Collaborative group work: Effects of group size and assignment structure on learning gain, student satisfaction and perceived participation

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Abstract

Background: Collaborative group sessions in Nijmegen include 15 students who work all together on a group assignment. Sometimes, the group is split-up in three and every subgroup elaborates a part of the assignment. At the end, they peer-teach each other. It is believed that the split-up enhances participation and therefore learning gain.

Aims: To establish the effect of group size and structure of the assignment on the perceived participation, the satisfaction and learning gain of collaborative group sessions.

Methods: In this study, 27 groups of 15 students were equally divided into:
A-group: all 15 students working on the complete assignment.
B-group: subgroups of 5 students working on the complete assignment.
C-group: subgroups of 5 students working on a smaller part, and peer-teaching each other at the end of the group session.

All students took a pre-test, a post-test and a follow-up test and completed a questionnaire. Questionnaires were analyzed with a one-way analysis of variance (ANOVA) and post hoc by multiple comparisons. Learning gain was analyzed using a repeated measures ANOVA.

Results: A group size effect is observed in favor of working in subgroups. Perceived participation of the students differs between A and B ($p \leq 0.001$) and between A and C ($p \leq 0.001$), but not between B and C. Also, an assignment effect is found in favor of the smaller assignment combined with peer-teaching. The students’ satisfaction differs between A and C ($p \leq 0.005$) and between B and C ($p \leq 0.001$), but not between A and B. The C-group also shows higher test results ($p \leq 0.043$).

Conclusions: The students prefer smaller groups as well as smaller assignments including peer-teaching. A possible larger learning gain of this format needs to be re-investigated.

Introduction

Motivation

In many medical curricula collaborative group sessions are part of the routine learning activities. Both optimal group size and optimal structure of the assignment are still in debate (Dolmans & Schmidt 2006; Edmunds & Brown 2010). In the (bio)medical curricula at the Radboud University Nijmegen Medical Centre, The Netherlands, various variants of group size and structure have evolved. A preferred variant is a collaborative group session of 15 students in which the group is split in three equal subgroups and every subgroup discusses a different part of the assignment during the first half of the session. In the second half, the groups peer-teach each other: every group presents its solutions and discussions, moderated by an expert. The variant described above is preferred because our teachers assume that, in contrary to collaborative sessions of a total of 15 students working all together from the start, students in smaller subgroups feel more obligation and self-confidence to participate and will learn more because of their active participation. There is evidence to this assumption, since learning has been shown to be enhanced by having students explain material to each other or by having students listen to others who explain matters (Moust et al. 1987; Schmidt et al. 1989; De Grave et al. 1996, 2002). Also, too many quiet students might put tension in a group with verbally dominant students (De Grave et al. 1996, Hendry et al. 2003).

Practice points

- Students prefer smaller sizes of subgroups when they have to participate in collaborative groups; in our case they prefer subgroups of 5 students in contrast to 15.
- Students prefer to work on a smaller part of the assignment and to receive solutions of the remaining parts by peer-teaching.
- Retention of knowledge after 2 weeks might be better when students have worked in a small group on a smaller part of the assignment and have learned by peer-teaching from the remaining part of the assignment.
A drawback of the split-up in subgroups may be that a student gains thorough knowledge of one part of the assignment, but only superficial information of the remaining part. We therefore studied student participation, satisfaction and learning gain in conditions that differ in group size and in structure of the assignment. Although our motivation came from local concerns, this study may add to the discussions to optimize collaborative group work in other curricula.

Group size and learning gain

Small group learning may stimulate (Slavin 1996): (1) motivation – the group stimulates its individual members, (2) cohesiveness – the members feel responsible for the group results, (3) development – the members grow intellectually by weighing each other’s arguments, and (4) cognition – by verbalizing their thoughts, the members deepen their knowledge. The optimal group size in collaborative learning is not fixed. In most problem-based learning curricula, 10 students are gathered in small group sessions (Dolmans & Schmidt 2006). Miflin (2004, citing Barrows 1988) writes that when a small group is used it “cannot function well beyond eight members.” An effective group size in collaborative learning is mostly argued to be five or six. The arguments for this size are: not so many students per tutor (Miflin 2004), a group size just reaching the point in which enough views and knowledge are available for the problem-solving process (Lohman & Finkelstein 2000), more balanced discussions (Moust et al. 2005), and promotion of individual development (McLean et al. 2006).

Structure of the assignment and learning gain

There are no clear rules for the structure of an effective small group assignment. All studies point more or less at the following: preferably the assignment deals with a significant problem (Parmelee & Michaelsen 2010), is ill-structured so that a true group task is needed to solve the problem which cannot be carried out individually (Cohen 1994), and should involve the checking out of what is learned and understood by the students (Steinert 2004). Moreover, the assignment should elicit controversies and contradictions and not only exploratory and cumulative discussions (Visschers-Pleijers et al. 2006), because contradictions and cognitive conflicts create conceptual changes from existing knowledge (De Grave et al. 1996).

Research questions

1. Do students who solve a smaller part of the assignment and learn about the remaining part of the assignment by peer-teaching learn the same as students who solve the complete assignment?
2. Do students who work in subgroups of five learn the same as students who work in groups of 15?
3. Do students’ satisfaction and perceived participation differ when working in subgroups of five instead of in larger groups of 15?
4. Do students’ satisfaction and perceived participation differ when working on a smaller part and being informed about the solution of the remaining part of the assignment instead of working on the complete assignment?

Educational context

This study was carried out among first year medical and biomedical students during our gross anatomy course, which lasts 4 weeks. The small group session selected for this research was programmed at the end of the second week. The assignment was made up of three clinical cases (see below), which had to be solved within that particular session. Available resources during the session were textbooks prescribed by the faculty, the knowledge that every member brought in, notes from previous assignments, and the knowledge of the expert teacher.

The goal of the assignment selected for this investigation was to learn the system of the branches of the abdominal aorta (unilateral or bilateral, feeding primary or secondary peritoneal organs). It has been found that first-year students, because of their age, need to get more focused and should be offered less complex problems in small group work (Schmidt & Moust 2000). We fulfilled this requirement by giving specific instructions such as: “Connect the area supplied by the vessels and the specific anatomical location of the root of the vessel” and “Discuss the similarities of the early vascularisation of the intestines from your embryology book and the adult situation, and involve the intraextra-peritoneal organization of the intestines in the discussion.” The second part of the assignment illustrated the clinical relevancy by three cases: (1) aneurysm cranial to the bifurcation, (2) atherosclerosis of the arteria iliaca communis, and (3) an accessory renal artery.

Students were stimulated again to ‘solve’ these cases by discussing questions such as “Consider possible complaints of the patients in these cases.”

Methods

Participants were first year students, 276 medical and 115 biomedical, enrolled in the course (October 2009). They were divided into 27 groups of about 15 or 16 students by the faculty. The 27 student groups were randomly assigned to one of the following experimental groups:

- A-group: all 15 students in the group working together on all three cases.
- B-group: three subgroups of 5 students working on all three cases.
- C-group: three subgroups of 5 students working on one of the cases, peer-teaching each other at the end of the session during informal group presentations.

The arrangement of the A-group has been the standard in our curriculum. The structure of the C-group is what has evolved in courses over time. The arrangement of the B-group is added for the sake of this study and allows us to distinguish between the effect of group size and the effect of the structure of the assignment.
The sessions lasted 90 min each. All students were subjected to a pre-test at the start of the session and to a post-test directly following the session. Both tests included one theme with seven items (Appendix). The questionnaires were also completed directly after the post-test. The follow-up test was constituted of the same theme with the same seven items, but now included as one of the 10 themes that were presented in the examination of the complete course 2 weeks later.

The scores from the three tests were analyzed using a repeated measures analysis of variance (ANOVA). The questionnaires asked about satisfaction (12 items; example: “I am satisfied about the group size during this group session”) and participation (2 items; example: “All group members have participated actively during the group session”). All questions were on a 6-point (Likert) scale. The 12 and 2 items were grouped into the constructs satisfaction and perceived participation, respectively. These constructs were analyzed using a repeated measures ANOVA. Significant differences were post hoc explored by multiple comparisons, according to Bonferroni, when equal variances were found, and according to Dunnett T3, when the variances were not equal. Equality of the variances was explored with a Levene-test.

Results

The average proportion of the right answers increased over time for all three experimental groups, obviously (Figure 1). There were no significant differences between the groups at the start of the session, nor at the end of the session, neither at the follow-up test during the exam of the course 2 weeks later. The slope of the increase over time in the C-group seemed to be somewhat steeper compared to either the A- or B-group. The increase of the C-group compared to the combined data of the A- and B-groups showed a significant difference ($p < 0.043$). All other scores of the A-, B-, and C-groups show no differences.

Student perceived participation and student satisfaction were different for the three tested groups (Table 1; $p \leq 0.001$). Post hoc evaluation of these differences showed that the A-group scored lower in perceived participation compared to the B-group (Table 2, $p \leq 0.001$) as well as the C-group (Table 2: $p \leq 0.001$). There was no difference between the B- and C-groups. Furthermore, both the A- and B-groups scored lower for satisfaction compared to the C-group (Table 2: $p \leq 0.002$ and 0.001, respectively). There was no difference in satisfaction between the A- and B-groups.

From the scores on the individual items (not shown), we concluded that the larger satisfaction of the students in the C-group was related to items such as organization and overall mark for the complete session. The C-group also scored higher than the B-group for items such as goals achieved and perceived learning gain. The B-group marked time allotted as less and the arrangement of the groups in the classroom as worse than the A- and C-groups did.

Discussion

We found a considerable effect of group size: students who worked in smaller groups of five members scored definitely higher on perceived participation. Also a large assignment effect was found: students were significantly more satisfied working on a smaller portion of the total assignment and to learn from the group results from others. The effect of group size was elicited by the fact that students’ perceived participation in the large group (A-group) differed from both small groups (B- and C-groups). The assignment effect was elicited by the fact that we found differences in students’ satisfaction between the group that elaborated a smaller portion (C-group) and both groups that elaborate the complete assignment (A- and B-groups).

The increase in the scores of all groups between the post-test and the follow-up test 2 weeks later is largely the effect of study activities of the students, nearing the final examination. A small test-effect might underlie these data, but since this effect will be equal in all the groups, this effect will not have contributed to differences between the groups.

The students who worked in smaller groups and on a smaller portion of the assignment scored equal to the other groups at all time-points with respect to learning gain. But, a small effect in favor of the C-group was found in the significantly higher results in the follow-up test compared to the pre-test. This effect is not straightforward, because it is probably dependent on the coincidence that the C-group scored lowest in the pre-test. The possible explanation is that working in the C-group really has had a positive effect on the retention of knowledge in the follow-up test 2 weeks later. This explanation is plausible since working in smaller groups does stimulate deeper learning, because of the larger involvement and greater enthusiasm of the students (Slavin 1996; Dolmans & Schmidt 2006).
The way in which we split-up the larger group into smaller subgroups and reunited the subgroups again is a sort of pyramiding (Edmunds & Brown 2010). Our study has shown beneficial effects of this approach in collaborative group work.

Limitations

The expert teachers in the small group sessions were senior anatomists, surgeons, and one radiologist, who all had more than sufficient knowledge of the subject. The behaviors of the expert teachers toward the group and its processes, though, may have been different. For instance, we did not control for the way in which the presentations in the C-group were held. Therefore, the individual interpretation of the teachers may have influenced satisfaction and participation or even the learning gain of the students.

The time spent on the assignment was 90 min, being the duration of the original assignment. The students in the B-group, who worked on all three cases in three subgroups, scored worst on satisfaction. They reported that there was not enough time to finish the complete assignment. Although it was explained to the students during the sessions that the hard core of the assignment was to learn about the abdominal aorta and that the cases were added as clinical applications, the B-group scored worst on available time. This time constraint may have influenced other scores in the questionnaires.

Implications and future work

This study implies that in the design of curricula group sessions with smaller number of students than usual should be considered in order to enhance participation. This study also shows that peer-teaching is an effective way to transfer knowledge between students.

During next season, we intend to extend this study by the introduction of a formal presentation at the end of the session and by streamlining the tutor behavior of the expert teachers. We will also stretch the duration with half an hour, to account for the perceived time-stress.

Conclusion

The students have a strong preference for small group sessions and for the “small group one case plus peer-teaching” format. It is very clear that this format produces at least the perception of higher learning gain, more goals reached and more active participation. There is an indication that the preferred format also has an effect on the retention of knowledge, but whether this effect is real needs further investigation.

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References


Appendix

Extended Matching Questions used for the post-test and for the course test 2 weeks later. Schematic drawing of the abdominal aorta is taken from: Antevil et al. (2006)

Theme: Arteries in the abdomen

Optional answers: In the diagram below you find a schematic drawing of the aorta abdominalis, branching into arteries. These arteries are indicated by a figure. These figures are the optional answers of this theme.
**Instruction:** Answer the questions in the table below with the use of the figures in the diagram above. The number between parentheses indicates the maximum allowed number of answers.

**Questions:**

| Q1   | Which arteries supply blood to retroperitoneal organs as well as intraperitoneal organs? | 4 | B F I E |
| Q2   | Which arteries supply blood to organs that are located retroperitoneal primarily?      | 5 | A C G H E |
| Q3   | Which arteries take care of the blood supply to the abdominal wall?                   | 2 | D K     |
| Q4   | Which arteries take care of the blood supply to the duodenum?                        | 2 | B F     |
| Q5   | Which arteries pass ventral from the ureter?                                        | 3 | D J L   |
| Q6   | Which arteries take care of the blood supply to the suprarenal gland?               | 3 | A C G   |
| Q7   | Which arteries are positioned dorsally from the vena cava inferior?                 | 3 | A C D   |