Effect of an individual readiness assurance test on a team readiness assurance test in the team-based learning of physiology

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Gopalan C, Fox DJ, Gaebelein CJ. Effect of an individual readiness assurance test on a team readiness assurance test in the team-based learning of physiology. Adv Physiol Educ 37: 61–64, 2013; doi:10.1152/advan.00095.2012.—We examined whether requiring an individual readiness assurance test (iRAT) before a team readiness assurance test (tRAT) would benefit students in becoming better problem solvers in physiology. It was tested in the form of tRAT scores, the time required to complete the tRAT assignment, and individual performance on the unit examinations. Students in one section were given the iRAT at the beginning of the team-based learning session. The same set of questions was given to students as their tRAT immediately after their iRAT. Students in the second section were not given the iRAT before the tRAT. This pattern was reversed for the next scheduled team-based learning activity between the two sections. We found that the section having both the iRAT and tRAT scored higher on the tRAT and completed their assignments in less time than the section with the tRAT alone. This suggests that the tRAT combined with the iRAT is an effective team-based approach to the teaching of physiology compared with the tRAT alone.

MATERIALS AND METHODS

The study included the following preparations.

Study Preparations

The study included the following preparations. Formulation of the groups. Groups were constructed by the instructor at the beginning of the semester to include 5–6 students/team. Each group consisted of at least one student with a grade of a B or above in the introductory physiology course that the students had to complete immediately before the advanced physiology course. Every team had a combination of both male and female students and a blend of the TBL requires reading assignments along with lectures on selected topics before a scheduled TBL session. The TBL session itself requires students to complete an individual readiness assurance test (iRAT), where students answer questions over the reading material or the lecture content individually. After the iRAT, students would break up into their preassigned groups to complete the team readiness assurance test (tRAT), which consists of identical questions that students received as the iRAT. Here, students solve problems as a team, where they portray and justify their thought processes, to accurately answer each question (3).

The purpose of this study was to examine the role of the iRAT during the scheduled TBL session. The class was divided into two sections. Both sections were given the iRAT and tRAT during the first TBL session. During the second TBL session, section 1 received the tRAT only, whereas section 2 received both the iRAT and tRAT. During the third TBL session, section 1 received both the iRAT and tRAT, whereas section 2 received the iRAT only. This cross-over study pattern between the second and third TBL sessions was repeated over the reading material or the lecture content individually.

MATERIALS AND METHODS

This study was designed to involve two sections of the advanced physiology (AP 3100) course, consisting of 222 third-year (first year of the Professional program) pharmacy students, of which 96 students were male and 126 students were female. Most students in this study had been exposed to factual knowledge in physiology and participated in TBL sessions in their spring semester of the second year as part of the introductory physiology (AP 2100) course. A small group of the participants, who had also been exposed to basic knowledge in physiology as transfer students, may or may not have had any exposure to TBL and were always grouped with students who had prior experience in the introductory course.

TBL methodology, introduced by Michaelsen (10), involves the grouping of students in a strategic manner, a readiness assurance process (RAP), and a TBL session. The RAP portion of the TBL requires reading assignments along with lectures on selected topics before a scheduled TBL session. The TBL session itself requires students to complete an individual readiness assurance test (iRAT), where students answer questions over the reading material or the lecture content individually. After the iRAT, students would break up into their preassigned groups to complete the team readiness assurance test (tRAT), which consists of identical questions that students received as the iRAT. Here, students solve problems as a team, where they portray and justify their thought processes, to accurately answer each question (3).

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of different ethnicities. These groups were permanent for the entire semester.

Consent forms. An Institutional Review Board-approved consent form was distributed to all students in the advanced physiology class early in the semester. The consent forms were gathered and stored by the Divisional Secretary until after the completion of the course and grade submission. All students gave their consent to participate in the study, and, thus, no one was excluded from either of the sections.

Study Design

RAP. Reading assignments and lectures were provided before the scheduled 50-min TBL session. Students sat in their predetermined groups with closed access to resources. They were given the iRAT, which consisted of 10 higher-order thinking questions in a multiple-choice, sequence, or fill-in-the-blank format. Upon completion of the iRAT, students learned how well they did on the iRAT by receiving their scores on the computer but did not know which questions they missed. Afterward, groups were given the exact copy of the quiz to complete as a team. Groups discussed each question while the instructors and the teaching assistants were in the room answering questions but not revealing answers. Once students had completed all the questions, the TBL session would typically end with a short time for discussion since the class met for 50 min only. Students were always encouraged to discuss the questions through the discussion board, and the correct answers were eventually posted on the course page. Some of the same questions from the iRAT/tRAT were modified slightly and used in the following examinations.

A TBL session was always scheduled right before a major unit examination. The first TBL session served as the baseline for the study, where both sections received the iRAT and tRAT. Subsequently, the iRAT was alternated between the two sections for the remaining four units. If a section was receiving both the iRAT and tRAT, the iRAT was administered at the beginning of the TBL session. The same set of questions was given as the tRAT immediately after the completion of the iRAT. During the TBL session, students were not allowed to access their notes or any other resources. Each team was requested to record their start and end times for the tRAT assignment.

Experimental manipulation. Experimental manipulation started with the second TBL session, where section 1 became the interventional group as it received the tRAT alone. Section 2 was given both the iRAT and tRAT. This pattern was reversed during the third TBL session, where section 2 became the interventional group. The fourth and fifth TBL sessions were repeats of the second and third TBL sessions, respectively. This crossover design was implemented to prevent one section from continuously being deprived of the opportunity to complete both the iRAT and tRAT. Overall, each team had two experiments where they served as control groups and two experiments where they served as interventional groups.

Data collections. Data collected from this study included the tRAT scores, duration of time required to complete the iRAT, and unit exam scores. The design of the study is shown in Table 1. To control for the effects of differential learning in the introductory physiology course, data were split into two groups (above and below the median) based on the median iRAT score at baseline.

Fig. 1. A: team readiness assurance test (tRAT) scores of above median students compared with individual readiness assurance test (iRAT) and tRAT scores. B: tRAT scores of below median students compared with iRAT and tRAT scores. *P < 0.05.
ANOVA models were used to compare tRAT scores, tRAT completion times, and unit examination scores for the iRAT/tRAT and iRAT alone conditions. Statistically significant main effects were further assessed with post hoc Bonferroni tests and statistically significant interactions with analyses of simple effects. All tests were conducted with an experiment-wise \( \alpha \)-level of 0.05.

Statistical Analysis

Student feedback was obtained specifically on their TBL experience as part of the course evaluation at the end of the study. Students also completed peer evaluations of their team members.

RESULTS

The results of this study are summarized below. Scores and times are expressed as means ± SD.

Teams from one section that were given the tRAT alone were compared with teams that were given both the iRAT and tRAT from the other section. To better understand the outcome of the study, we separated each section into two tiers, one above median and one below median. As expected, the section completing both the iRAT and tRAT showed higher scores on the tRAT than the section with the tRAT alone (Fig. 1, A and B). The group above median that completed both the iRAT and tRAT performed significantly better than the section taking the tRAT alone in units 2 and 3. This was true of the group below median as well in units 3 and 4. The remaining groups showed an increase in tRAT scores that was not statistically significant.

Similarly, the time required to complete the tRAT was significantly shorter when students completed both the iRAT and tRAT compared with students who completed only the tRAT. This observation was true in both the above median and below median groups (Fig. 2, A and B). Exam scores, however, were not affected by the experimental manipulation (Fig. 3, A and B) and were not statistically significant throughout the entire study.

DISCUSSION

From our results, it is apparent that administering the iRAT before the tRAT improved tRAT scores and decreased the completion time compared with the tRAT alone condition. If students had not taken the iRAT but only participated in the tRAT, it is possible that not all students would contribute to the problem-solving exercise. On the other hand, when students were asked to complete the iRAT before the tRAT, students were required to consider the questions individually. Since iRAT scores were used in the overall grading scheme, students were motivated to approach the questions to provide the best answers they could. Additionally, since students became familiar with the questions through the iRAT, perhaps they were curious to learn how other students approached the same questions, which could have led to increased levels of involvement during the TBL session. Being exposed to the same questions multiple times appeared to help students arrive at the correct answers rather quickly, thus increasing the tRAT score while decreasing the time taken to complete the assignment, as expected.
On the other hand, when a section completed only the tRAT, students had no opportunity to review questions in the form of the iRAT. This affected the time required to complete the tRAT, causing it to be significantly higher than students receiving both the iRAT and tRAT.

The presence or absence of iRAT completion before the tRAT did not influence students’ unit examination scores. The unit examination was divided into ~50% factual knowledge, 30% comprehension, and 20% application, graphical analysis, and problem-solving questions. The group exercise during a TBL session mostly consisted of the application, graphical analysis, and problem-solving questions. Whether students have dealt with these questions in the tRAT form alone or both the iRAT and tRAT forms seemed to make minimal difference in their examination scores. Considering that there were fewer problem-solving questions in the actual examination, the impact of not visiting the questions multiple times in a TBL session on the unit examination may have been small. We also believe that the TBL session helped students understand the topics covered in depth. However, it is always a challenge to measure indepth understanding. We are designing a study to better understand the process involved in measuring the in-depth learning.

According to the poststudy student survey, the TBL session improved students’ understanding of physiology, challenged students to apply factual knowledge in solving problems, and engaged students in critical thinking and problem-solving activities. Students believed that the contributions of their peers helped them learn to solve problems. Furthermore, students claimed that the iRAT facilitated participation and problem-solving activities during the TBL session (1, 5, 13). Our study explored the effect of TBL on learning abilities, particularly on examination performance. We also noted that our TBL sessions were 50 min long, which is shorter than most traditional TBL sessions. We will expand the duration of the session in the future to allow discussion and feedback.

In conclusion, providing an individual review experience before a team problem-solving activity may facilitate learning during the team activity, leading to improved team scores and decreased time to completion of team activities.

DISCLOSURES
No conflicts of interest, financial or otherwise, are declared by the author(s).

AUTHOR CONTRIBUTIONS
Author contributions: C.G. conception and design of research; C.G. performed experiments; C.G. and D.J.F. analyzed data; C.G. and C.J.G. interpreted results of experiments; C.G. and C.J.G. prepared figures; C.G. and D.J.F. drafted manuscript; C.G., D.J.F., and C.J.G. edited and revised manuscript; C.G. approved final version of manuscript.

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