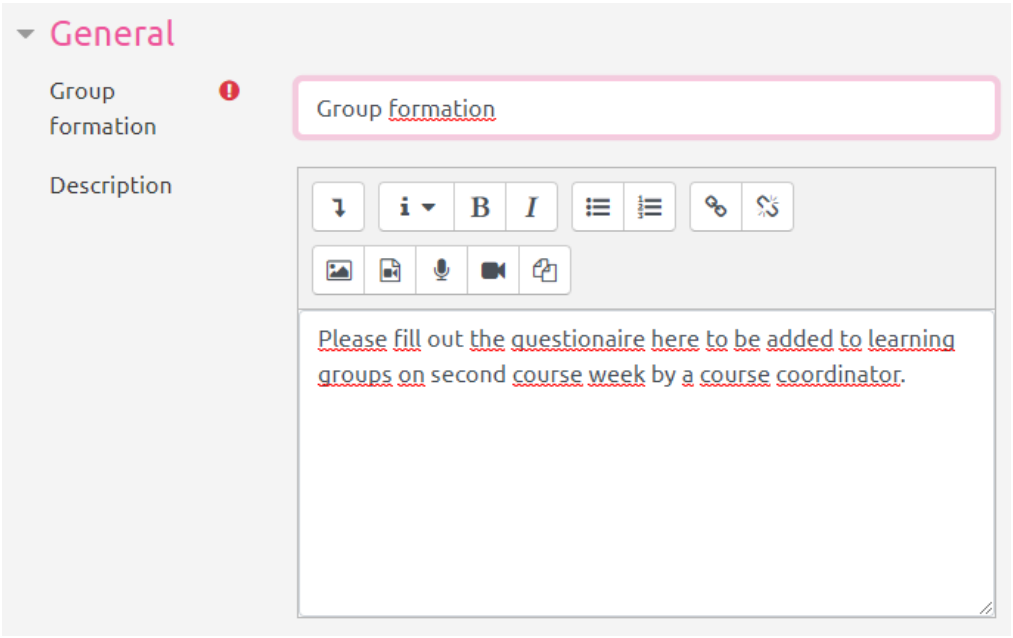

Figure 6: Settings - the Title is displayed directly in the course. Description is displayed to participants when they click the group formation activity. Thus, make sure the title explains what it is (e.g. questionnaire for homework groups or like here “group formation”)

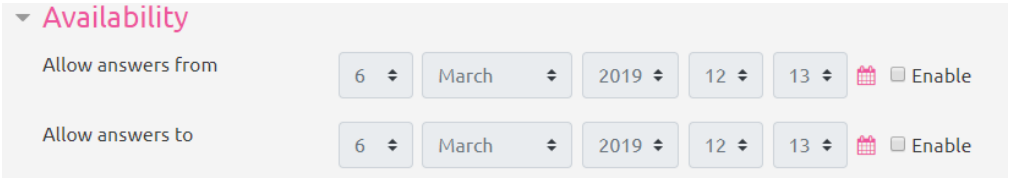

Figure 7: Setup - Availability is displayed to participants and allows you to enforce a deadline for the group formation questionnaire to be filled. A start date is good in case you want to adjust settings and explain first during class (not needed for openVM scenarios)

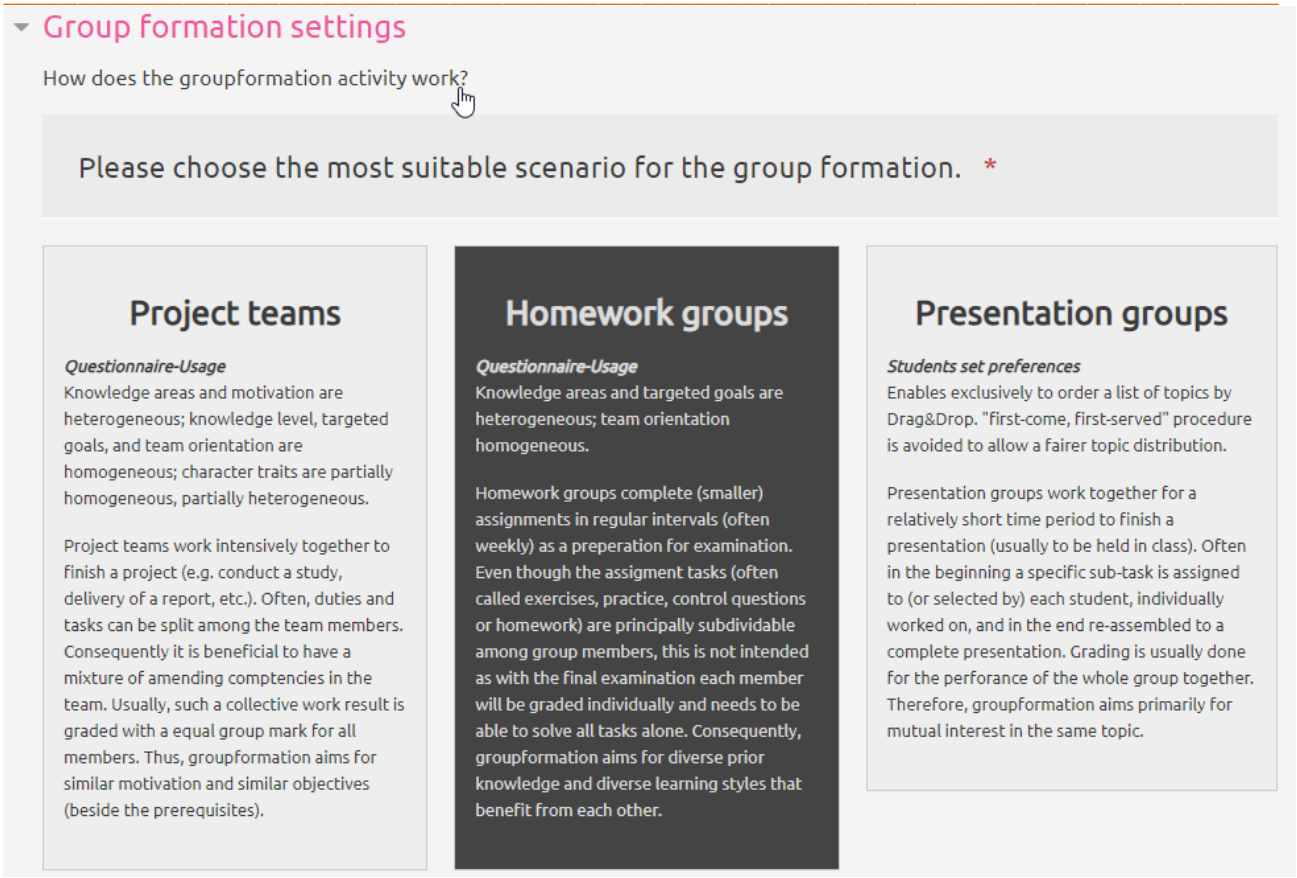

Figure 8: Setup - the scenario selected influences the length of questionnaire and the optimization algorithm. The text explains it nicely. You need to select one scenario.

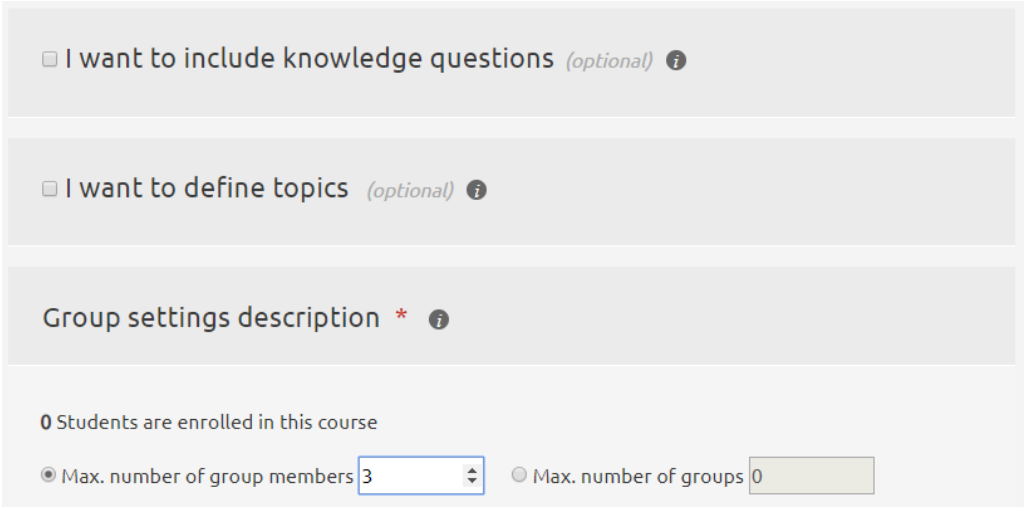

Figure 9: Setup - You can either set a group size or a number of groups.

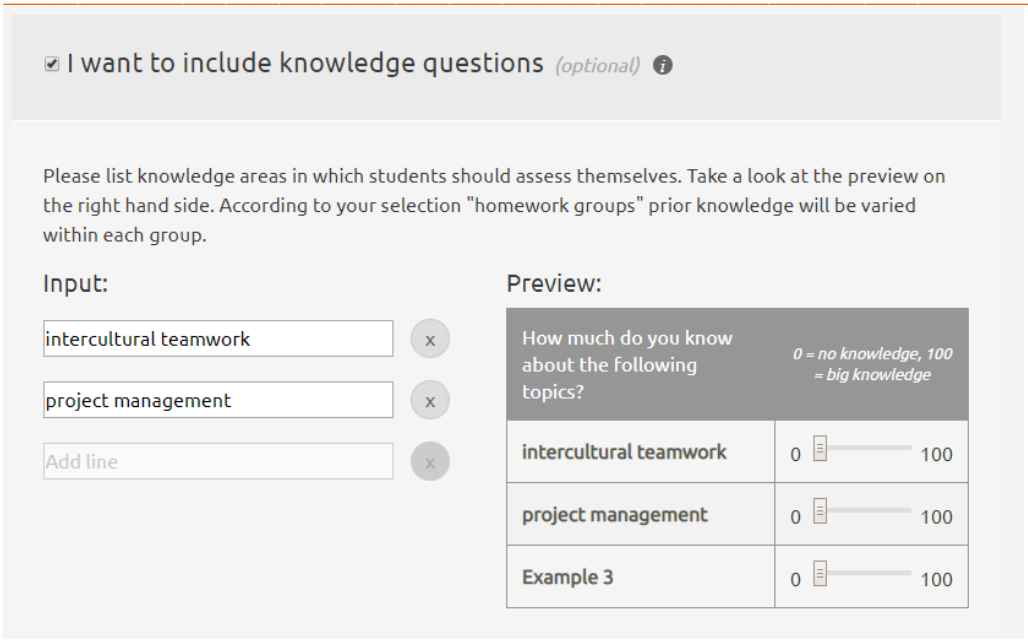

Figure 10: Setup - in case you included prior knowledge areas, a preview is provided of the presented extra questions to participants (sliders). Be aware that these knowledge fields are not translated on display. (This functionality is not used in openVM setup)

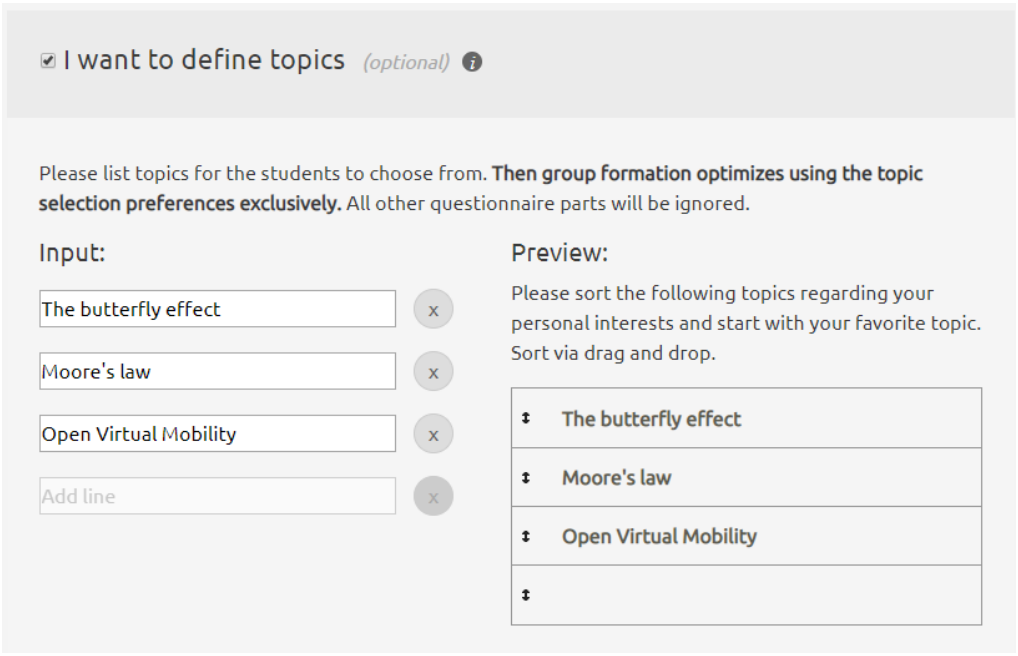

Figure 11: Setup – preselected for scenario presentation groups. If topics are set, the algorithm only optimizes distribution of participants based on selected preferences. No other questions are shown to them. A preview is given (see right side). (This functionality is not used in openVM setup).

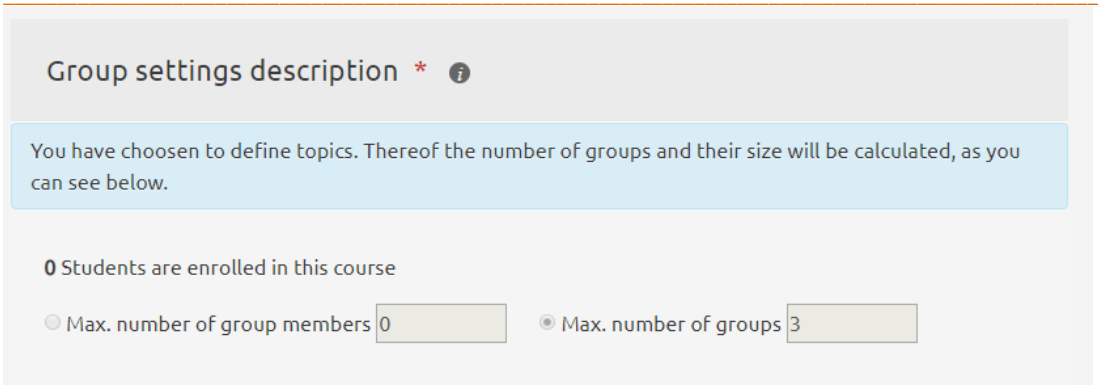

Figure 12: Setup - if topics are given to participants to select their preferences (for assignments), the number of groups is set automatically accordingly.

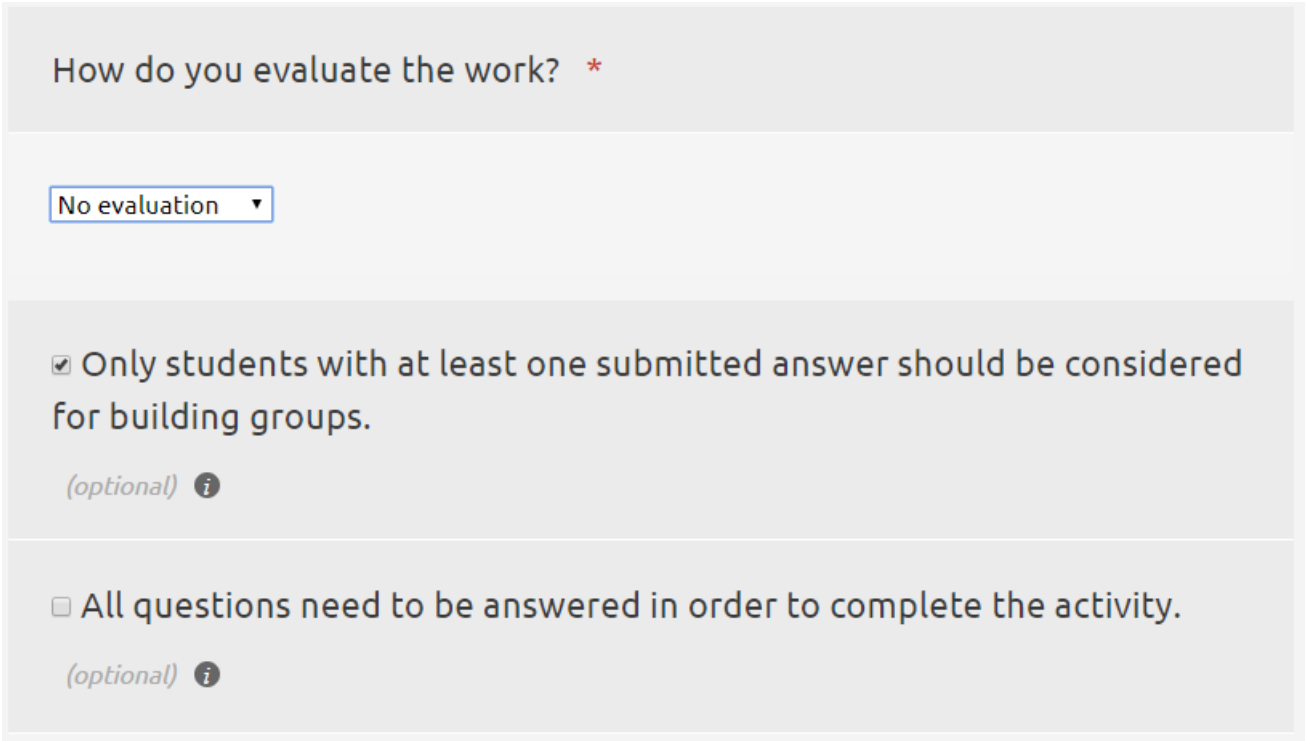

Figure 13: Setup – As a grading method you can select no grading, only pass, marks (1.0 to 5.0) or points (which allows you to set the max. number of points). If set, participants are asked for their grading goals and this parameter is included as a homogeneous criterion for matching.
Checkbox for 'only students with at least one submitted answer' is important if you might have inactive course-members and do not want to add them to groups. Alternatively (or additionally) restrict the group formation to a Moodle grouping with only committed participants (see below later).
Checkbox for all questions which need to be answered is useful if you strongly depend on optimized groupings. As all participants with incomplete questionnaire data are matched randomly among them into groups and only participants with complete data are optimized into groups, this setting might lead to more complete data sets, but can be annoying as participants cannot proceed, if one answer is missing. (For openVM MOOCs the settings are recommended as displayed)

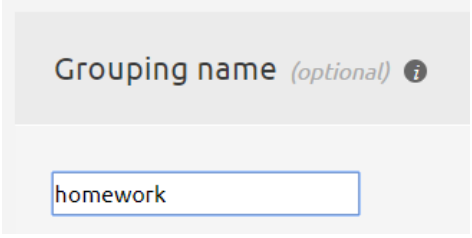

Figure 14: Setup - a prefix name can be added which is used for the Moodle group names later on.

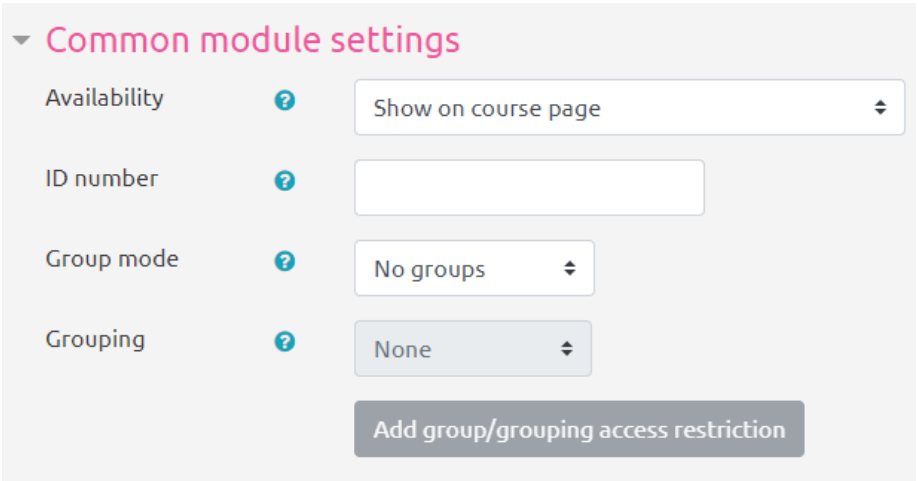

Figure 15: Setup - common settings allow you to restrict the group formation to a Moodle grouping (subset of your participants). If not set (as here) all participants are used for grouping (maybe without the ones that have not given any answer to the questionnaire)

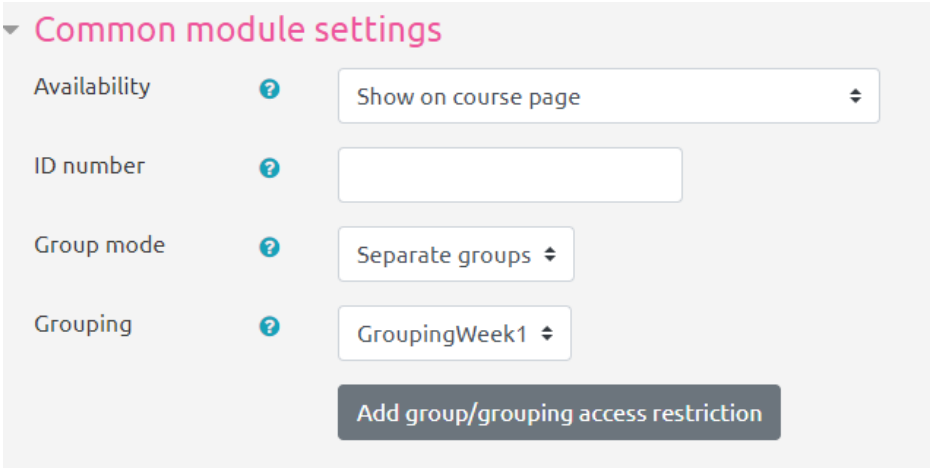

Figure 16: Setup - if a restriction is set to separate groups and a Grouping (e.g. GroupingWeek1), within the grouping there needs to be **one group** (name is irrelevant) with all the participants to consider for group formation. This way you can even offer several group formation activities in one course which respect different subsets (groupings) of all enrolled participants.

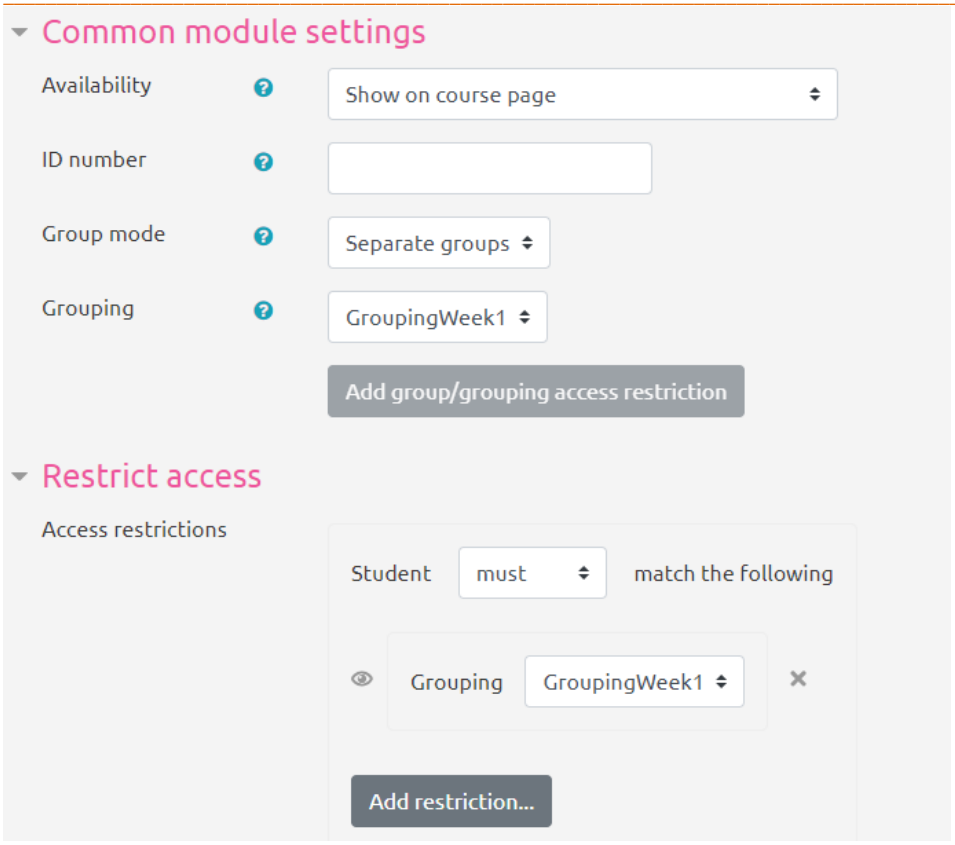

Figure 17: Setup - if group mode is set to separate groups with the grouping (here GroupWeek1) it could be useful to add a corresponding access restriction (click the button) that only the participants of that grouping can see/access the activity.

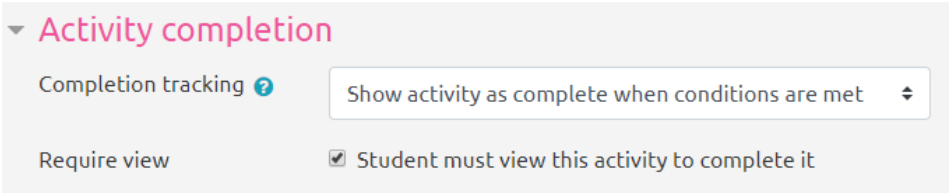

Figure 18: Setup - if you use activity control in your course, you can set the 'require view' checkbox. The naming is Moodle default and misleading. Precisely, the group formation activity is marked complete for participants, if they filled and submitted the questionnaire of the activity.

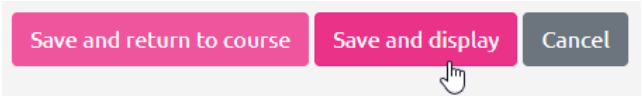

Figure 19: Setup - finally save the settings

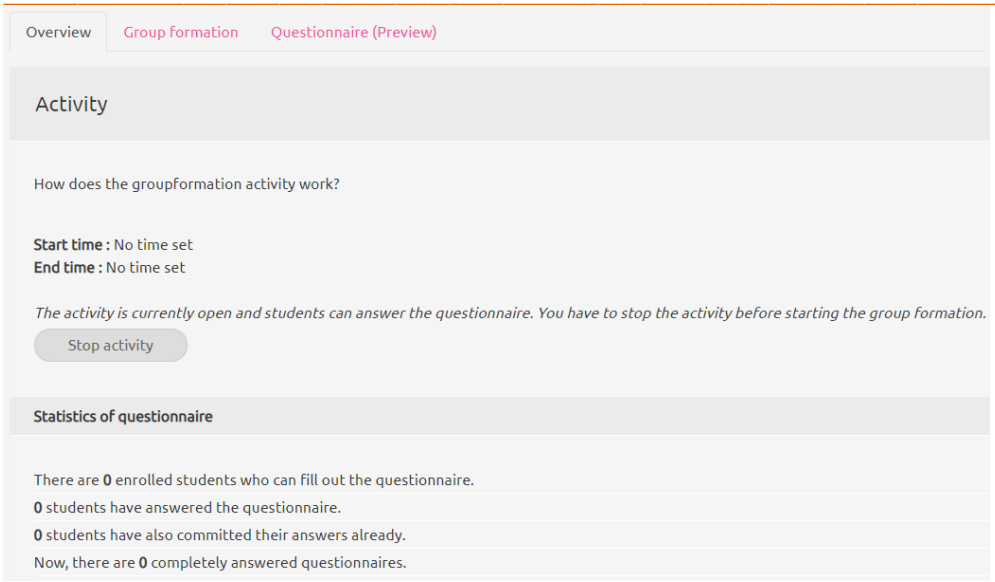

Figure 20: Coordinator overview - after setup or if you click the activity in the course you see an overview status as a course coordinator. Three tabs are provided: Overview, Group formation, Questionnaire preview

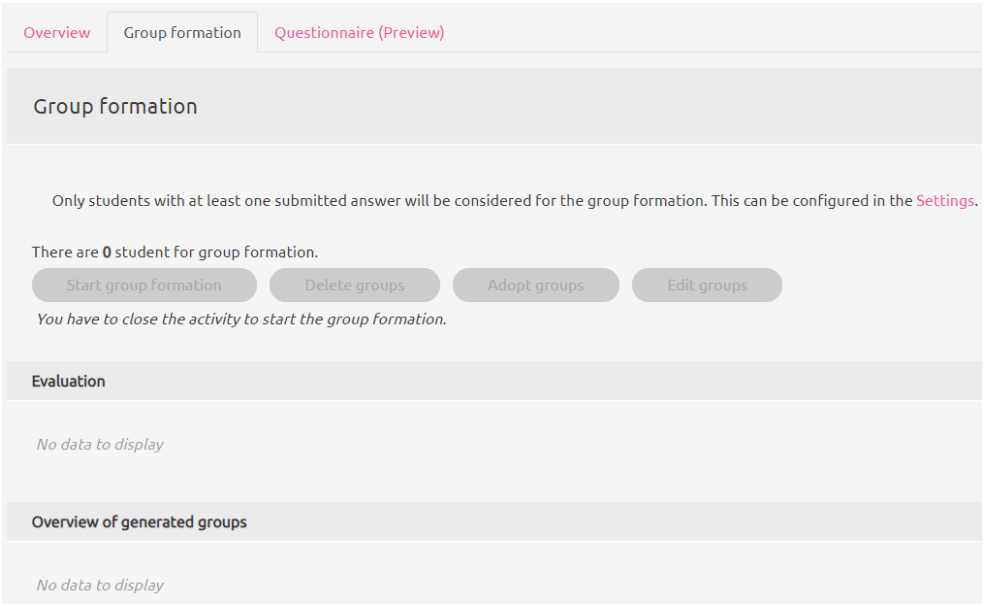

Figure 21: Group formation - this tab is used later after data is collected from participants and the activity has been stopped on tab Overview.

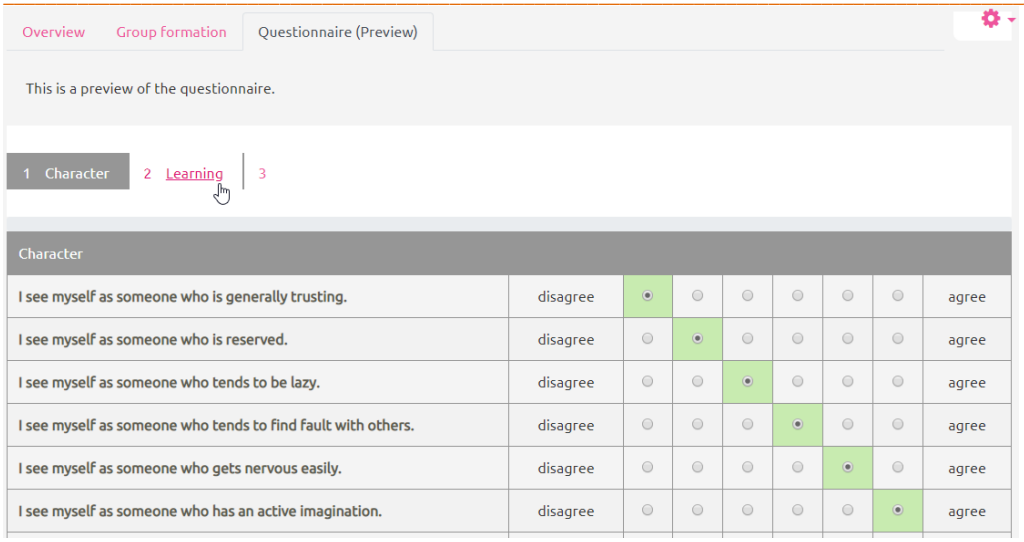

Figure 22: Questionnaire preview - depending on the settings, the preview shows all the questions participants need to answer. This helps in case participants have questions and difficulties with some items. If filled as a course coordinator the answers are not used for later group formation. Only the role 'student' in Moodle is considered.

Step 2: data collection (participant view)

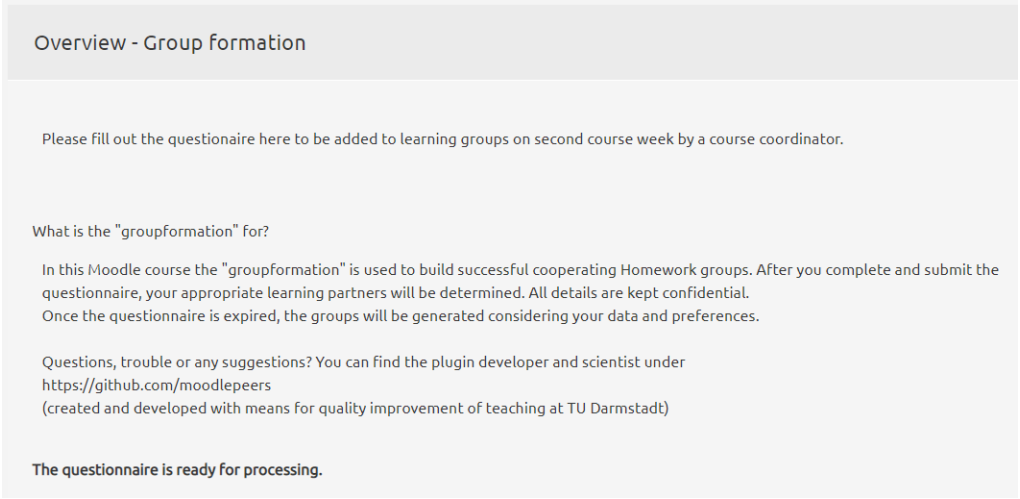

Figure 23: Participant overview: On first access participants see a short description and the description text you entered on setup.

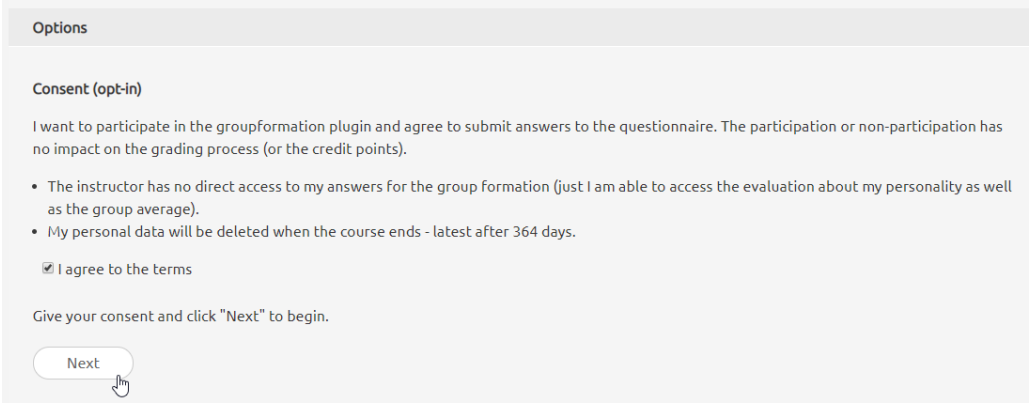

Figure 24: participant consent - below the overview participants need to accept the opt-in dialog. If they do not, they can still be matched into groups by random assignment (depending on your setup whether or not participants with no answers are excluded). The agreement can be revoked later on.

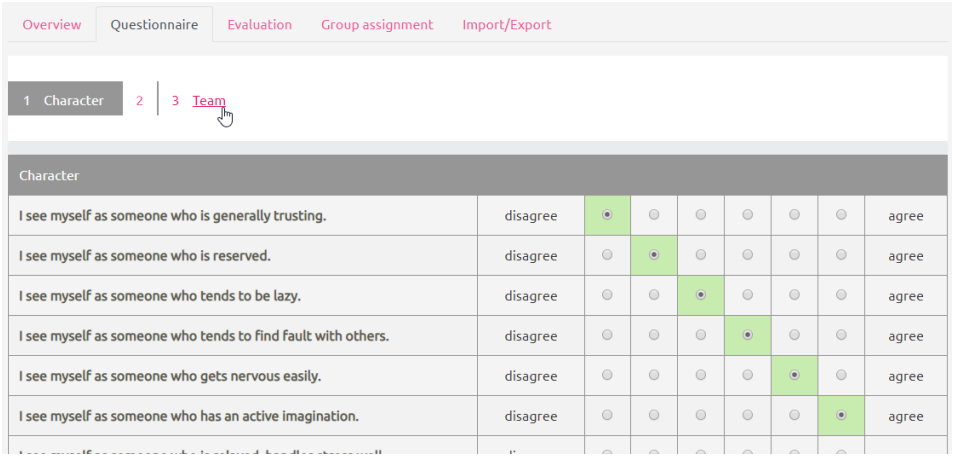

Figure 25: Questionnaire tab - allows participants to jump between categories and save intermediate answers.

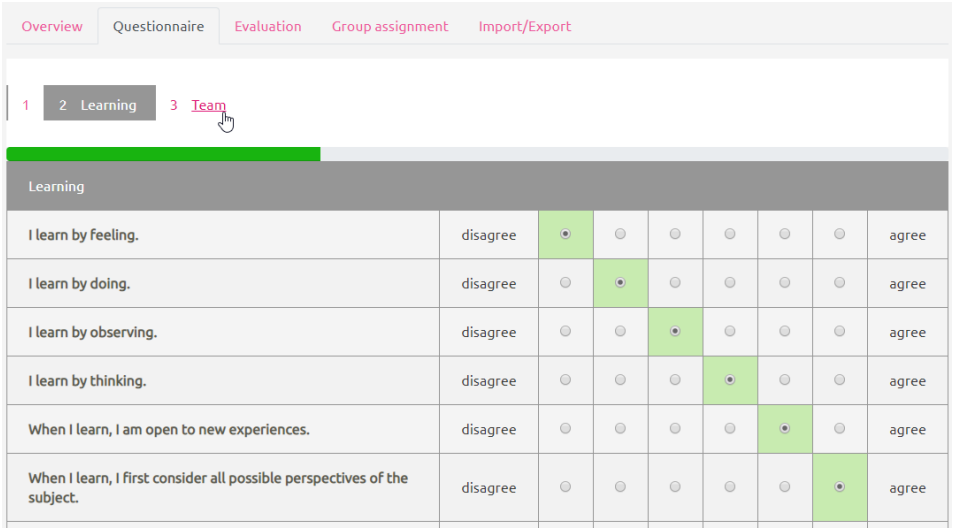

Figure 26: Questionnaire tab - the interface is mobile responsively designed (not shown on the screenshot)

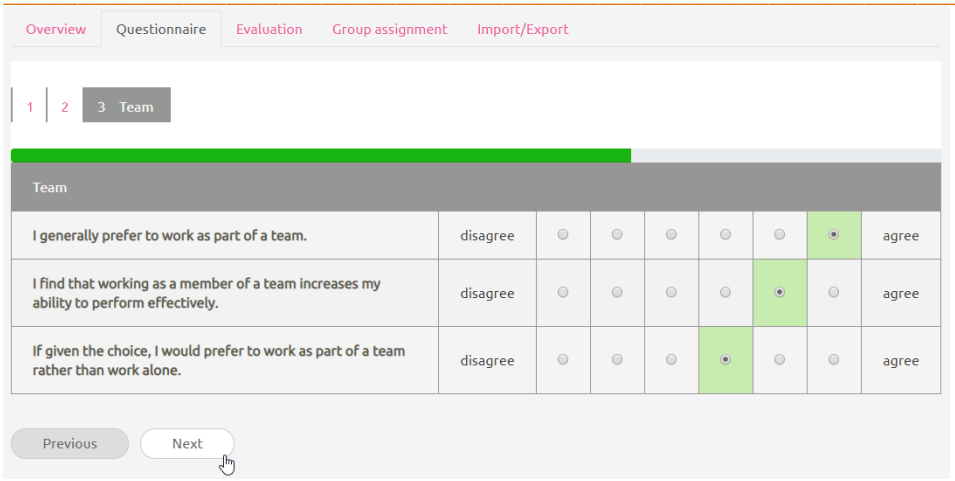

Figure 27: Questionnaire tab - a progress bar shows a rough estimation of completion

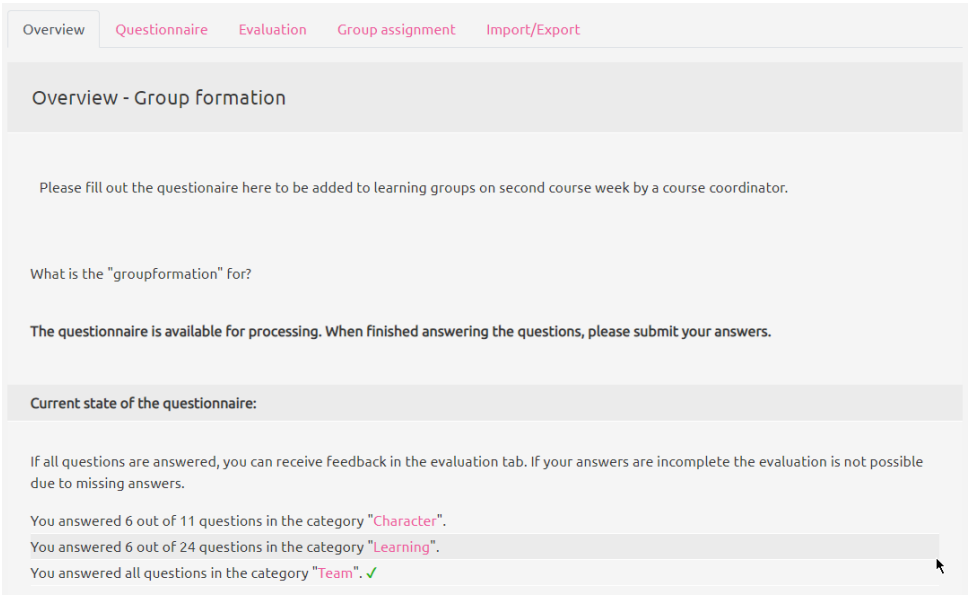

Figure 28: After completion of the last questionnaire tab participants are redirected to overview, which shows the status of answers in each category. Prior studies indicated that the display with incomplete categories might encourage participants to finish questions later on.

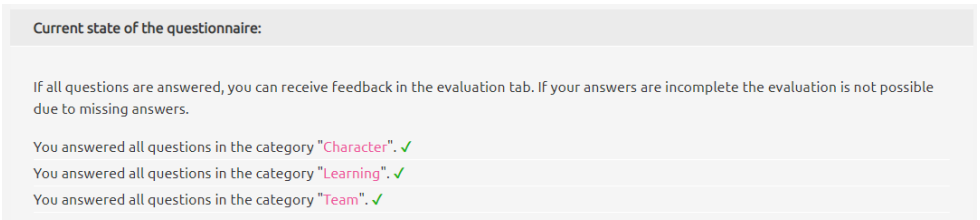

Figure 29: On completion of all categories these are marked with a green arrow.

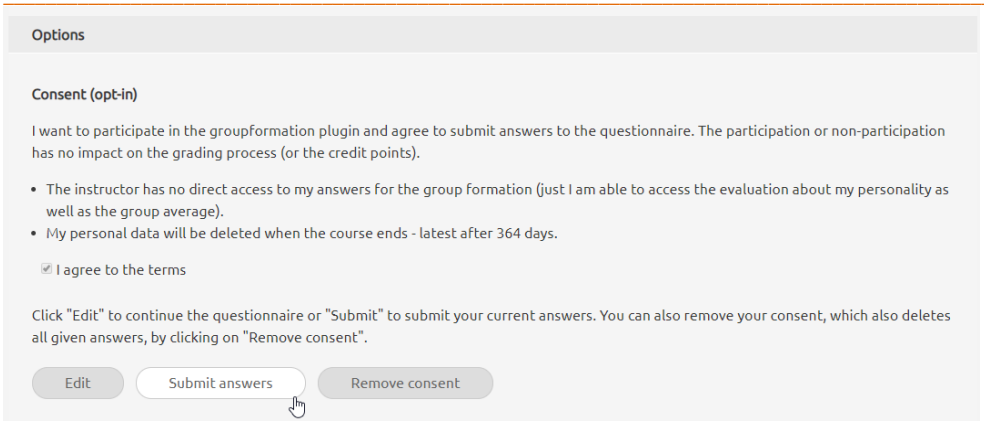

Figure 30: On Overview, below the consent (opt-in) participants can remove consent (which leads to deletion of all answers), edit the questionnaire answers, or submit them finally. This leads to the activity completion status.

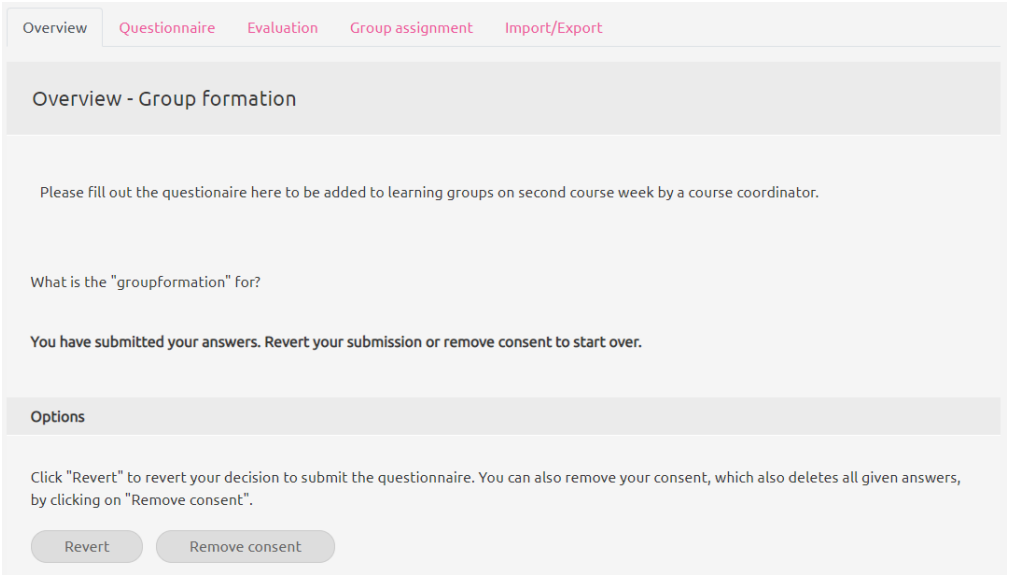

Figure 31: After submission of answers, participants can revoke the submission and re-edit their answers as long as the activity has not ended.

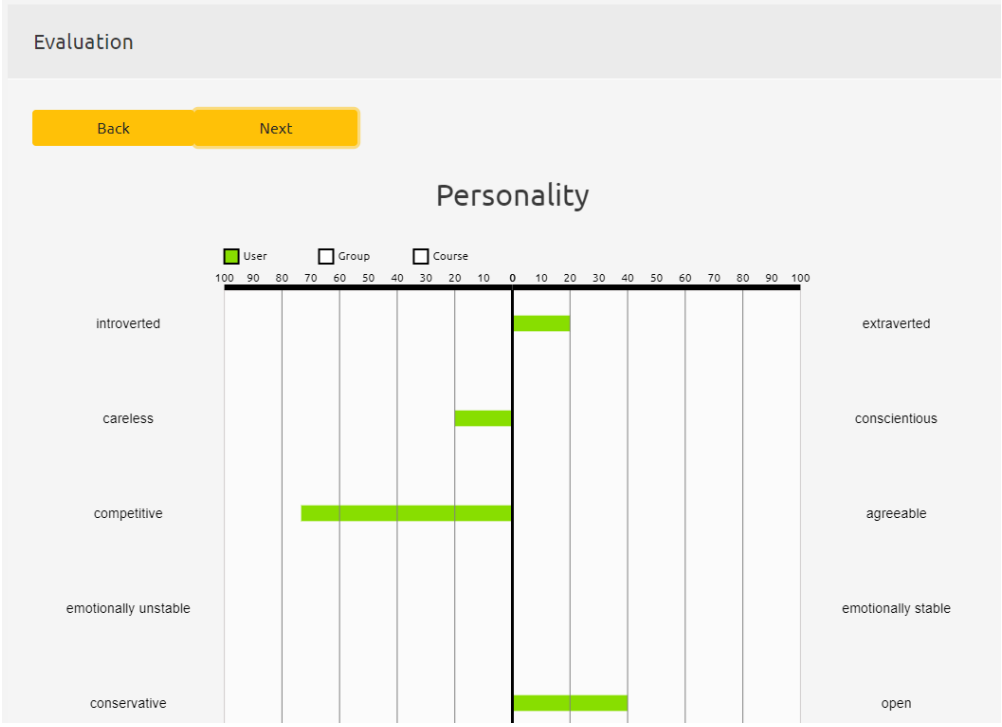

Figure 32: Evaluation tab shows statistical results to participants, if they submitted their complete answers. Depending on the setup, it contains overview over personality traits and/or motivational aspects. After group formation finished there are as well bars to compare own values with the group mean value (for group size above 2) and the whole course mean value (for courses with more than 2 participants).

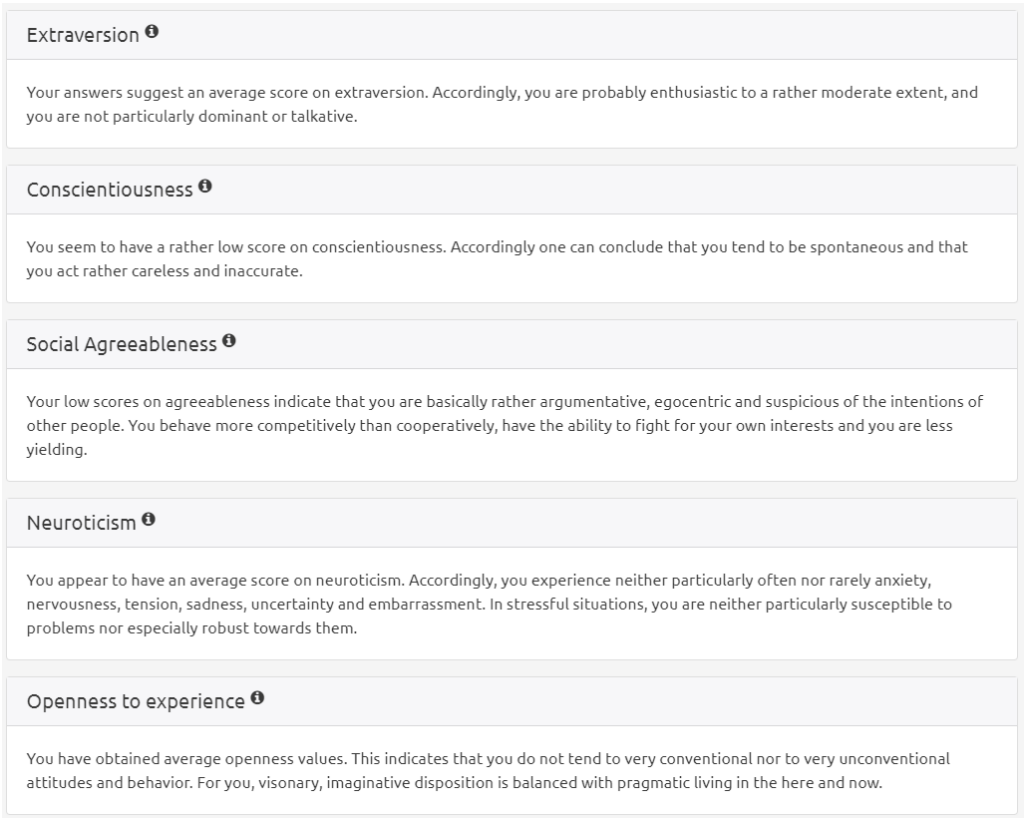

Figure 33: Evaluation tab - below the graphical overview a written statement helps in interpretation of the displayed data.

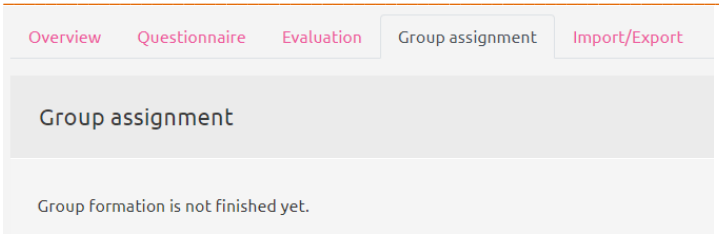

Figure 34: Group assignment tab - shows the group members with a link to their Moodle profile (to assist in contacting group members). In this example seen here, group formation has not yet finished.

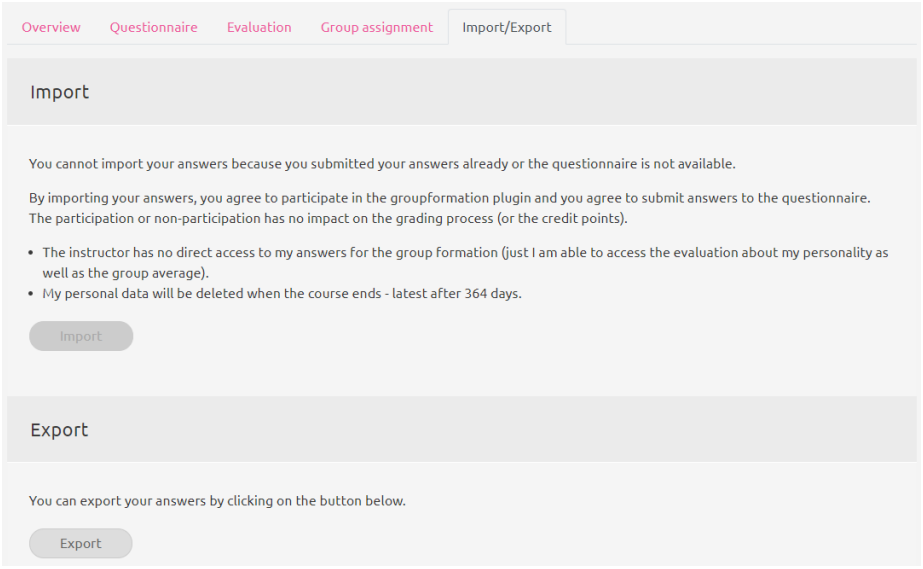

Figure 35: Import/export tab - if system administrators enabled import/export, participants can export their answers as XML files and later re-import them (e.g. in other group formation questionnaires). Thus, only remaining open questions need to be answered.

Step 3: group formation (course coordinator view)

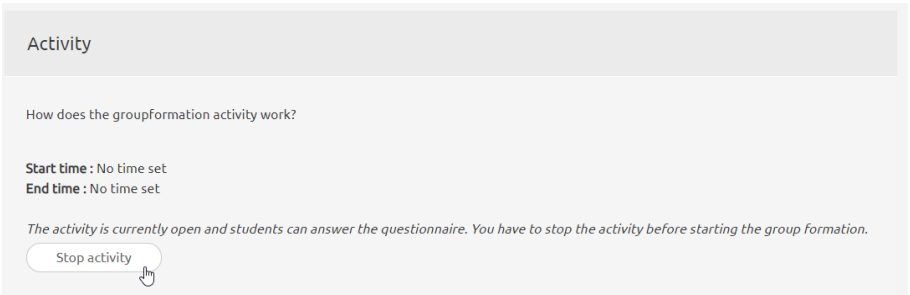

Figure 36: Activity end - when the deadline is reached or manually the activity needs to be stopped before groups can be built.

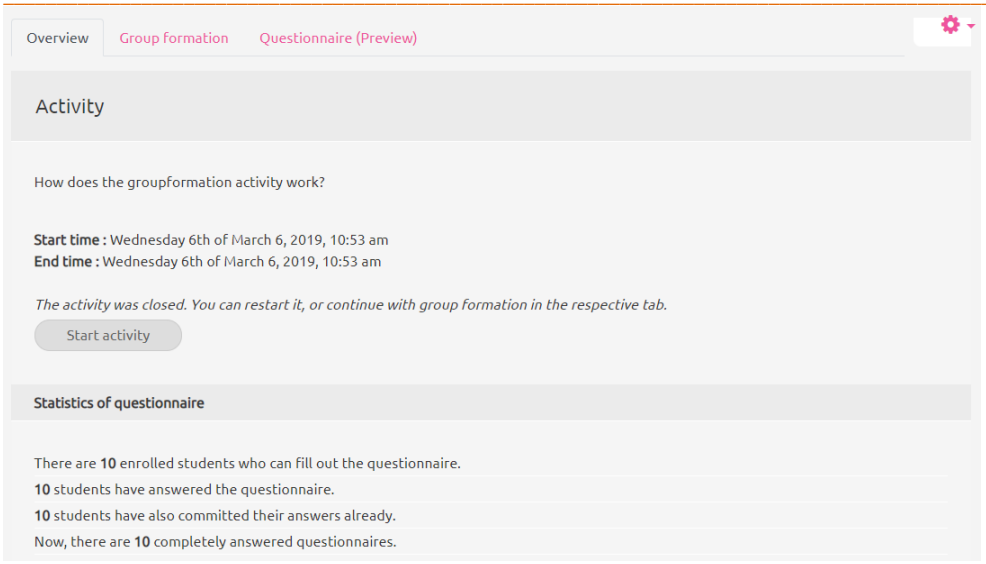

Figure 37: activity ended - when stopped the end date is shown and now group formation can be started

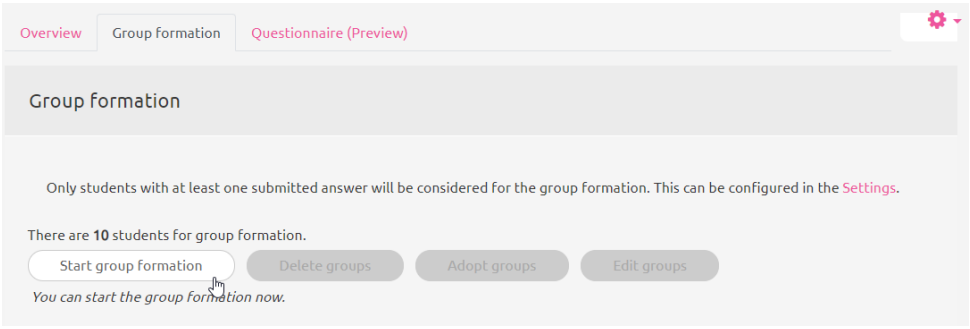

Figure 38: group formation - start the formation for the number of listed participants (the number respects the filtering by grouping and - if set in setup - by no answers.

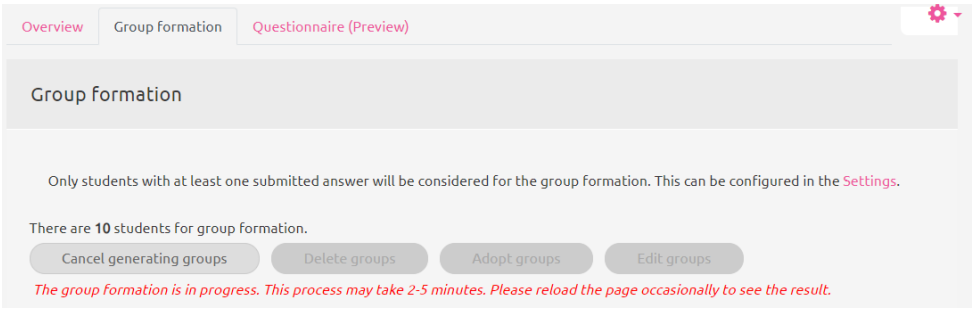

Figure 39: group formation runs - the job for group formation is runtime intensive and thus not performed directly but by Moodle cron jobs. Depending on the configuration of your Moodle this may take some time until the cron job starts (e.g. every 15 minutes). The calculation of groups is then ready within a few minutes (depending on the number of criteria and participants). The algorithm was tested with up to 1000 participants and manyfold criteria (>100).

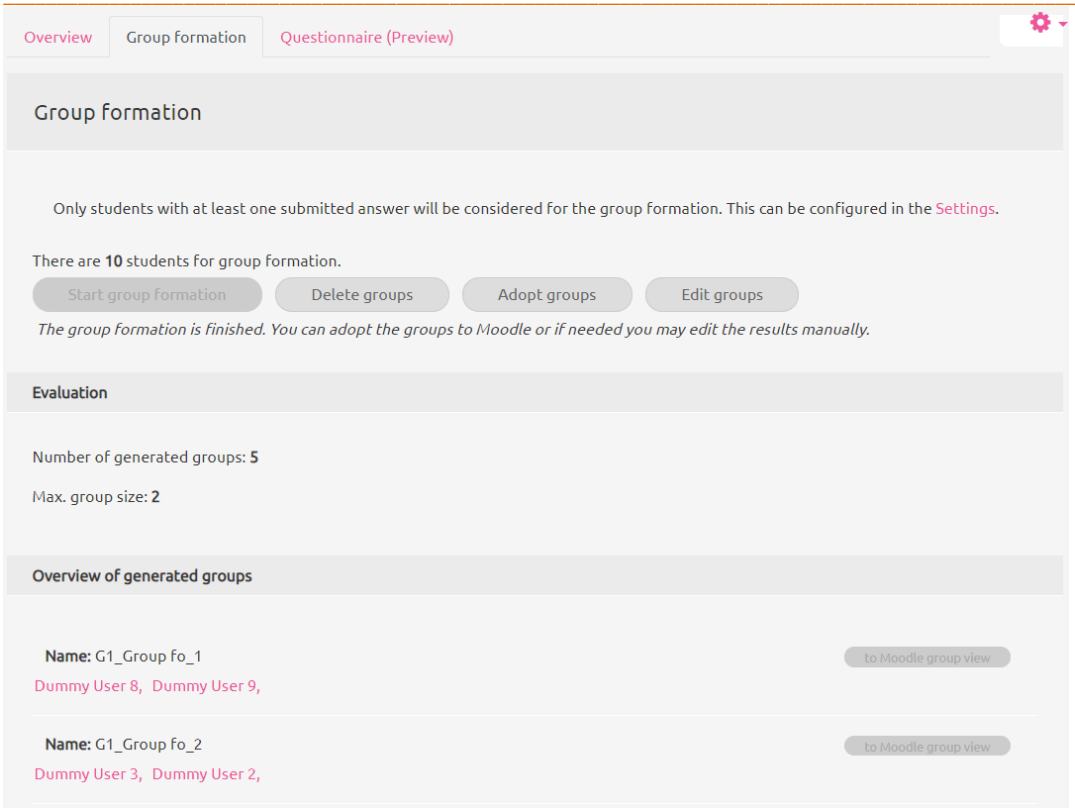

Figure 40: group formation done - to see the result of the group formation you need to reload the page manually. In the example here, the group size was set to 2 and resulted in 5 groups (2 are shown on the screen, the rest below is not visible)

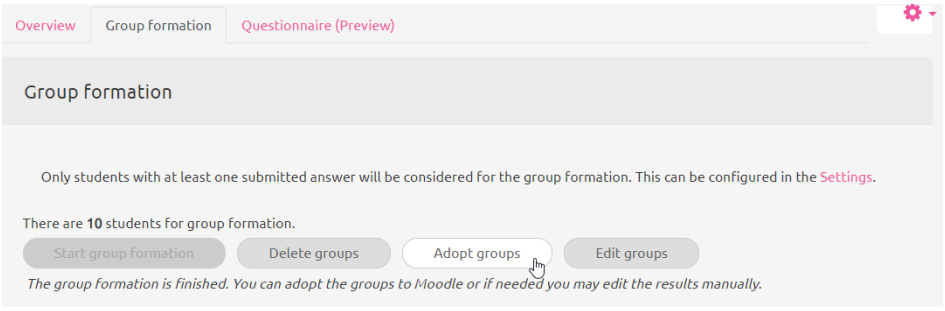

Figure 41: group creation in Moodle - when you are satisfied with the result the groups can be created as Moodle groups. Therefore, click 'adopt'. This is as well a cron task which is done as soon as the next cron cycle in Moodle happens. Ask your system administrator how often Moodle cron is starting (Moodle documentation v3.6 and above recommends every 1 minute).

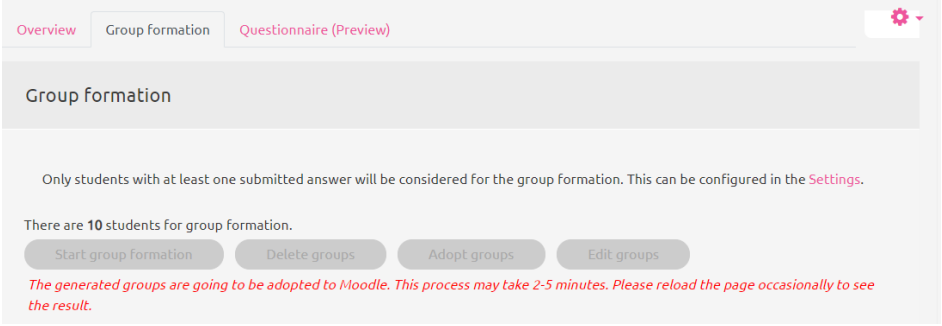

Figure 42: moodle group creation - a red text informs about the cron job to be added.

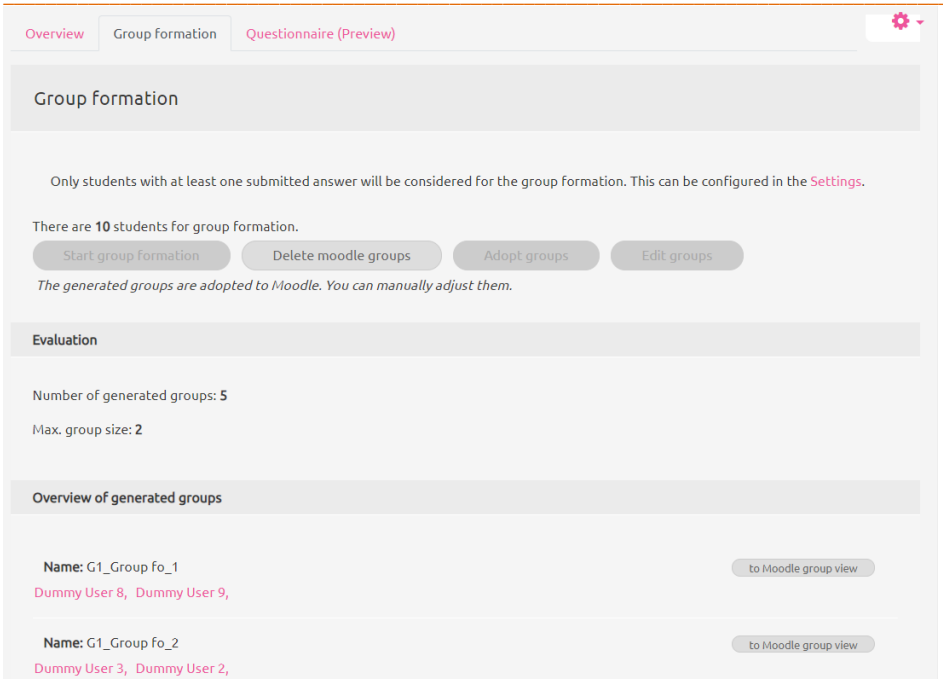

Figure 43: moodle group creation - the groups are created in Moodle. Editing is only possible manually now.

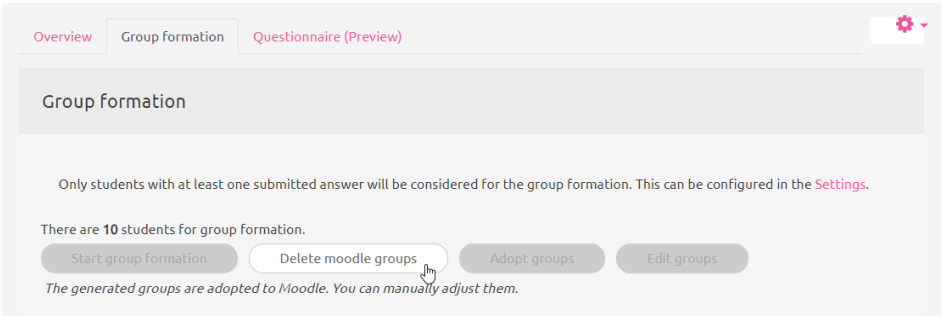

Figure 44: moodle group deletion - you can delete all created Moodle groups as the plugin tracks their IDs internally. Afterwards new group formation is possible. Attention: All changes you might have applied to the groups using other Moodle interface dialogs are lost, too.

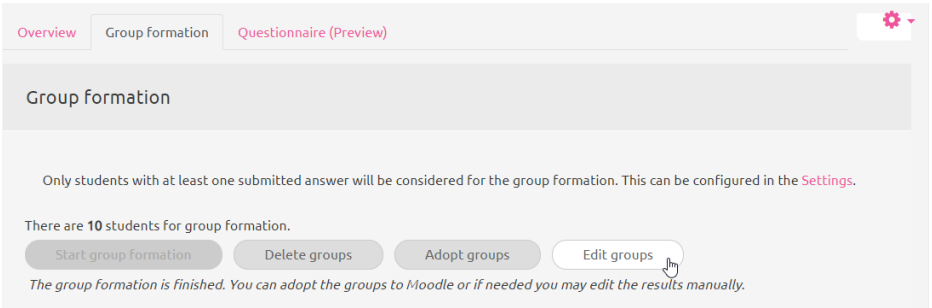

Figure 45: edit group proposal - instead of directly adopting groups to Moodle you can edit the proposed group formation

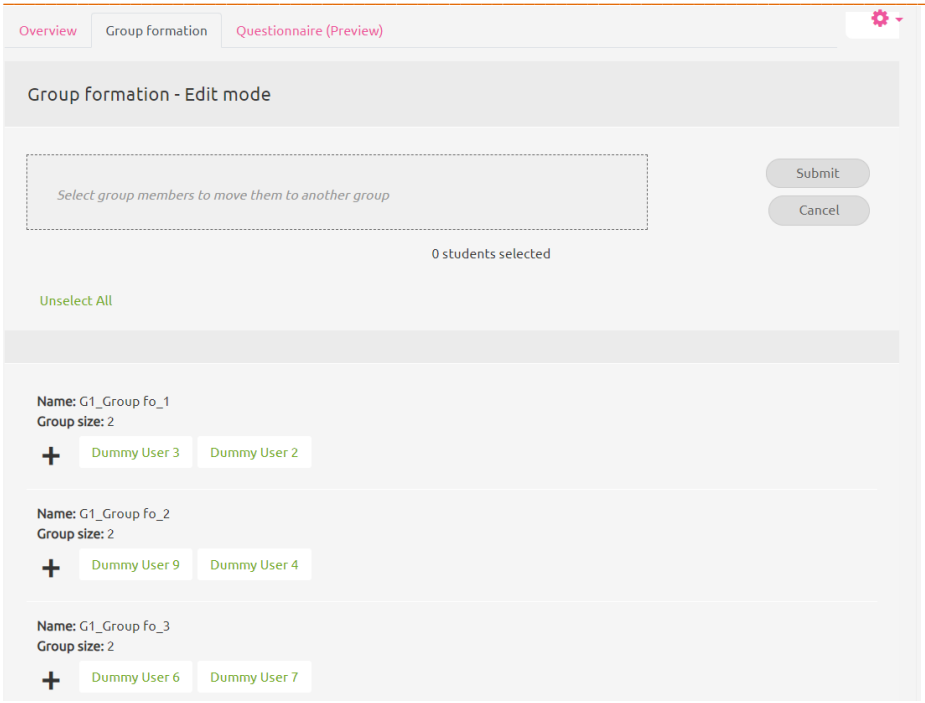

Figure 46: group editing - the dialog for editing contains a clipboard of participants on top and the current group constellation below.

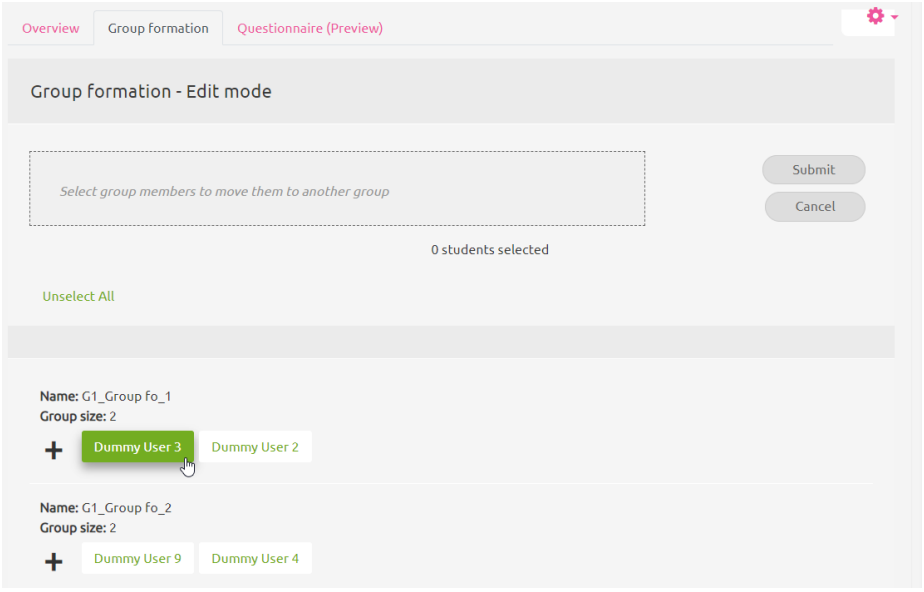

Figure 47: group editing - click on users to add them to the clipboard

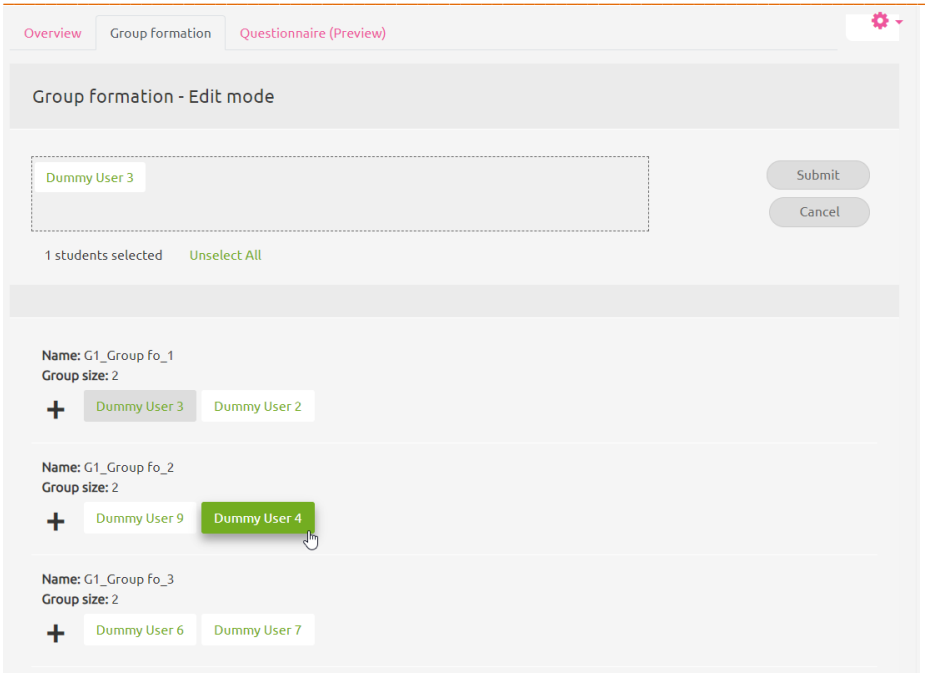

Figure 48: group editing - click on users to add them to the clipboard (second example)

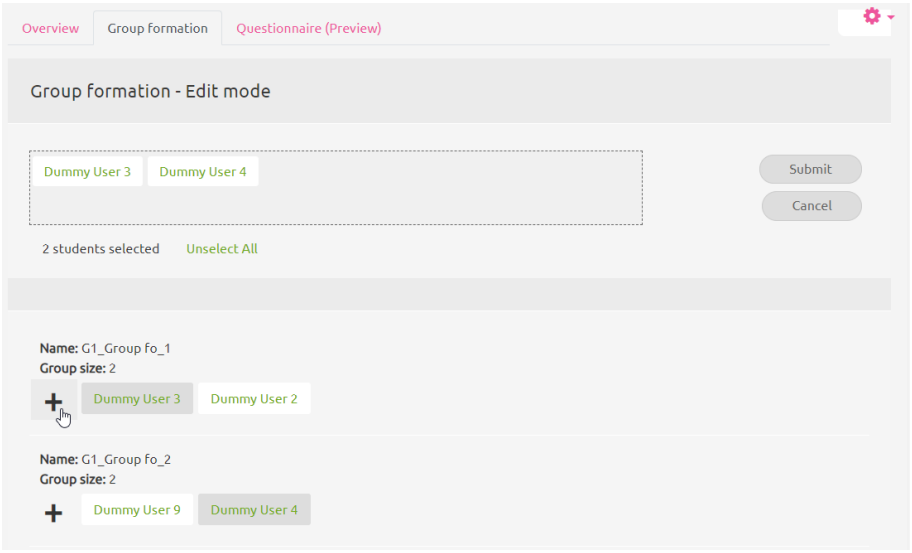

Figure 49: group editing - to insert into a group click on the plus (+) symbol next to a group to activate this group as the target for pasting

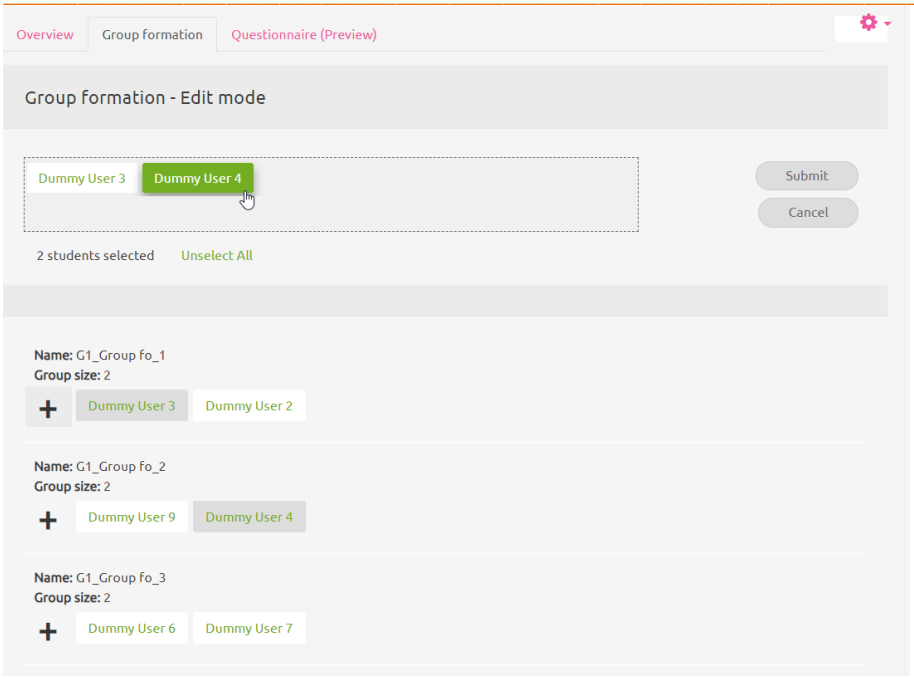

Figure 50: group editing - if you now click on participants from the clipboard they are moved to the target group (here User 4 to G1_Group.._1)

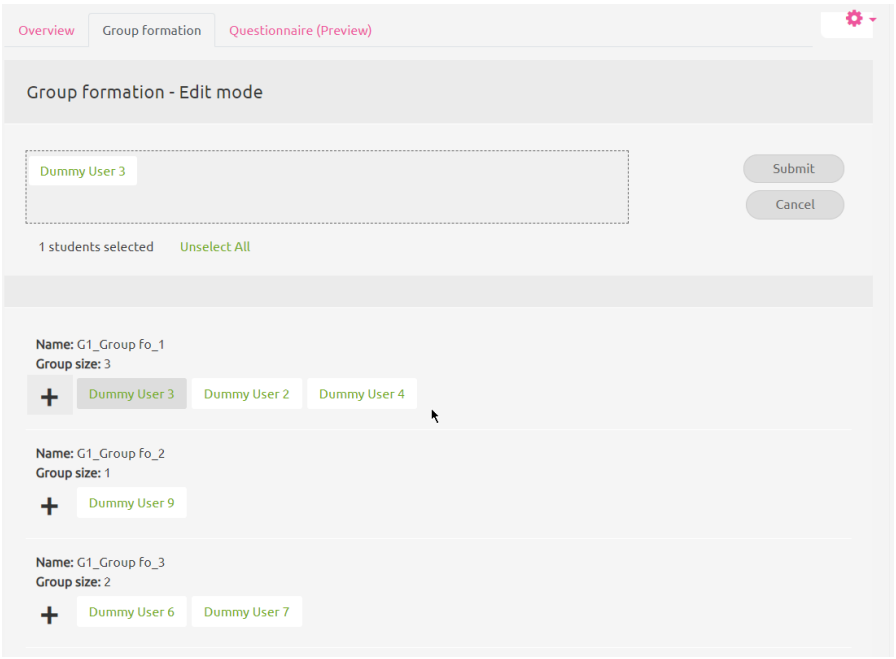

Figure 51: group editing - the group memberships are updated (here: User 4 has been moved to Group 1)

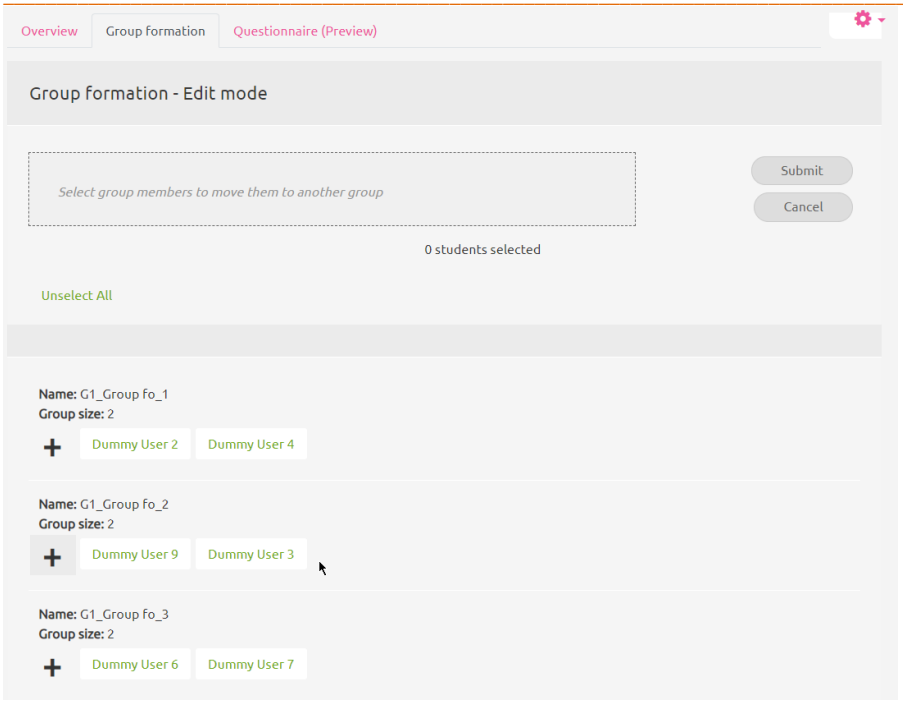

Figure 52: group editing - by selecting another group as target (here Group 2) and then clicking User 3 from the clipboard, this user has been moved, too. (now User 3 and User 4 switched groups finally)

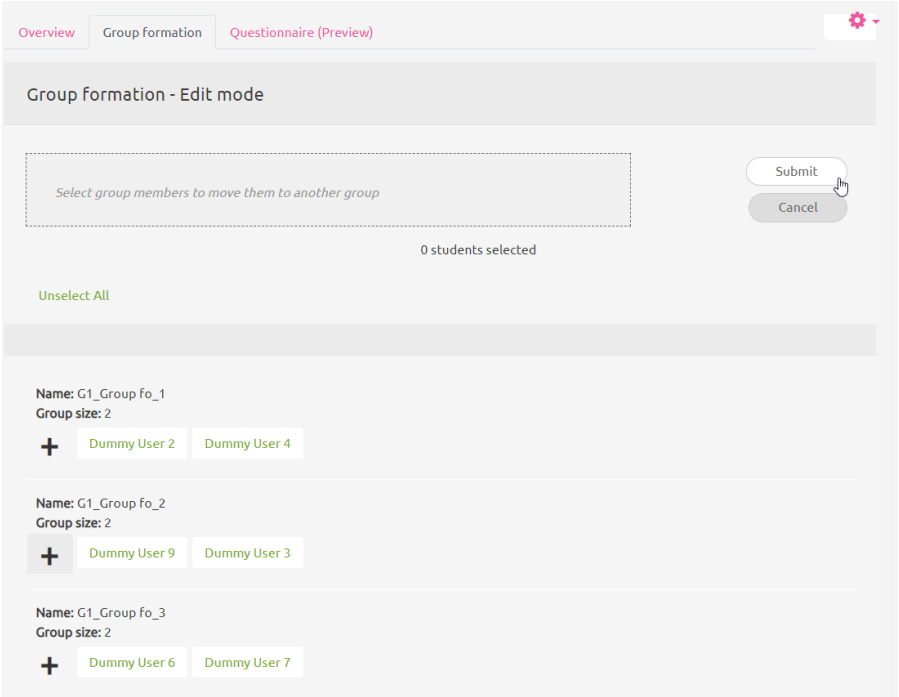

Figure 53: group editing - to keep the changes, click 'submit'. Otherwise the group proposal remains as before editing.

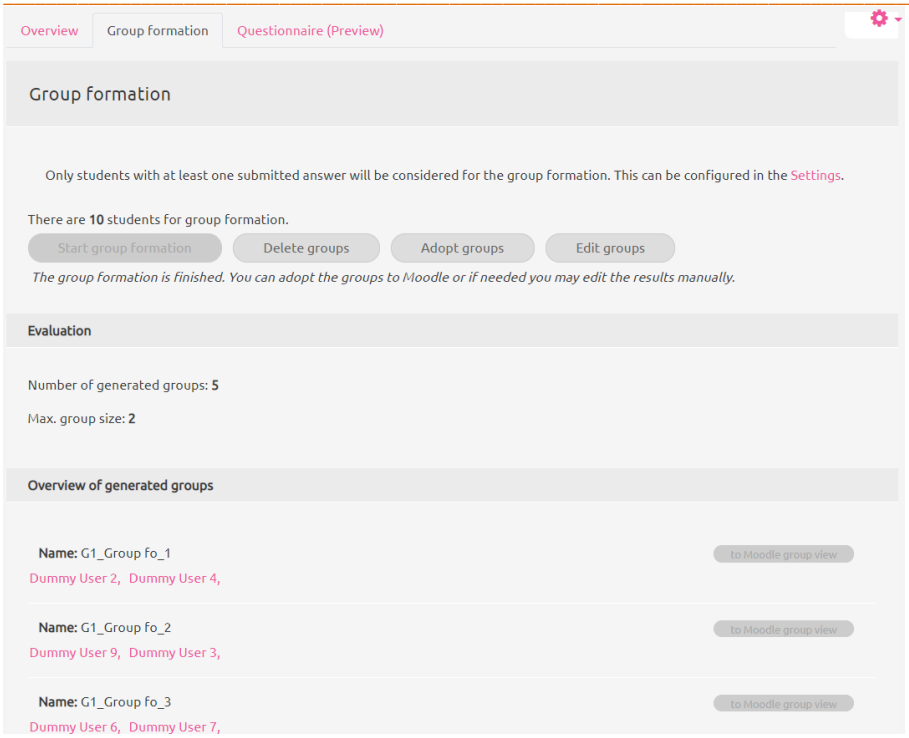

Figure 54: group editing - the changes made are reflected in the group formation tab view. The new group constellation can now be adopted to Moodle groups.

A2 Details about plugin installation

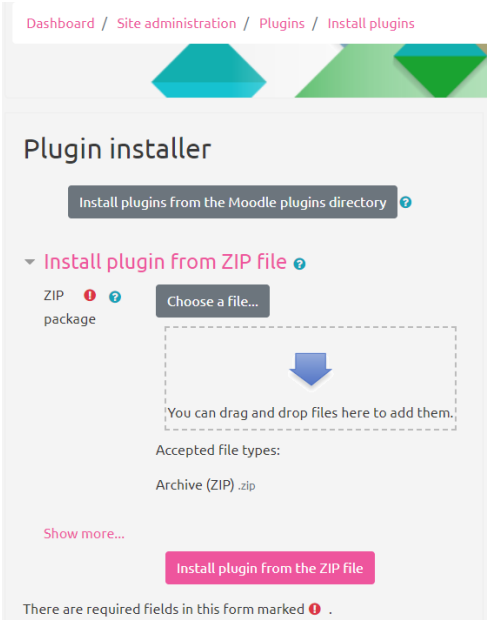

Figure 55: plugin installation - as admin user either drop a ZIP of the whole plugin repository or select 'groupformation' from the Moodle plugin directory. Another way for advanced users is to manually checkout the git repository into your moodle subfolder /mod/groupformation . Moodle will recognize it on the next admin login and prompt you for installation of the new found plugin. It works similarly for plugin updates (if version is newer, Moodle prompts for updating).

Figure 56: plugin installation - after installation you are directly forwarded to the settings of the plugin. Later on, click in 'Settings' in the plugin list of installed plugins

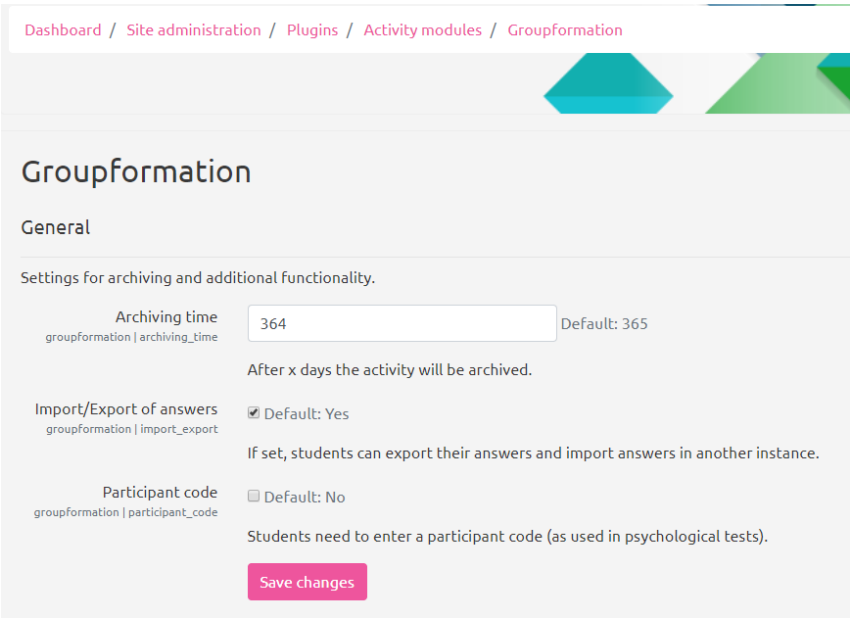

Figure 57: plugin settings - the system wide settings allow you to set a maximum age of personal data of participants (e.g. questionnaire answers). They are deleted by cron jobs after this amount of time passed. The number set here is displayed to participants when they submit their consent (opt-in) for the group formation activity. Administrators can allow/restrict export/import of questionnaire answers as XML-files. The last option allows to ask participants for an individual code, which is then included in the XML-download data. This is useful, if you plan to re-use the anonymized answers to questionnaires in a scientific study and want them associated with a certain participant code (e.g. distributed by you before).