Implementation of a Metacognitive Learning Strategies Session in an Online Asynchronous Human Anatomy and Physiology Course

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Abstract

A unique approach to improving student success in Human Anatomy and Physiology can be centered around teaching the students about metacognitive learning strategies. This perspective discusses the implementation of a metacognitive learning strategies session and highlights some of the outcomes that resulted from the session through exam wrapper responses. A one-hour session discussing metacognitive learning strategies was presented for the students through a pre-recorded video with embedded participation questions. Topics included methods for changing student studying habits to be more efficient and to retain a deeper level of understanding of the material. The session was also accompanied by exam wrappers to help the students to apply the concepts from the session.
https://doi.org/10.21692/haps.2021.013

Key words: metacognition, study cycle, exam wrappers, self-regulation, self-reflection

Introduction

Student success in Human Anatomy and Physiology (A&P) is exceptionally important for students who desire to enter any health profession as a career. The foundational knowledge learned in A&P not only helps them to be prepared for entrance exams, but it also readies them for their subsequent related coursework. The A&P course itself is riddled with challenges, including an exceptionally large amount of content and tricky terminology (Slominski et al. 2019). Students are expected to develop a mastery of the anatomy of the human body at the gross and cellular levels, as well as the physiology to be able to explain how the body works down to the molecular level. The majority of students who enter into these courses are deficient in the knowledge of tools and study strategies best suited for this type of material and for how they personally learn best (Gultice et al. 2015).

One way to assist students with study strategy issues is to help them understand and apply aspects of metacognition and the associated learning strategies. The approach described here included introducing the students to metacognition and providing them with resources to improve their studying. Metacognition has been described as thinking about thinking (Flavell 1979). When there is an understanding of metacognition, individuals use self-reflection to assess the methods they used to attain success. However, the concept of metacognition is not something of which many students are aware or know how to approach in a productive manner. Teaching students about metacognition has been shown to improve student performance in courses (Flavell 1979; Langdon et al. 2019; McGuire 2015; Zhao et al. 2014). With increasing metacognition, students become aware of their own weaknesses in terms of preparation for their coursework, resulting in the creation of plans of action to improve their performance.

To improve metacognition in students, they need to be given opportunities to demonstrate and strengthen their metacognitive skills (McGuire 2015). They need

continued on next page

the practice of thinking about their own thinking, to be consciously aware of themselves as problem solvers, and then to monitor, plan, and control their mental processing, making adjustments where appropriate (McGuire 2015). Students at the beginning level in their studies often have failed to plan, have misjudged the time required to complete activities, have confused time spent with quality time implementing effective learning strategies, and are often overconfident in their predicted grades. These behaviors are often due to underdeveloped metacognitive skills. Thus, students often benefit from implementing strategies aimed at improving study efficiency, time management, and incorporating more active learning techniques, thus allowing their scores and achievements to better reflect their time investment (Cook et al. 2013; McGuire 2015; Zhao et al. 2014).

Teaching students metacognitive learning strategies involves providing a concrete definition of metacognition, and teaching students how to use this knowledge to streamline their study techniques to effectively master course content and link concepts (Cook et al. 2013). In addition, methods such as exam wrappers can be used to enhance students' metacognition (Achacoso 2004). Exam wrappers for this experience were short surveys given following the exam where students were asked to self-assess how well they had prepared for the exam they had just completed and to share which study strategies they used to prepare for the exam.

Methods and Logistics

The overall goal of this classroom activity set was to use metacognitive training to improve study habits and course outcomes in a community college (CC) asynchronous online A&P course. The student population was a cohort of 10 students enrolled in an asynchronous online Human A&P II course taught by CBO who all completed the course. The course began with 14 students, but 3 withdrew from the course before exam 1 and one more immediately after taking exam 1 and the exam 1 wrapper, leaving 10 total students. The 10 remaining students participated in the session and the two sets of exam wrappers described below. These students were predominantly 1st or 2nd year students taking prerequisite courses for entrance into nursing or other health professions career program. The majority of students had taken the mandatory prerequisite course (Human A&P I) in the previous semester, but some had obtained a transfer credit (1 student) or had taken the course in a previous year (2 students).

In order to understand the full scope of the activity set, the following timeline was used: Students participated in the course as usual, then took exam 1 and completed an exam wrapper survey about their performance. After receiving their scores for exam 1, students were given a 30-minute presentation on metacognitive learning strategies which included specific strategies for studying course material. In general, students are often not receptive to changing their study techniques until they have achieved a poor outcome using their traditional methods (McGuire 2015; Zhao et al. 2014). Furthermore, students are often ill prepared for the first exam and they need advice in terms of how to improve their study habits (McGuire 2015). With this in mind, the learning strategies session was given after exam 1.

Students wrote exam 2 and then completed an exam wrapper survey about their exam performance. Both exam wrappers contained free response questions to capture areas that the students found to be helpful or where they still needed some extra help. A timeline for the events of the activity set is provided in Table 1.

Activity	Week of Course Given
Course begins	Week 1
Exam 1	Week 4
Exam 1 wrapper	Week 4
Metacognitive strategies session	Week 5
Students apply learned skills to study	Weeks 5-8
Exam 2	Week 8
Exam 2 wrapper	Week 8
End of course	Week 16

Table 1. *Timeline of the study over the 16-week semester*

The Metacognitive Learning Strategies Session

This activity was inspired by Dr. Saundra McGuire. After hearing her speak at the National Institute of Staff and Organizational Development Conference, we immediately began adapting her metacognitive session to fit the A&P classroom. The general structure of the session is from Dr. McGuire's session, but the specific references to A&P, as well as the additions of how this has been applied by my students are the authors' contributions.

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The activity set began by teaching community college students about metacognition and various study techniques through a metacognitive learning strategies session, which was based on the model used by Zhao and colleagues with modifications (Zhao et al. 2014). Due to the online nature of the course, the session was a pre-recorded 30-minute PowerPoint presentation that included five embedded questions to ensure that the students interacted with the video and actually watched it. With the embedded questions, the average watch time of the session was 36 minutes. The questions were designed to engage the students in the presentation rather than obtain correct answers, so every answer was correct as long as they filled in an answer. The participation was 100% for every question.

The presentation began with a story of three students from McGuire's (2015) examples plus one of my own who went through the same course in which these students were enrolled. The main idea behind these stories is that the students struggled to attain high scores on their exams in their courses, then showed marked improvement in their subsequent scores, leading to final course grades of A or B. When these stories are shared, the point is made that what they all have in common is that the students became expert learners and applied metacognition to help themselves improve in their coursework.

Next, students were asked to reflect on the difference between studying and learning and to select for which activity they would work harder: 1) to earn an A on an exam or 2) to teach material to the class. This question became one of the embedded questions for participation and 100% of the students said they would work harder to teach the material to the class. To ensure that students understood the general differences between studying and learning, they were then provided with the information that studying is related to "memorizing, short term recall, and more "what" style questions", while learning is related to "understanding and applying, long term retention of information, and more "why", "how", and "what if" style questions". This was followed by suggesting that to do well in STEM courses, students needed to be in "learn mode" rather than "study mode" and that they should prepare as if they were teaching to the class rather than to simply earn a good grade.

Next, the students were introduced to big picture ways to engage in "learn mode" by doing think aloud exercises, asking themselves "why" and "what if" questions, testing their knowledge through retrieval exercises by writing out or verbalizing concepts, and by moving their level of understanding up Bloom's taxonomy ladder. This was then followed by an explanation of Bloom's taxonomy, with Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating. Each level was explained, and then an example was given using Goldilocks and the Three Bears as an application of each level (McGuire 2015).

Students were then asked what level of Bloom's taxonomy they needed to attain high-school-level grades of A or B versus what level they would now need to attain those same grades. These again were embedded questions in the presentation. With these questions, 100% of the students selected Remembering or Understanding as levels for high school and most of them (80%) selected Applying or higher for where they should be now. The students were then asked to reflect on how to change their level of preparedness.

This set the stage for introducing students to the study cycle (McGuire 2015). This includes the steps Preview, Attend, Review, Study, and Assess. Each step was explained in detail, but the general ideas were that, in order to be successful, students should preview material before class, go to class (or in this case, watch the online lectures), review the material soon after class, perform intense study sessions, and then assess how they're doing by doing practice questions or trying to explain concepts to others. Due to this being in an online course, I made clear to them that these steps could be used before and after listening to the online lectures and that they would benefit by using a pause button to take notes. The intense study sessions were explained as a 75-minute session which included the following: a 1-2 minute planning session (where they identified specifically what they would study in this session (e.g. cardiac conduction and blood flow through the heart), 30-50 minutes of studying deeply using various formats (e.g. concept maps, drawing out processes, summarizing material, filling in gaps in their notes), 10-15 minutes for a break where they set a timer and stepped away from the work to reward themselves for the intense focus session (grab a snack, play a short game, call a friend, check social media, etc.), and then a 5 minute recap of the material they just covered (quickly explain cardiac conduction and the flow of blood through the heart while noting what is still unclear for the next session). It was suggested that they do this process several times as they progressed through the course content.

The presentation then provided a motivational, "you can do it" message and encouraged students to not give up if they were struggling. I emphasized with them that it may seem like a lot, but that once they started trying the process and seeing results, it would get easier to put into practice.

Next, the students were given some more examples of metacognitive learning strategies to use in their studying, with each related to an example in A&P. These included doing practice questions as if they were test questions

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(don't look up the answers right away), memorizing what they were told to memorize (such as new vocabulary or the names/numbers and functions of cranial nerves), asking the "how", "why", and "what if" questions ("how does blood flow through the heart", "why does the respiratory membrane need to be a thin layer", and "what if we couldn't reabsorb water, what would happen to urine output?"), giving mini lectures on key topics (use friends, family, pets, stuffed animals, the mirror, etc.), spending time on the course every day, using the study cycle, using campus resources (tutors, review sessions, supplemental instructors, learning centers), and aiming for 100% mastery, not 90%.

Students were also encouraged to use active reading for the reading assignments, to form study groups, to answer and/or make practice exam questions, and to discover their learning style preference(s). They were made aware of benefits associated with understanding how individual learning styles (kinesthetic, visual, auditory, etc.) can help them engage with the material in ways they enjoy and find useful (e.g. auditory learners would find recorded notes or other videos more helpful than drawing the steps in a process).

The session then summarized the top 5 examples of reasons why students performed poorly on their first exam from McGuire's book: not spending enough time on preparation, starting homework too late, not prioritizing the correct information (not memorizing what they were told to), not using the textbook, or thinking they knew the material, but had not tried to apply it (McGuire 2015). Students were asked whether any of these sounded like potential reasons for not doing well on an exam. This was then contrasted with the top 5 examples from McGuire's book for those who made an A on the exam: doing preview/review for each class, doing homework a little at a time, used the book and doing practice problems, making flashcards, and practicing explaining the information to others (McGuire 2015). It was then reinforced that these trends have appeared in my A&P courses over the past 20 years, with the activities of the second scenario linking to the attainment of high scores on A&P exams.

The presentation ended with survey results and narrative statements from students who applied the strategies from the session (McGuire 2015). I plan to expand this final section to include data and statements from my A&P courses in future iterations.

Supplements to the Metacognitive Learning Strategies Session

Students were also provided with an example of how to apply active reading using one of their textbook chapters. I selected a chapter they would encounter in the next 2 weeks and broke it down paragraph by paragraph, showing them examples of section summaries and how to interpret the images for the entire chapter. In addition, they were provided with a time sheet broken down by hour for the entire 24-hour day to help them manage their time and fit in their study sessions each day. They were given an example of what it could look like for a few days, including time for sleeping, eating, commuting, studying, attending classes, exercising, and work. One aspect that I nurture throughout the course is that their wellbeing is important, so activities like sleeping, eating nutritious food, and exercising are important. And I wanted them to see where they could have pockets of time to use the study cycle.

Exam Wrappers

The exam wrappers were designed to assess self-reported levels of preparedness for the exams and the methods used to study for the exams, with questions directly related to the learning strategies presented in the metacognitive learning strategies session. Student were provided online with the first short exam wrapper immediately following exam 1 with a due date of 1 week following the exam. The completion of the wrapper was directly tied to release of the next chapter's materials to encourage early completion. This process was repeated for exam 2.

The questions from the exam wrappers used are included in Table 2. The exam wrappers were a portion of a project that was approved as an exempt study by the Palm Beach State College Institutional Review Board (IRB), and informed consent was obtained from all participants. In alignment with the IRB, there was no "extra credit" incentive offered to individual participants of the study.

continued on next page

1. How confident did you feel with course material *prior* to taking the first exam? □ extremely confident □ somewhat confident □ neither confident nor unconfident □ somewhat unconfident □ extremely unconfident
2. How confident did you feel with course material *while* taking the first exam? □ extremely confident □ somewhat confident □ neither confident nor unconfident □ somewhat unconfident □ extremely unconfident
3. Did your first exam score match your expectations? □ yes □ no If question 3 = no: On which section(s) of the exam did you score lower than expected? (Choose all that apply.) □ multiple choice □ essays
4. Are you reading the textbook for each chapter? □ yes □ no □ sometimes If question 4= no or sometimes: What barriers prevent you from reading each chapter? (Choose all that apply.) □ I do not have access to course resources □ I do not have time to read □ I do not feel that reading is necessary for success in the course □ Other _____ If question 4 = yes or sometimes: Are you using active reading to read the textbook? □ yes □ no □ sometimes
5. Are you actively reviewing course material daily? □ yes □ no □ sometimes If question 5 = no or sometimes: What barriers prevent you from actively studying within 24 hours? (Choose all that apply.) □ I do not have access to course resources (1) □ I do not have time to actively study daily (2) □ I do not know how to actively study (3) □ I do not feel that actively studying is necessary for success in the course (4) □ Other (5) _____
6. Which of the following strategies did you use to study for this exam? (Choose all that apply) □ Writing out flow charts □ Drawing out concepts □ Studying in a group □ Flashcards □ Doing practice questions as practice exam questions □ Doing practice questions □ Writing my own practice questions □ Teaching concepts to others □ Watching videos about the concepts □ Listening to the lecture □ Making tables □ Rewriting notes □ Previewing material prior to beginning a new chapter/section □ Memorizing vocabulary
7. Do you intend to change anything about how you study for the remaining exams in the course? □ yes □ no □ maybe
8. Please provide any additional information related to your course preparation, experience, and/or assessment that may be helpful for your instructor to consider.

Table 2. *Exam wrapper questions used in the study.*

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Results

When comparing the student responses on the exam wrappers related to study techniques outside of the metacognitive study strategies provided to them, students reported an increase in writing out flowcharts, drawing out concepts, completing practice questions, teaching concepts to others, making tables, and memorizing vocabulary from exam 1 to exam 2 (Table 3).

Study Technique	Exam 1	Exam 2
Writing out flow charts	14%	20%
Drawing out concepts	7%	40%
Studying in a group	7%	0%
Flashcards	43%	40%
Doing practice questions as practice exam questions	43%	40%
Doing practice questions	43%	50%
Writing my own practice questions	14%	0%
Teaching concepts to others	0%	10%
Watching videos about the concepts	50%	40%
Listening to the lecture	64%	50%
Making tables	0%	10%
Rewriting notes	57%	40%
Previewing material prior to beginning a new chapter/section	36%	20%
Memorizing vocabulary	21%	40%
Other	0%	10%*

Table 3. *Study techniques used by the students as reported in their exam wrappers for exams 1 and 2. Data is represented as a percent of the students responding to the surveys [n=11 (exam wrapper 1) and n=10 (exam wrapper 2)].*

There was also a free response section of the exam wrappers for exam 2 that related to the effectiveness of the metacognitive session. Here, students reported: "I learned many tips on how to study better. For instance, I do outlines more for the information I don't understand and I don't study to remember but to comprehend." and "… pro-actively studying prior weeks to the week something is assigned. I have started making my flashcards and going over material now!"

The overarching IRB approved research project was aimed to improve student performance in the course, as well as their metacognitive study skills. However, due to the low number of students and other issues with design and implementation of the surveys (not discussed in this perspective), the data showed no statistically significant differences. However, exam scores from exam 1 to the final exam showed an increasing trend of 13% for the class as a whole. One student went from a 43% on exam 1 to scores in the 80s and 90s for the remaining exams and 3 other students showed improvements of at least 5 points from exam 1 to the remaining exams. Overall, the session and lessons learned by the students from it appeared to be helpful, but further studies involving larger sample sizes are needed.

Conclusions

Providing a metacognitive learning strategies session and study tips can be beneficial to students who take the information seriously and apply the information gained in the session. The sessions presented here were designed specifically for techniques pertinent to success in the study of A&P. However, given that metacognition and study skills are transferable across subject matter

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(Schuster et al. 2020), it is hoped that these sessions would also pave the way for future success in other courses by providing tools and skills that allow identification of those strategies uniquely helpful to each student's learning preferences. Traditionally, human A&P is a challenging course, but with the right study tools, students can increase their overall success. I highly encourage instructors interested in helping their students study more efficiently to consider implementing a similar approach in their classrooms.

For future directions, I would like to repeat this study using a similar class cohort of CC students and apply a direct measurement of their metacognitive skills (in particular, self-regulation) that are affected by the session. There are several validated surveys available that could be implemented. In addition, I am working to apply this strategy to an advanced level of students (Master's degree level students enrolled in graduate physiology) in order to compare the CC cohorts and the Master's level cohorts for their growth in metacognitive skills.

About the Authors

Chasity O'Malley is an Associate Professor of Medical Education at Nova Southeastern University. She also does some part time adjunct teaching for Palm Beach State College. Her research goals aim to improve the learning experience for students by helping them learn to study the material and for faculty by helping guide them on implementing active learning into their classrooms. She also is actively involved in promoting diversity through her funded research projects centered around enhancing training for medical students related to the LGBTQ population. Kyla Ross is the Assistant Vice Provost for Advocacy and Conflict Resolution at the Georgia Institute of Technology (Georgia Tech). She is a registered mediator and promotes positive lab, work, and class environments across campus. She has been instrumental in transforming undergraduate physiology courses at Georgia State University and Georgia Tech. Kerry Hull, Ph.D. is a Professor in the Department of Biology and the Dean of Science at Bishop's University in Sherbrooke, Quebec. She teaches anatomy, physiology, advanced physiology, and exercise physiology. Suzanne Hood is an Associate Professor in the Psychology Department at Bishop's University. Her research interests include how individual differences in psychological states affect academic performance. She also teaches courses in cognitive psychology and neuroscience. Olivia Page is a recent graduate of Bishop's University who assisted in the research process while completing her undergraduate studies. Murray Jensen's research focuses on how to implement Process Oriented Guided Inquiry Learning (POGIL) within entry-level anatomy and physiology courses. He also works on developing continuing education opportunities for educators who wish to promote inquiry and cooperative group learning within their classrooms.

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Back to TOC