Readiness Assurance Tests for Team-Based Learning in the Anatomy and Physiology Classroom

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1. Introduction to Readiness Assurance Tests

Readiness Assurance Tests (RATs) are an integral part of Team-Based Learning. The aim is to provide students with immediate feedback regarding answers to test questions. This feedback enhances learning and retention as well as promoting team development (Michaelsen, 2008).

Readiness Assurance Tests are meant to determine if a student is prepared for the next step in class - application of the advanced preparation material (terminology lists and learning objectives in this case). There are two parts to the RAT: the individual RAT (iRAT) and the team RAT (tRAT). The iRAT reveals individual preparation while the tRAT promotes collaborative learning as students discuss their answers to multiple-choice questions to arrive at a consensus. Research shows that giving an individual RAT followed by a team RAT is a more effective way of teaching than giving a team RAT alone (Gopalan, 2013).

The use of Epstein’s (n.d.) Immediate Feedback Assessment Technique cards (IF-AT) or scratch cards during tRATs has been the most engaging part of team-based learning for my students. Each team uses one card and once they determine an answer to a multiple-choice question, they scratch the card for instant answers.

The multiple-choice questions for RATs could be simple to ensure basic knowledge recall in advance of class. Alternatively, the questions could be complex requiring much thought and covering many of the assigned terms and concepts. I follow the latter approach. If challenging RAT questions are used in order to promote deep discussion, the students may initially feel overwhelmed. Therefore, I refer to the RATs as “learning quizzes”. I reassure the students that preparing together as a team will help raise both individual and team scores. High team RAT scores can pull up their individual RAT mark as the total final grade for the RAT is an average of the two scores.

It is important for all students to contribute to the discussions during the team RAT. If assertive students are not prepared, and a knowledgeable student lacks confidence to stand by their answer, a resulting poor tRAT could pull down their grade. Here is where developing functional team dynamics comes into play. Teams learn to ask the quiet, prepared students their opinions.

When designing the RAT test, note that the IF-AT cards come with set numbers of questions (10, 25, or 50). I design the RAT test to have 10 challenging, multiple-choice questions. I also include one learning objective question (explained later) which requires a thoughtful, written
response. I make every effort to ensure that all of the questions, plus room for the learning objective answer, fit on 1 double-sided piece of paper.

2. Important Directions for Students
   - Both iRATs and tRATs are to be written closed-book. This includes no notes or electronic devices.
   - Use a different color of writing implement for marking your iRAT (using the correct answers exposed on the scratched IF-AT card)
   - Emphasize to students the importance of writing on their iRAT paper to show their thought processes when determining their choices. It is helpful to indicate the terms and concepts they did not understand in order to ask the group to explain them during the tRAT. To encourage this, I give extra credit or bonus marks (up to 2 additional marks) during the first RATs of the semester, and then periodically afterwards (unannounced until just prior to handing in their RATs).
   - If an LO question is included, remind students during the first few RATs to respond in complete sentences, using point-by-point comparisons, and defining terms as though they are explaining to a patient. Refer them to the rubric for grading learning objectives (see Appendix I)
   - Prior to the tRAT, announce to the teams that there may be at least one intentional error on the scratch card and they will have an opportunity to appeal (but to do this quietly with the instructor after they have finished marking the tRAT)

3. Developing Readiness Assurance Test (RAT) Multiple-Choice Questions
   The basic process for developing a RAT multiple-choice question:
   - Select a learning objective to be the basis of the question
   - Create choices (as determined by IF-AT cards and typically ABCD) by gathering four statements relevant to the learning objective
   - Make one of these statements incorrect by altering key terms or phrases
     o Each question essentially becomes a combination of true and false statements
   - Note that the standard IF-AT cards cannot accommodate more than one correct response

Example of a Readiness Assurance Test Multiple-Choice Question with “Answer Key”
   - Note: remove the bold type and delete the italicized statements (and of the course correct answers) before generating the student iRAT handout
   - The learning objective addressed is “Compare and contrast the various types of shock”. Students should approach this question by treating each statement as a true or false statement and correct it.
     1. Which of the following is true of hypovolemic shock?
        A. It is due to a large drop in peripheral resistance as a result of extreme vasodilation. – due to loss of blood volume
        B. It is compensated for by hypothalamic stimulation of antidiuretic hormone which results in water elimination by the kidneys. – water retention
C. It is compensated for by **parasympathetic** stimulation to **decrease** HR as well as cause intense vasoconstriction. – **sympathetic, increase**
D. It is detected by chemoreceptors (↓pH) and baroreceptors (↓stretch on vessel walls)

- correct answer

For more information on developing multiple-choice questions for IF-AT cards, see the LifeSciTRC resource entitled “Designing Multiple-Choice Questions for Scratch Cards”.

4. **Individual RATs (iRATs)**
It should take about 15-20 minutes to complete the paper handout of the iRAT consisting of 10 challenging multiple-choice questions. Alternatively, multiple-choice questions which focus on recall of information will require less time to complete. (If a learning objective question is included, add 5-10 minutes to the iRAT length). Set the value for each multiple-choice question at one mark. Beginning the iRAT right at the start of class is a great way to encourage on-time attendance!

5. **Team RATs (tRATs)**
The purpose of the tRAT is to allow for deeper learning. Both team members (preparation and active participation) and the instructor play a role in this. (See Role of the Instructor for more information on how they can enhance learning during the tRAT.) When teams are balanced, with a mix of well-prepared and less prepared students, the opportunities for learning increase as team members teach each other. This is especially true if the instructor follows TBL guidelines and does not provide answers to the students’ questions.

Once students have completed the individual RAT or the time limit has been reached, students should obtain a different color of writing implement and move to sit with their teams. They keep their iRAT to use in discussion and they will be marking it in the group as they discover the correct answers. Just like the iRAT, the tRAT should also be written closed-book – no access to electronic devices, textbooks or notes.

Teams can record their choices on a new answer sheet or question booklet or they can use Immediate Feedback Assessment (IF-AT) scratch cards. Students love using these! The correct answers for multiple-choice questions must match the scratch card key. Partial marks could be earned using the IF-AT cards if the correct answer wasn’t obtained on the first try. See the Epstein Education Website for more information about these cards.

If scratch card aren’t used, an answer key should be made available for students, or the instructor needs to be available to give feedback as soon as the team commits to an answer.

While discussing the possible correct answer for a question, students can seek help from their team regarding areas of difficulty. Once a consensus has been reached, students scratch the card. An asterix revealed indicates the correct answer. If the box is blank, they know immediately that
they need to learn more about the topic and correct their misconceptions. Without help from the instructor, teams realize they need to hear from all students in their group. This ultimately leads to enhanced collaborations in the future.

When the team has finished marking the tRAT, they whisper to me the question number they feel was incorrect on the card. If they are correct the first time, they receive the mark. It is up to the instructor to determine if partial marks are given if the first attempt at answering a multiple-choice question is incorrect, but the second is correct. Students record the final score on the card. This card or the corrected team RAT answer form/exam booklet is used by individual students to mark in their own iRAT.

The time required to write the team portion can vary from a few minutes to up to 30 minutes. This depends upon student preparation and the amount of time the instructor spends giving mini-lectures to clarify concepts. To ensure that teams spend more time working through the questions, I purposely make the answer for one question on the scratch card incorrect. This way teams must carefully dissect each question to ensure they have accurately identified the error on the scratch card.

Upon completion of both the iRAT and tRAT, students are given the opportunity to appeal (especially if there is an intentional incorrect answer on the IF-AT card).

Students mark their iRAT based on the finalized tRAT exam (after appeals). They then each record their scores on their iRAT handout. See Determining the Final RAT Grade. Each team is given a large envelope into which they put all iRATs and the scratch card (or team answer sheet). If peer and self-evaluations were carried out, these forms go in the envelope as well.

6. Learning Objective Question (Optional)
If you have time, you may wish to include in the RAT one learning objective question worth 5 marks (chosen from the 3-5 highlighted ones from the advanced preparation material). These are answered by students on the iRAT question handout and are graded when discussing this question during the tRAT.

There are several ways to grade the learning objective answers, but use of a rubric would be helpful (see Appendix I):
1. Marked by the instructor
   • The unmarked LO on the iRAT is handed in via the envelope
   • The instructor should then share with the class what they expected to be included in the answer at this time
2. The instructor discusses the expected answer with the class referring to the rubric
   • In their teams, students determine their own grade by discussing responses, looking at rubric, and determining what they are missing (i.e. content, complete sentences, point-by-point comparisons, in their own words, etc.)
• using a different color, add missing information to their answer
• Self-graded iRAT is handed in and instructor reviews the grade, comments, and adjust the grade if necessary
• Some students are too harsh with self-marking and others too generous

3. Team members discuss their answers to the LO question
• using a different color, add missing information to their answer
• students should refer to the rubric to ensure they are meeting all expectations
• the team can show the instructor their best LO answer to which the instructor will, on the spot, provide a grade while referring to the rubric
• each student determines their own grade based on this feedback
• at this stage the jigsaw method could be used to allow comparisons of responses between teams
  o students in teams number off (1, 2, 3, etc.), then all of the 1’s from every team form a new group, 2’s do the same and so on
  o they compare their responses, add missing information and return to their groups for a final discussion
  o allow about 15 minutes for the addition of the jigsaw method; worth doing once or twice a semester

7. Role of the Instructor
The phrase “guide on the side” certainly applies in the Team-Based Learning classroom although there is a place for the “sage on the stage” in the form of directed “mini-lectures” when warranted. Experienced Anatomy and Physiology instructors have a good idea which concepts will give students difficulty. They can prepare mini-lectures on these concepts in anticipation of student questions. Direct teams to call you over if they are having difficulties during their tRAT. Help guide them to the answer by confirming if they are on the right track, or steer them in the right direction. Try not to directly answer their questions. Make them work as a team to figure it out. However, if a similar area of difficulty arises in multiple groups interrupt the class and give a mini-lecture to the entire group. Students really like it when this is done on the whiteboard as opposed to putting up PowerPoint slides. Try not to just repeat what was already available to them prior to class.

To increase student-instructor interaction, walk around throughout the team RAT session and ask teams questions as they are discussing a concept or having troubles coming to a consensus. Sometimes it’s a simple as “Which question are you on?” or “Have you had trouble coming to a consensus on any of the questions so far?”. It is vitally important that the instructor not act as an answering machine. With team-based learning, the process of figuring out “the answer” along with making mistakes is how students really learn the tough concepts.

In larger classes, where interactions with each team are not possible, teams can be surveyed to determine which questions gave them the most trouble. Alternatively, teams could write
questions or topics on the board which they found challenging. This could then guide the instructor’s mini-lecture delivery.

8. Appeals Process
Once the tRAT is complete, students can use their textbooks, notes, and electronic devices to look up information regarding incorrect questions. One aspect of Team-Based Learning is the appeals process whereby teams can challenge the answer to an incorrect question on the test (Michaelsen, 2008). I include one intentional error on the answer key for each test to create this opportunity. Students must provide evidence for what they believe to be the correct answer. I do this each time, so that strong teams spend a bit more time going through the tRAT to reinforce their learning. Teams have only once chance on appeal, and only earn the mark if they are correct the first time. If correct, they should fix the IF-AT card, and then grade their individual RAT at this time.

9. Determining the Final RAT Grade
In order to reinforce the benefits of working in teams, an individual final RAT grade each week should take into account both their iRAT and tRAT scores. The Team-Based Learning Consortium recommendation for weighting is 75% for the iRAT and 25% for the tRAT. However, in order to encourage full team participation, I inform the students that I will give a 50:50 weighting to the two RATs if all students appear to be contributing in class. Besides, this is an easier calculation for students to do! Students calculate the average for their two tests and record it on the top of their iRAT handout.

\[
iRAT \quad /10 \quad tRAT \quad /10 \quad \text{Final RAT} \quad /10 \quad \text{optional Learning Objective} \quad /5
\]

I recommend using a spreadsheet to record the RAT scores and organize it by teams. I input all grades (iRAT, tRAT, LO) as I like to keep track of the components that are individually tested (iRAT and learning objective scores).

The following is an example with 50:50 weighting of iRAT and tRAT combined with a LO response mark.
If bonus marks are earned, they are added to the iRAT score before the averaged final RAT mark is calculated. The averaged RAT mark out of 10 can be added to the LO mark out of 5, for a total of 15 marks.

Example with bonus marks:

- iRAT = 10 + 2 bonus marks = 12
- tRAT = 10
- RAT average = 11
- LO mark = 3

Total 11 + 3 = 14/15

**Final Thoughts**

Although the implementation of Readiness Assurance Tests may seem complicated at first, students quickly pick up on the process and appreciate the benefits of learning in teams. Also, announcing that there will be at least one intentionally incorrect answer on the scratch card paired with an appeals process takes the pressure of the instructor if there are occasional mistakes in the questions.

**REFERENCES**


# Appendix I

## Rubric for Grading Learning Objective Questions

<table>
<thead>
<tr>
<th>Mark (/5)</th>
<th>0-2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Use of content from the course</strong></td>
<td>Little or no course content is included in the answer And/or most of the information is common knowledge, not drawn from the course content</td>
<td>Some attempt at incorporating course content, but important concepts/terms missing from the answer And/or much of the information is common knowledge, not drawn from the course content</td>
<td>1-2 key pieces of information necessary to answer the question are missing, but otherwise quite well done</td>
<td>All the necessary information is included in the answer This information is drawn from several different areas of the course (i.e. some learning objectives involve integrating information from previous topics)</td>
</tr>
<tr>
<td><strong>Relevance of information included in your answer</strong></td>
<td>Little or none of the content relates to the learning objective question</td>
<td>Some of the content relates to the learning objective question</td>
<td>Most of the content relates to the learning objective question</td>
<td>All of the content included is relevant to the learning objective question</td>
</tr>
<tr>
<td><strong>Demonstrates a clear understanding of the learning objective</strong></td>
<td>Any correct information included in the answer isn’t explained in such a way as to demonstrate an understanding of the concept</td>
<td>Some learning objective points explained well, but several are explained poorly or not at all</td>
<td>Very good demonstration of understanding the learning objective; 1-2 ideas not explained well</td>
<td>Excellent understanding of the learning objective is demonstrated in a clear fashion</td>
</tr>
<tr>
<td><strong>Point-by-Point Comparisons (When Appropriate) in complete sentences</strong></td>
<td>Information is listed with no attempt at complete sentences or relating the ideas</td>
<td>Weak point-by-point comparison (point form or sentences)</td>
<td>Point form used, but a good attempt made at point-by-point comparisons</td>
<td>Consistent point-by-point comparisons written in complete sentences; well done</td>
</tr>
<tr>
<td><strong>Use of proper grammar and spelling necessary for nurses who will be charting legal documents</strong></td>
<td>10 or more spelling mistakes whether in complete sentences or point form</td>
<td>6 -10 spelling mistakes whether in complete sentences or point form</td>
<td>3-5 spelling mistakes Or Point form used</td>
<td>Complete, grammatically correct sentences are used with two or fewer spelling mistakes</td>
</tr>
</tbody>
</table>