Conversations and cancer- using team-based learning to enhance comprehension and retention of AP biology content related to the cell cycle and cancer

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Abstract: AP Biology has only been taught for a few years recently after a long absence from Mandarin High School. Early scores are promising but engagement typically wanes throughout the year reaching a low at the critical time immediately before the final AP exam. Many of the students who enroll in AP Biology are enrolled in either the medical academy or the biotech program that are offered as magnet programs at Mandarin High. It would greatly benefit these students to incorporate more biomedical concepts and skills into the AP Biology framework.

This action proposal will assess if using the collaborative, conversation-based strategy of team-based learning strategy increase initial comprehension of material as well as longer-term retention. Comprehension will be measured using a pre-test at the start of the unit and a post test at the conclusion. Longer-term retention will be measured by evaluating performance on content questions embedded in a semester exam 4 months after delivery of the intervention.

Rationale

I have chosen to incorporate activates from War of the 21st Century because it more closely meets the learning objectives for AP Biology than my previous activity. As cancer is a highly publicized public health concern there are a multitude of resources available to address it in the classroom. War of the 21st Century is a wonderful teaching resource because it is not only engaging but aligns well with the AP biology curriculum. In the past I have had students research a particular cancer and write a short paper on it as well as read a case study on contagious face tumors in wild Tasmanian devil populations. We would then have a Socratic seminar on the case study and students would brain storm ideas on how to treat the epidemic before being given information about actual current interventions. While this activity was engaging, the whole group discussion invariably left some students out. The concepts covered were more extension idea and did not stay close to the learning objectives that would help them be successful on the AP exam. The cell cycle poster activity from the War of the 21st Century curriculum (specifically the mutation table) and the "Keeping it all in Check" activity are much more closely related to the AP learning objectives.

Teaching AP Biology for two years now I am always looking for ways to engage my students in this very demanding course. Due to the large amount of content and as an attempt to optimize face-to-face class time I flipped my classroom. This mostly consists of providing students power point presentations through my class website, having students take notes and post questions to Padlet[1] and then addressing questions and main areas of misconception at the beginning of class. In the past, students had not been held accountable for the actual note taking until test

day when I conduct notebook checks. This strategy became problematic as students would delay taking their notes and reduce their comprehension of the material but trying to complete all of the notes for the module right before the exam. This problem worsens as the year progresses leading to an overall reduction in engagement, especially as we got close to the test date.

Another challenge facing current AP bio teachers is the limited amount of practice questions available in the AP Exam format. The AP Biology exam was rewritten in 2012 so there have only been a few years of exams with the new curriculum. In my classroom exams, the multiple choice questions tend to focus more on comprehension of the basic concepts (blooms taxonomy levels 1 and 2) where the AP Exam focuses more on long-stemmed questions with novel scenarios testing multiple concepts at once. Students have reported needing a lot more practice with this style of question to feel comfortable with the exam.

At the bench to bedside program in 2016 I was introduced to the Team Based Learning (TBL) as a learning pedagogy. This seemed like a wonderful strategy for addressing several problems I have been having with my lesson plan structure. The readiness assurance component appears to be a great way to hold students accountable for their learning done outside of class without standard entrance quizzes which can often feel punitive (according to conversations with previous students). My hypothesis is that using both the individual readiness assurance test (iRAT) and the team readiness assurance test (tRAT) will make students feel more empowered

and less demotivated. I also hypothesize that this constant accountability in their learning will lead to gains in knowledge as it has been shown to do in medical schools (Gaudet, et al)

My second goal in using TBL is an increase in student engagement. My hypothesis is the competitive, team-based atmosphere will increase student engagement over the full course of the year. Study of this effect is beyond the scope of this action proposal due to time constrains but would be a valuable area of future study. There is evidence to support TBL as a high engagement pedagogy in medical schools (Hunt, et all)

Intervention

This lesson will be delivered to my AP Biology class which meets for a 90 minute period every day. This lesson will likely fall toward the end of the first quarter, after biochemistry. Before this lesson they students will have prior instruction on the cell cycle overall.

The lesson will be delivered in the TBL format. The class will begin with an iRAT consisting of 5 questions from the material they were supposed to learn at home the night before. This material will include concepts about the causes of cancer, both behavioral and genetic. The genetic component will include specific information about mutation types that can contribute to cancer. After completion of the iRAT each student group will complete a tRAT. Student

groups will be prompted to discuss with the whole class their rational for selecting the answers they did. The instructor will use a spot check to look for questions many groups had difficulty with and provide feedback on that material before moving on to the group activity. As part of the instructor feedback portion of class, students will watch a 4 minute video explaining the different outcomes related to mutations in proto-onco genes and tumor suppressor genes.

After the readiness assessment component student will engage in the application portion of the model. The first application will be completing the cell cycle posters they began in the previous class. This lesson will focus on students researching the different common proto-onco and tumor suppressor genes that can lead to cancer and using that information to complete the table on the poster as well as their individual table for their notebook. Once each group has successfully complete this activity the whole class will move on to the "What Happens when Genes Loose Control?"(Broo and Mahoney). The instructor will circulate during this time to ensure students understand the cause and effect relationship between gene mutation and consequences for cell cycle regulation. Each student group will also complete the "Development of Cancer Concept Map" (Broo and Mahoney).

The final application of this lesson will be practice questions with each student group voting for the correct answer in a simultaneous reveal situation and then justifying their selections to the class. This will begin with an instructor led version of the "What's Your Risk?" activity (Broo and Mahoney). The instructor will collect the "cause" and "effect" cards. Four of the effect cards each be assigned a letter so students can vote on what they predict the effect will be. The

instructor will follow the procedure listed and prompt the students to make the predictions. The instructor will go through several examples. The exact number of examples will depend on the class and when all student groups are coming to the correct conclusion.

The last two application questions will be practice AP exam questions related to cancer pulled from previous year's exams.

Changes to Intervention

The test schedule was changed when the intervention was implemented. The assessment questions were presented to the students three times. The students were first given a pre-test before any presentation of the materials and that test included only the five questions listed in this action plan. The students were asked the same five questions in their readiness assessment. This assessment was given after students had read and taken notes on the topic but had not engaged in any of the activities described in this action plan. The questions were asked a third time as part of a 50 question unit exam, two weeks after the intervention was implemented.

Connections to Bench to Bedside

The TBL strategy used to teach this lesson was learned at the Bench to Bedside institute. It was modeled in two different lessons during the institute.

The application activities used in this lesson were also directly obtained from the Bench to Bedside institute. The cell cycle poster, "What Happens When Genes Loose Control?", "Development of Cancer Concept Map" and the "What's Your Risk?" activities all come from the "The War Of the 21st Century: The Cell Cycle, Cancer and Clinical Trials" curriculum created by Broo and Mahoney and provided to participants of the Bench to Bedside Institute. We also completed many of these activities hands-on during the institute.

Data collection and analysis

Data collection:

I used a pre and post-test and the beginning and end of the module (not just this lesson) to assess comprehension of the content presented. The questions listed in appendix 1 following this proposal will be embedded in a larger unit exam. Only these questions were evaluated to measure the effectiveness of this lesson. I totaled the number of correct responses on the pre and post and compare the two values to assess growth as a result of this intervention.

These same questions were also asked at the start of the class period when the intervention was implemented as their TBL readiness assurance test.

Results:

Question #	Correct responses on the pre-test	Correct responses on the readiness assessment	Correct responses on the unit exam
1	6	14	11
2	13	21	20
3	6	21	16
4	4	10	8

5	2	5	15

Analysis:

After implementation I see my experimental design was flawed. I changed my initial plan to fit the Team Based Learning strategy I have been using and in doing so gave a readiness assessment at the beginning of class and not at the end due to time constraints. Due to this change I failed to assess the direct impact of the intervention. My data shows a) what background knowledge the students already had b) the impact of their reading and notetaking and c) their retention difficulties only two weeks later. However, there is one clear conclusion that can be drawn from this data. The role of proto-onco genes and tumor suppressor genes was difficult for students to grasp from their own readings. There were two correct responses on the pre test and that number only rose to five on the readiness assessment. One the unit test fifteen students chose the correct response. This shows that the increased exposure to that concept from the "What's Your Risk" activity really helped students.

This action research was a real learning experience for me. If I have the opportunity to do this type of research again I will plan my assessments more carefully to ensure I am measuring what I set out to measure.

References

Broo, Jennifer and Mahoney, Jessica. *The War of the 21st Century: The Cell Cycle, Cancer and Clinical Trials*. Gainesville, FL: University of Florida Center for Precollegiate Education and Training, 2012. Print.

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Appendix 1: Lesson Plan

TITLE: Conversations and Cancer

KEY QUESTION(S): What is the relationship between a healthy body cell and a cancer cell?
What does cell cycle regulation have to do with cancer?
What kind of genetic mutations can contribute to cancer?
What behaviors can lead to an increased risk of cancer?

SCIENCE SUBJECT: AP Biology

GRADE AND ABILITY LEVEL: 11th and 12th grade

SCIENCE CONCEPTS: Cell cycle, cancer, genetic mutation

OVERALL TIME ESTIMATE: 90 minutes

LEARNING STYLES: Visual, auditory, and kinesthetic.

VOCABULARY: proto-onco gene, tumor suppressor gene, mutation

LESSON SUMMARY: Students explore genetic mutations and their role in the development of cancer though Team-Based Learning and hands-on activities.

STUDENT LEARNING OBJECTIVES WITH STANDARDS:
> The student will be able to...
> 1. Identify the types of genetic mutation that contribute to cancer.
> 2. Predict the effect of genetic and behavioral factors on an individuals risk of developing cancer.

MATERIALS:
Cell cycle poster and label tags
Cause and Effect cards
Risk factor cards
Development of cancer concept map
Keeping it all in check – student sheet
Colored A, B, C, D cards for student groups

BACKGROUND INFORMATION: Please see background information provided with "The War of the 21st Century" activities.

ADVANCE PREPARATION: The instructor will have to create or procure the cell cycle poster and components.

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:
Readiness Assurance – 25 minutes
- iRAT – 7 minutes
Students will individually answer the provided 5 question quiz. These should be answered on a scantron form with a #2 pencil
- tRAT – 10 minutes
Students will work in teams to answer the 5 question quiz using the scratch off answer cards. Student groups will engage in whole class discussion about questions they did not get correct on the first try
- Instructor feedback – 4 minutes – verbal clarification
Extra time provided for any additional explanation needed for anything not clarified during the tRAT discussion
- 4 minute - Video
Student will watch a 4 minute video explaining proto-onco genes and tumor suppressor genes

Application – 65 minutes
- Finish Cell Cycle poster – 15 minutes
  Student teams will look up each of the gene mutations provided on the gene mutation cards and group the genes in the correct categories as either a proto-onco gene or a tumor suppressor gene. Students will also record their findings are their individual sheet in their notebook (they should already have this sheet from last class).
  Discussion Question:
  What clues allowed you to determine if a gene was a proto-onco gene or a tumor suppressor gene if it was not explicitly stated in your research?

- What happens when genes lose control? – 15 minutes
  Student groups will receive the cause and effect card set. Students should randomly select a card from the "cause" set and try to find the card that correctly describes the outcome in the "effect" set. The instructor will circulate to monitor on-task behavior and walk students through the decision making process if they are struggling.
  Discussion questions:
  How is the cell cycle related to cancer?
  At what points in the cycle could something go wrong that could lead to cancer?
  What normally happens that the checkpoints in a healthy cell? How is this different than a cancer cell?
  What effect do mutated proto-onco genes have on the cell cycle? Are one or two mutated genes required for cancer to occur?
  What effect do mutated tumor suppressor genes have on the cell cycle? Are one or two mutated genes required for cancer?
- Development of Cancer Concept Map – 5 minutes
  Based on what they learned in the previous activity, students will complete the concept map with their team. The instructor will circulate and spot check for the correct flow and discuss with students how they are making their choices.
- What's your risk? – 20 minutes
  Student teams will work together to predict the outcome of a combination of genetic and behavioral factors in an individual's risk of developing cancer. The instructor will present (on the board, project, etc) the following effect options: A. The cell cycle continues as normal and the individual does not develop cancer B. The cancer cell continues through the cell cycle and the individual develops cancer C. Apoptosis occurs at a checkpoint D. No mutations are present. The instructor will randomly draw one proto-onco gene card, one tumor suppressor gene card and a risk factor card. Each student group will take a minute to discuss the likely outcome and choose their prediction. At the instructors signal, all teams will simultaneously present their prediction choice. Student groups will then justify/explain their choice before the instructor identifies the correct selection.
- Practice AP Exam Questions – 10 minutes
  The instructor will present 2 AP Exam questions from previous year's test relating to cancer. Each team will discuss and select the best answer. On the instructor's cue, each group will present their chosen answer. If answers vary, groups will justify/explain their answer choice. After student groups have discussed the instructor will identify the correct selection and provide any additional justification needed.

ASSESSMENT SUGGESTIONS:
Both objective 1 and 2 will be formally assessed on the post test.

Assessment Questions:
1. Cancer cells require lots of nutrients, which are supplied by blood vessels. The growth of new blood vessels to cancerous tissue is called
   A) angiogenesis.
   B) metastasis.
   C) carcinogenesis.
   D) apoptosis.

2. Which represents the correct sequence of stages in the cell cycle?
   A) G1, G2, S, M
   B) G1, G2, M, S
   C) G1, M, G2, S
   D) G1, S, G2, M

3. The critical checkpoints that control the cell cycle are at the
   A) G1 to S stage and G2 to M stage.
   B) S to G2 stage and G2 to M stage.
   C) M to G1 stage and G2 to M stage.
   D) M to G1 stage and S to G2 stage.

4. Which is NOT correctly associated with cancer?
   A) Angiogenesis forms new blood vessels and brings nutrients and oxygen to the tumor.
   B) The disorganized mass of cells is encapsulated and does not invade adjacent tissue.
   C) Metastasis establishes new tumors distant from the site of the primary tumor.
   D) Telomerase keeps telomeres at a constant length.

5. Which of the following is true about the relationship between proto-onco genes and tumor suppressor genes?
   A) Proto-onco genes can lead to cancer but tumor suppressor genes cannot.
   B) Tumor suppressor genes can lead to cancer but proto-onco genes cannot.
   C) It takes a mutation in both copies of a tumor suppressor gene to cause cancer but only one in proto-onco genes
   D) It takes a mutation in one copy of a tumor suppressor gene to cause cancer but both in proto-onco genes

RESOURCES/REFERENCES:

Broo, Jennifer and Mahoney, Jessica. *The War of the 21st Century: The Cell Cycle, Cancer and Clinical Trials*. Gainesville, FL: University of Florida Center for Precollegiate Education and Training, 2012. Print.