Lessons Learned from a Quality Enhancement Plan

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Abstract

The Quality Enhancement Plan (QEP) at the University of Louisiana at Monroe aimed to improve academic performance in two gateway science courses that are required for all STEM and pre-health sciences majors and are known to be barriers to student success. The project sought to achieve this primarily by a course redesign that incorporated an extra hour of instruction each week that provided active learning on historically difficult topics and lessons on metacognition. The literature on science pedagogy has shown that faculty who successfully create active learning classrooms help to improve learning outcomes (Suchman, 2014). Additionally, "planning, monitoring, and evaluating one's own learning processes" through metacognition improve thinking skills and increase academic success (Tanner, 2012, p. 114). The lessons learned from this project include important implications for the implementation of a directive, such as garnering the support of faculty in the initial design, creating cohesion within the class, and ensuring a culture of active learning and student success across disciplines.

Keywords: quality enhancement place (QEP), academic performance, active learning, STEM education

Introduction and Background

The Southern Association of Colleges and Schools Commission on Colleges (SACSCOC) stated that the Quality Enhancement Plan (QEP), submitted six weeks in advance of the On-Site Reaffirmation Review Committee, (a) is a topic identified through ongoing comprehensive and "evaluation processes," (b) "has [a] broad-based support of institutional constituencies," (c) "focuses on improving specific student learning outcomes and/or student success[es]," (d) commits resources to initiate, implement and complete the QEP, and (e) includes a plan to assess achievement (SACSCOC, 2020, p. 33). This is a requirement for all institutions accredited by SACSCOC, and the development of the project must focus on broad-based input as well as student success in an area meaningful to the institution. *FOCUS on Biology*, the Quality Enhancement Plan (QEP) of one institution, sought to increase student success in two introductory science courses regardless of their declared major through instructional enhancement.

The institution where the project was undertaken, the University of Louisiana Monroe (ULM), is a publicly supported regional university that offers undergraduate and graduate programs as well as the only public pharmacy program in the state (ULM Office of Recruitment, 2024). The institution also has a large population of students who are interested in pre-nursing, computer science, pre-medical, and other allied health programs. Annual enrollment is usually around 8,000 students, including many first-generation college students, international students, and underrepresented students. Additionally, nearly 90% of the institution's freshman enrollment consists of students from Louisiana, and the institution enrolls more female and African American students by percentage than the national average (ULM QEP, 2024). As Louisiana students, females, and African Americans generally exhibit achievement gaps in science outcomes from their national counterparts, it is likely that the 60% of the institution's freshmen who declare majors in STEM or pre-health sciences fields will need additional resources to be successful (National Assessment of Educational Progress, 2015).

Analyses of student success data between 2012 and 2017 identified two introductory gateway courses hindering fulfillment of the institution's mission and vision. The course descriptions of these two courses can be found in Appendix II. The mission and vision at the time of the project are included in Appendix III. The first course, BIOL 1014, Fundamentals of Anatomy and Physiology I, is the gateway biology course for students on a pre-allied health sciences path, and the second course, BIOL 1020, Principles of Biology I, is the gateway biology course for STEM majors. Approximately 335 students enroll in BIOL 1014 each fall, yet only 67% earn a passing (A, B, or C) grade. Similarly, of the 330 students who enroll in BIOL 1020 each fall, 76% pass the course. Some students who are not STEM majors also take these two courses to fulfill requirements for general education or their majors. For this reason, the project described, sought to increase student success in these courses for all students in the courses regardless of major through instructional enhancement. The QEP was given the name FOCUS as an acronym for Formulate, Observe, Communicate, Use, and Synthesize. These higher-order thinking skills were a priority in the design and intent of the project and the activities undertaken in the course redesign.

FOCUS was integrated into all sections of these courses and was directed and administered by the QEP Coordinator, a biology faculty member hired specifically for this purpose. FOCUS was taught as a fourth class hour/period during the week. The primary goal of the QEP was to improve the performance and success of students in two gateway biology courses, and a secondary goal was to improve students' metacognitive skills. Thus, the QEP used high-impact practices, such as active learning and peer learning, to implement an innovative strategy focused on improving student learning by enhancing critical thinking.

Literature Review

A thorough understanding of why students struggle and how the situation could be addressed effectively was needed to begin the project. Exploration centered on two areas: (a) factors hindering student success in post-secondary education, and (b) pedagogical strategies to improve learning in gateway biology courses. Essentially, the project began with a look into why students struggle when they begin college and how their chances for success could best be improved. The literature review focused on the success of all students in STEM courses, not just STEM majors, because all students take STEM courses during their time in higher education, and success in STEM classes for all students must be facilitated to remove this barrier in pursuit of a higher education degree.

Factors Hindering Success

A complex interplay of student-related factors can overlap and range from demographic characteristics (e.g., gender, race) to academic preparedness and have a large impact on student success. One of the most frequently cited challenges facing incoming freshman students is a lack of readiness for college. The intention of most high school curricula is to be college preparatory in nature, but questions remain as to whether students are truly prepared for learning at a higher level (Chen & Soldner, 2013; Harackiewicz et al., 2016; Ramsey & Baethe, 2013; Sithole et al., 2017). This lack of preparedness may be in content knowledge or in social-cognitive skills that facilitate successful learning.

Understanding factors that contribute to a lack of student success in science courses required an exploration of diverse components. Students are scoring lower on measures of college and career readiness and meeting fewer benchmarks to be successful in science courses

(ACT, 2019). This is more pronounced in underserved populations, and some recommendations for remedies have included “ensur[ing] that all students take rigorous academic course[work],” providing instructors with more resources, and “assess[ing] student learning [to] implement improvement strategies” (ACT, 2019, p. 4). Additional evidence suggests that these foundational problems can be attributed to prior academic challenges; low student reading abilities was cited as the most frequently occurring barrier to effective mathematics instruction (National Science Board, 2022, p 1). This suggests that students are not developing the critical content mastery skills required to handle college-level coursework in the sciences or mathematics (Ramsey & Baethe, 2013). Without the necessary foundation from high school, students struggle with even the introductory courses once they begin college (Drew, 2011; Ramsey & Baethe, 2013). Surprisingly, a significant number of students who pursue STEM majors did not take advanced math courses beyond Algebra II in high school, resulting in a lack of preparedness for courses that are often required for science majors (Chen & Soldner, 2013; Ramsey & Baethe, 2013).

Students also lack certain skills that are necessary for the successful completion of college-level coursework. As Tanner points out, many of the skills that are part of metacognition contribute to academic success (Tanner, 2012, p114). Two of the key proficiencies for success, study skills and time management, overlap (Ramsey & Baethe, 2013). Studying and completing tasks and assignments within set deadlines require time management. Thirty-two percent of students in the 2018 Noel-Levitz report confirmed that their study habits were “very irregular and unpredictable” (p. 4). The same report revealed that seven out of 10 incoming freshmen want assistance to improve their study skills (Noel-Levitz, 2018). Sithole et al. (2017) noted that many science courses require more study time than other academic disciplines “due to laboratory course requirements” (p. 51). Incoming freshmen may not realize the extra work required to successfully complete science courses and therefore struggle to balance time required to complete assignments in both science and non-science courses. Furthermore, students often develop significant anxiety when faced with intense course loads.

Improving Student Success

In light of these factors and the potential under-preparedness of students for college, pedagogy was an important component of this QEP to improve students’ chances for success. Pedagogy examines how information is exchanged between learners and instructors in educational contexts, also known as teaching approaches (Center for Educational Innovation, 2018). Active learning was the teaching approach primarily used in this QEP; it was chosen as an important component of this project for many reasons. According to Suchman (2014), faculty who successfully create active learning classrooms help to improve student outcomes. Active learning is not a new concept and is not, pedagogically speaking, the purview of any particular discipline.. Active learning refers to "any approach to instruction in which all students are asked to engage in the learning process," and it "stands in contrast to 'traditional' modes of instruction in which students are passive recipients of knowledge from an expert" (Center for Educational Innovation, 2018, para 1). Student engagement in the learning process occurred as a result of the curricular redesign intended to enhance students' learning experiences and help improve their academic performances. The Center for Research on Learning and Teaching (2016) at the University of Michigan offered the following definition for active learning: "any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing." (Center for Research on Learning and Teaching, 2016, para 1 as cited in Prince, 2004), This definition implies that active learning encompasses a wide variety of activities and approaches, which accounts for its applicability across multiple disciplines. Additionally, research has suggested that active learning, as opposed to a traditional lecture, can improve student learning outcomes (Freeman et al., 2014).

Peer and near-peer mentoring can also engage students in the learning process. Peer mentoring is the collaboration of students from similar backgrounds, including factors like age and major, or, in the case of the sciences, laboratory experience (Edgcomb et al., 2010, p. 18). Research has suggested that peer and near-peer mentoring have potential benefits for novice students who need timely feedback or guidance (Edgcomb et al., 2010, p. 18). Sithole et al. (2017) observed that "education and learning are dynamic processes," and that while facts may be stationary, "knowledge itself is not static" (p. 49). Thus, students can only excel to the degree that their learning environments and the methods used to create those environments acknowledge these contextual facets of the learning process. Additionally, as knowledge changes, pedagogical approaches must communicate those changes.

Taking into account the information on pedagogy such as active learning and peer mentoring, the classes were redesigned to incorporate these two elements for one hour each week. Sithole et al. (2017) characterized the importance of the pedagogical adjustment:

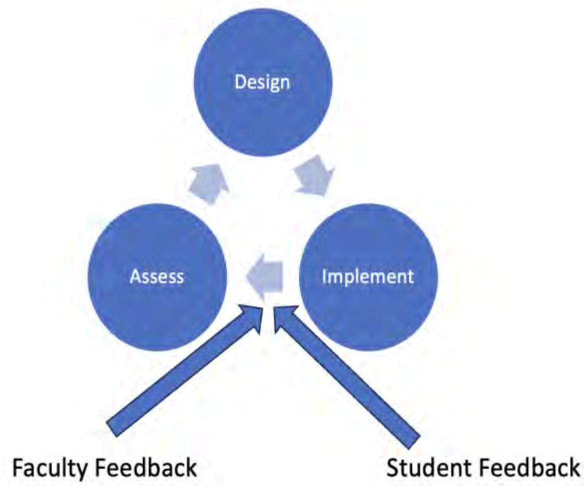
"Education is a service activity and must, therefore, be responsive to the changing needs of its clientele" (p. 50). FOCUS sessions, as the additional instructional hour came to be known, were designed to "'create safe spaces for all students to interact more closely with teachers and with fellow students'" to develop the benefits of a true learning community (Smith et al., 2004, as cited in Otto et al., 2015, p. 9). Considering the demographics and preparedness of the students in gateway science courses at this institution, the application of deliberate pedagogical approaches (e.g. active learning) and the use of social learning opportunities (e.g. peer and near-peer mentoring) appeared to be the best methods to enhance student learning.

Case Study: The QEP

The initial overarching goal of the QEP was to improve academic performance in the two gateway science courses that all STEM and pre-health sciences majors must take, BIOL 1014 and BIOL 1020. This was monitored by student success rates in the two courses, measured by the percentage of students who achieved an A, B, or C in the class versus those who received a D, F, or W. Similarly, the initial learning outcomes were improved critical thinking skills as defined by the Critical Thinking Assessment Test (CAT) developed at Tennessee Tech and improved discipline-specific knowledge as defined by a set of locally developed diagnostic questions. The approach to the project was that it would continually be an iterative process and take into consideration student performance and feedback as well as faculty feedback. A theoretical framework was not employed, as the lessons learned were attempting to report on the experience and not the design of a new construct. As seen in Figure 1, the process of designing, implementing, assessing, and redesigning continued through the duration of the QEP.

Figure 1.

The iterative feedback process of the QEP.



Pilots

During Summer 2019, four activities proposed for FOCUS sessions were piloted in the classroom with students. In BIOL 1020, students participated in a case study on photosynthesis as well as a game of Jeopardy on genetic material. In BIOL 1014, students participated in a classroom thermometer activity on membrane potentials and a team-based lottery ticket test on the autonomic nervous system. All students in both classes expressed satisfaction with the activities and felt as though the activities enhanced their understanding of the material.

The impact of the QEP on student learning was difficult to measure during the first semester of FOCUS sessions, Spring 2020, due to the effects of COVID-19. Prior to the shift to online learning, the integration of FOCUS sessions did appear to assist students in learning historically difficult topics within the class. The metacognitive activities used to enhance critical thinking skills also appeared to successfully introduce the concepts of learning on a deeper level, sifting through information, and other relevant skills. However, the first semester was a learning process. Working with instructors and students identified many key areas of the FOCUS activities that could be improved in future semesters.

Early Implementation

FOCUS was implemented by hiring a new instructor in the biology program whose teaching load consisted entirely of designing, conducting, and assessing the additional hour for each of the two courses. The faculty who had historically taught these courses were biology instructors as well as biology tenure-track faculty. For the most part, they continued to teach their sections of the course as they always had or as they saw fit. One adjustment, however, was that the activities that were conducted during the extra contact hour, or FOCUS sessions, would make up 10% of each student's grade in the class. The new instructor, who also had the title of QEP Coordinator, had four graduate assistants to help facilitate the active learning within the class time; design, prepare, and grade activities for the FOCUS sessions; and work with students when necessary. As these are large enrollment classes with a maximum enrollment of 120 students per section in some cases, and as there were as many as eight sections in some semesters, this additional assistance was necessary for the smooth implementation of the project.

The QEP Coordinator had the sole discretion to design the activities for the FOCUS sessions along with rubrics for grading, but collaboration with the faculty who taught the courses was essential. The QEP coordinator worked diligently to ensure that the questions on the FOCUS activities aligned with the emphasis in the lecture portion of the courses and that the timing of the activities was appropriately aligned with the coverage of material in the lecture courses. The QEP coordinator also oversaw the administration, analysis, and reporting of the critical thinking assessments, diagnostic questions, course grades, and other metrics.

Structure of FOCUS Sessions

The design of the project morphed with each semester in response to feedback, but in general, the FOCUS sessions were a mix of lessons on historically difficult content in the courses and metacognition lessons on becoming an efficient learner. All the lessons included some type of active learning, and students were instructed to work in partners or small groups to complete the work for each lesson, incorporating peer learning. Additionally, students were not permitted to use notes, phones, or other assistance in answering the questions in the activity, which encouraged retrieval of material, an important learning tool.

Some of the activities on content were familiar games such as Jeopardy or crossword puzzles. Other activities were designed by the FOCUS coordinator in collaboration with faculty from other departments, such as education. One such activity that was a student favorite was a mock escape room with lock boxes, clues hidden around the classroom, and a video of a case study-type scenario. The QEP coordinator attended many conferences, webinars, and professional development sessions to build ideas and knowledge on both active learning and metacognition.

Feedback was collected from students each semester after the first exam as well as at the conclusion of the FOCUS sessions for the course to determine what should be adapted for the following semester. This information was used to redesign activities to be more helpful, inform decisions on which activities to eliminate, and generate ideas for new activities. The QEP coordinator also revamped activities to make questions more relevant to the way topics were covered within the lecture portion of the courses in conjunction with feedback from faculty. Table 1 shows a sample schedule of FOCUS sessions for a semester with the emphasized content and the type of activity.

Table 1

A sample schedule of material for FOCUS sessions.

Topic	**Activity**
Introduction and metacognition	Context/framework + growth mindset demonstrations
Biochemistry	Crossword puzzle + critical thinking questions
Membrane transport	Bingo + critical thinking questions
Metacognition	Exam wrapper for exam 1 + Bloom's Taxonomy
Skeletal system	Case studies
Membrane potential	Scratch off lottery quiz
Metacognition	Metacognitive awareness inventory + science of learning
Brain and cranial nerves	Escape room
Nervous integration	Jeopardy
Autonomic nervous system	Puzzles

Metacognition lessons delivered in FOCUS sessions also incorporated games or riddles to demonstrate valuable tools to become efficient learners on the college level. For example, activities that highlighted shortcomings of traditional learning techniques, such as cramming, were used to demonstrate metacognitive strategies such as building new knowledge around context and framework or the principle of interference, as opposed to the delivery of this information in a traditional lecture format. The FOCUS coordinator experimented with building these metacognition lessons into the beginning of each class, doing two or three full lessons on metacognition, and other methods of delivery in response to student feedback.

Communication between the FOCUS coordinator and the primary instructors was very important to ensure that the content for the FOCUS activities aligned with the material covered in lectures and emphasized on exams. Student feedback showed that their openness to the unique design of the class and their benefit from the activities was strongly tied to the timing of the activities. Specifically, it was exceedingly important for the lecture instructor to have covered the material before an activity was done on that topic in FOCUS. The QEP Coordinator made it a point to collaborate with the primary instructors throughout the semester. The instructors would notify the coordinator if they took longer or shorter than expected to cover a topic, if test dates needed to be moved, or if they heard from a student who was going to be absent for an extenuating circumstance.

Effect of COVID-19

FOCUS sessions were set to be implemented during Spring 2020. The global pandemic COVID-19 caused significant and unprecedented disruption to the world of higher education during that semester. In line with universities across the country, ULM converted classes to online instruction, including the FOCUS sessions for the QEP. Instructors produced the best online materials possible with the tight timeline required, but the sudden shift to online learning, as well as many other intervening factors for students, significantly affected their ability to learn, engage with the material, and excel. The QEP Coordinator converted all of the FOCUS activities to a format that could be done online, but some of the activities did not work as well in that environment as the one originally intended. Additionally, the instruction in the primary lecture portion of the class might not have been as effective as it would have been in person.

FOCUS sessions were held virtually during the Fall 2020 semester with some activities done synchronously over Zoom and some done asynchronously in the Moodle Learning System. During the Spring 2021 semester, FOCUS sessions remained 100% online for one section and were face-to-face for three sections. To comply with COVID-19 guidelines, the in-person sections were split into two classrooms and socially distanced. This modality seemed to be more conducive to the spirit of the FOCUS sessions but was still limited in the types of group work that could be done.

Fall 2021 and Spring 2022 semesters saw a return to all face-to-face instruction for FOCUS sessions. While this greatly improved the effectiveness of the delivery of the FOCUS session activities, the institution was still seeing a drastic change in its students. After not attending in-person classes for up to two years in some cases, students were coming to college with not only a different base of content knowledge but also different expectations and skills surrounding learning and college-level work. FOCUS sessions and the lecture classes that accompanied them were adapted to accommodate the shift in our students' preparedness by providing more basic activities to establish a foundation of knowledge and by providing more detail on certain learning strategies to help them become efficient learners.

Subsequent Implementation and Adaptations

Once the circumstances of the pandemic allowed for the project to be implemented as originally intended, the FOCUS sessions returned to a weekly in-person meeting for each section of both courses. At the beginning of the semester, the QEP coordinator would often go into the first day of class with the primary instructor to introduce the model, concept, and important expectations of the project. The syllabus for each section of the courses included information about FOCUS, the expectations for the additional component, and the impact it would have on course grades. The QEP coordinator during the first FOCUS session of the semester would also spend a great deal of time discussing expectations for the sessions so that students were prepared. It was made clear that the QEP coordinator would not be re-teaching the material and that students should come prepared to class on the topic for that day.

The QEP Coordinator experimented with different methods of grouping students to complete their activities, including allowing them to choose their groups and/or partners, randomly assigning partners/groups as students came into the classroom, and grouping students by major or discipline. These approaches all had strengths and weaknesses. For example, allowing students to choose their own groups led to an increased willingness to work together in the spirit of the activity; however, they tended to group with their friends or people with whom they already studied, so they often already shared the same level of understanding on the various topics. The QEP coordinator and at least two of the graduate assistants would walk around the classroom for the entirety of the activity to assist students with questions or misconceptions.

Weekly FOCUS sessions were conducted in this manner from the first day of classes through the last day before finals, and points earned were recorded weekly in the same gradebook as their grades for the lecture portion of the course in the learning management system.

Assessment Measures

The assessment measures for the project included a set of locally developed diagnostic questions, performance on the Critical Thinking Assessment Test (CAT), pass rates in the class, as well as qualitative feedback. The project used non-probability sampling, as all students enrolled in BIOL 1014 and BIOL 1020 during the affected semesters were included in the project, administered the diagnostic questions, given either the CAT test or another locally developed critical thinking assessment, and asked for qualitative feedback. The data was collected by instructors in the courses. Initially, the diagnostic question data was collected as part of final exams in the courses. This methodology was changed over the course of the semester to be collected during FOCUS sessions as a separate assessment. These questions were analyzed by the QEP Coordinator and graduate assistants using an anonymized Excel spreadsheet to determine performance across the class and by question. Results on the CAT were collected as a report and summary issued to the QEP Coordinator from Tennessee Tech after each administration of the assessment. The locally administered critical thinking assessment was analyzed each semester by ULM's QEP Coordinator and graduate assistants with the help of a locally developed rubric. These results were analyzed to see if the average score increased over the course of the project.

The diagnostic questions to measure content knowledge in the two classes were originally designed to be incorporated as part of final exams in the courses. Final exams, including the diagnostic questions for the QEP for both courses, were administered online during the Spring 2020 and Fall 2020 semester. In Spring 2021, the decision was made to shift to a pre-test/post-test model for the diagnostic questions. The diagnostic questions were given in a FOCUS session at the beginning of the semester. This was predominantly in response to faculty input, which indicated that the variety of differences in final exams made it onerous for them to include the diagnostic questions. Many instructors did not previously administer a comprehensive final or were concerned about the additional length of the exam due to incorporating the questions. Additionally, some instructors did not want to count the diagnostic questions toward the students' scores on their finals, which reduced student motivation to perform well. Due to many class interruptions during Fall 2022, including weather closures, the post-test diagnostic questions had to be administered online in a FOCUS session, which also appeared to reduce performance.

Diagnostic questions were given as a pre-test/post-test model in all sections during the 2021–2022 academic year. The questions for the BIOL 1014 diagnostic test were changed and adapted during this time to reflect learning outcomes and testing styles of the lecture portion of the class more closely, as had been done for BIOL 1020 the previous academic year. The effort put into designing these questions to align with common learning outcomes for the courses was perhaps one of the greatest benefits to come out of the project, as it contributed to consistency and cohesion within the department and the course. During the 2022–2023 academic year, the implementation team decided to make the post-test diagnostic questions graded for correctness. In previous semesters, it had been graded for completion, and students did not seem to complete it with very much effort. The post-test remained the same 20 questions, each worth a half point, with the assessment being worth 10 points total as part of their FOCUS grade in the course. More information on the diagnostic questions can be found in the Results section of this paper.

The original project indicated that the Critical Thinking Assessment (CAT) would be administered during the final FOCUS session to a statistically significant number of students selected at random from each course section and that the students who did not participate in the CAT test would be given a locally developed computerized critical thinking test. Since FOCUS sessions were not implemented until the Spring of 2020, the CAT test was administered during one regularly scheduled class period during Fall 2019 for all sections of the two courses. All students in the courses took the CAT test in this manner during Fall 2019. During Spring 2020, the administration of the CAT Test occurred after the move to online learning due to COVID-19. All students in the two courses during that semester, therefore, remotely took the test online. A locally developed computerized critical thinking test was developed during the Summer 2020 session and administered to students in an online section of BIOL 1020.

Students in three online sections in Fall 2020 and the three face-to-face sections in Spring 2021 remotely took the CAT test online due to the remaining capacity and distance restrictions of the pandemic. A locally developed computerized critical thinking test was administered to students in sections that did not take the CAT. The CAT test was given in a campus computer lab during a FOCUS session for the Fall 2021 and Spring 2022 semesters to some students, and a locally developed version of a critical thinking assessment was administered in the Moodle Learning System to the other students asynchronously. This was the first time we had been able to do this since the inception of the QEP, and this manner of administration continued through the end of the project.

With the iterative design of the project, each semester began with the evaluation of feedback and data from student performance from previous semesters in order to assess what was working and what needed to be adjusted. The activities and approaches were then altered to accommodate new ideas, suggestions, and issues. As these new activities and strategies were implemented, the QEP team carefully monitored and kept notes on the progress to again reevaluate when necessary. This adaptive process contributed to the project's goal of improving student success in the context of a changing student population; however, the project did not achieve the gains that were originally hoped for. The lessons learned from this project, though, were very valuable, and the Biology Department benefited from the knowledge of how some changes to the implementation of the project may have contributed to more student success. Additionally, the department's awareness of the changing needs of students, the need for innovative pedagogy, and the importance of developing soft skills such as critical thinking was greatly improved.

Results

Data collected to measure the impact of the QEP included performance on a set of diagnostic questions for each course, performance on the Critical Thinking Assessment (CAT), and performance in the course measured by letter grades earned. Baseline data collected for the Spring 2019 semester provided a measure of impact on student learning in the future.

Course Performance

Course performance, as measured by letter grades earned in the course, was assessed by obtaining information from the university's Office of Institutional Research regarding the final course grade of every student enrolled in the classes. STEM majors were not separated from non-STEM majors, as the project sought to improve performance for all students in biology classes, regardless of major. The results for course performance were greatly affected by the disruption of COVID-19 and the many changes in the learning environment and resources. A preliminary report on A, B, C and D, F, I, W rates in the two courses showed that from 2012 to 2018 about 59% of students on average passed BIOL 1014, and about 72% of students on average passed

BIOL 1020. For the Spring 2019 semester, the data showed that 51% of students in BIOL 1014 and 78% of students in BIOL 1020 received a grade of A–C. For the Fall 2019 semester, the data showed that 63% of students in BIOL 1014 and 61% of students in BIOL 1020 received an A–C. For the Spring 2020 semester, the data showed that 70% of students in BIOL 1014 and 69% of students in BIOL 1020 received an A–C. For the Fall 2020 semester, the data showed that 78% of students in BIOL 1014 and 56% of students in BIOL 1020 received an A–C. For the Spring 2021 semester, the data showed that 62% of students in BIOL 1014 and 58% of students in BIOL 1020 received an A–C.

In Fall 2021, the instructors for BIOL 1014 began exploring new pedagogical techniques to meet the evolving needs of their students. While pass rates in BIOL 1020 improved for the 2021-2022 academic year over last academic year, pass rates for BIOL 1014 were lower, which may be due in part to the exploration of new techniques and the determination of what is effective and what is not. For the Fall 2021 semester, the data showed that 50% of students in BIOL 1014 and 60% of students in BIOL 1020 received an A–C. For the Spring 2022 semester, the data showed that 56% of students in BIOL 1014 and 78% of students in BIOL 1020 received an A–C. For the Fall 2022 semester, the data showed that 59% of students in BIOL 1014 and 62% of students in BIOL 1020 received an A–C. For the Spring 2023 semester, the data showed that 46% of students in BIOL 1014 and 79% of students in BIOL 1020 received an A–C. Table 2 shows semester pass rates from Spring 2019 to Fall 2023 in BIOL 1014 and 1020.

Table 2

Course performance as measured by the percentage of students who received an A, B, or C in the course.

	BIOL 1014	BIOL 1020
Spring 2019	51%	78%
Fall 2019	63%	61%
Spring 2020	70%	69%
Fall 2020	76%	56%

Spring 2021	62%	58%
Fall 2021	50%	60%
Spring 2022	56%	78%
Fall 2022	59%	62%
Spring 2023	46%	79%
Fall 2023	48%	70%

Critical Thinking Assessment (CAT)

The CAT test was given for the first time during Fall 2019. During the Fall 2019 semester, the average score of students across both courses on the CAT Test was 12.19, out of 38 possible points, with the national average being 15.5. Tennessee Tech issued a statement that they had seen an overall decline in performance on the CAT test during the Spring of 2020 due to the impact of COVID-19. The average score of students across both courses on the CAT Test for this semester was 12.14. The test was given remotely again during both Fall 2020 and Spring 2021 semesters due to Covid-19 and weather events; therefore, the commitment and effort of students might have been affected by this administration modality. ULM students across sections in BIOL 1014 and BIOL 1020 achieved an average score of 12.24 in Fall 2020 and 12.25 in Spring 2021.

Performance improved during the Fall 2021 semester, which may be a reflection of the improvement of the FOCUS session metacognition activities during that academic year and the return to the intended in-person model. ULM students across sections in BIOL 1014 and BIOL 1020 achieved an average of 13.13 in Fall 2021 and 13.20 in Spring 2022. The improvement in performance on the CAT test was very encouraging. The metacognitive lessons within FOCUS sessions, the increased effort toward critical thinking skills in the campus environment as a whole, and the improvement in learning environments as the pandemic conditions continued to improve were thought to have contributed to the gradual increase in performance on the CAT. The scores returned, however, to the previous average the following academic year. The students at the study institution across sections in BIOL 1014 and BIOL 1020 achieved an average of

12.28 in Fall 2022 and 11.52 in Spring 2023. Table 3 shows the average across students from Fall 2019 to Spring 2023.

Table 3

Average score on Critical Thinking Assessment across all students who took it.

	Average Across Students
Fall 2019	12.19
Spring 2020	12.14
Fall 2020	12.24
Spring 2021	12.25
Fall 2021	13.13
Spring 2022	13.20
Fall 2022	12.28
Spring 2023	11.52

Diagnostic Questions

For the two sections of BIOL 1020 in Spring 2019, 14% of students answered at least 75% of the diagnostic questions correctly. For the two sections of BIOL 1014 in Spring 2019, 2% of students answered at least 75% of the questions correctly. In BIOL 1020 courses in Fall 2019, 5% of students answered 75% or more of diagnostic questions correctly. For the two sections of BIOL 1020 in Spring 2020, 58% of students answered 75% or more of the questions correctly. This is noteworthy as the FOCUS sessions were implemented for the first time in BIOL 1020 during the Spring of 2020, and the scores on the diagnostic test greatly improved from Fall 2019. BIOL 1014 had not yet seen the implementation of FOCUS sessions, as the redesign began in that course in Fall 2020. Very little change, therefore, was seen in student performance on the BIOL 1014 diagnostic questions between Fall 2019, where 3% of students answered 75% or more of diagnostic questions correctly, and Spring 2020, where 4% of students answered 75% or more of the questions correctly. The lack of improvement in BIOL 1014 without FOCUS sessions and the notable improvement in BIOL 1020 after implementation of FOCUS sessions supported and confirmed the decision to continue the implementation of FOCUS sessions into both courses.

Review and revision of the diagnostic questions for BIOL 1020 in Fall 2020 improved course outcomes. Review for potential revision of diagnostic questions for BIOL 1014 occurred subsequently. Participation responses for diagnostic questions in Spring 2021 were low due to the administration of the questions being moved online. Participation was encouraged by offering extra credit, which might have led students in need of extra credit to participate. In Fall 2020, 2% of BIOL 1014 students and 22% of BIOL 1020 students answered 75% or more of the questions correctly. In Spring 2021, 2% of BIOL 1014 students and 17% of BIOL 1020 students answered 75% or more of the questions correctly.

In Fall 2021, 3% of BIOL 1014 students and 5% of BIOL 1020 students answered 75% or more of the questions correctly. In Spring 2022, 5% of BIOL 1014 students and 8% of BIOL 1020 students answered 75% or more of the questions correctly. Due to the lack of improvement in performance on the diagnostic questions, an additional metric was used to determine more about performance on these questions. The additional metric, the number of questions that were answered correctly by at least 50% of the students, was performed to determine if there were certain questions and/or topics that were understood by the majority of students and vice versa. In Fall 2021, there were eight questions for BIOL 1014 and 10 questions for BIOL 1020 that were answered correctly by at least 50% of the students. In Spring 2022, there were five questions for BIOL 1014 and five questions for BIOL 1020 that were answered correctly by at least 50% of the students.

At this point, the decision to give the diagnostic questions as a pre-test and post-test in FOCUS sessions as opposed to embedding them on final exams was primarily due to an effort toward consistency. As the instructors for the classes gave very different final exams in regard to length, degree of comprehensiveness, and content, embedding the questions on the final exam lacked consistency across sections.

In Fall 2022, 11% of BIOL 1014 students and 24% of BIOL 1020 students answered 75% or more of the questions correctly. In Spring 2023, 0% of BIOL 1014 students and 5% of BIOL 1020 students answered 75% or more of the questions correctly. As seen in this data, performance on the diagnostic questions greatly improved for both courses in Fall 2022 and then saw a dip in Spring 2023. This could be attributable to the student population that enrolls in these courses in the Fall versus the Spring. In Fall 2022, there were 10 questions for BIOL 1014 and 14 questions for BIOL 1020 that were answered correctly by at least 50% of the students. In Spring 2023, there were three questions for BIOL 1014 and nine questions for BIOL 1020 that were answered correctly by at least 50% of the students. This metric improved for all groups except for BIOL 1014 in Spring 2023, which may be in part due to the continued exploration and redesign of pedagogy in the online section. Appendix 1 includes the most recent version of the diagnostic questions for each class. Table 4 shows performance percentages on the diagnostic questions from Spring 2019 to Spring 2023.

Table 4

Performance on diagnostic questions as measured by the percentage of students who answered at least 75% of the questions correctly.

	BIOL 1014	BIOL 1020
Spring 2019	2%	14%
Fall 2019	3%	5%
Spring 2020	4%	58%
Fall 2020	2%	22%
Spring 2021	2%	17%
Fall 2021	3%	5%
Spring 2022	5%	8%
Fall 2022	11%	24%
Spring 2023	0%	5%

Qualitative Feedback from Students

Student feedback on FOCUS sessions was diverse for the duration of the project, as expected. In an email to the QEP Coordinator following the Spring 2020 semester, one student explained, “The things we’ve talked about in the FOCUS sessions are what I remember and understand the most from this class,” and went on to say that she would try to put into practice the metacognitive strategies in future classes. The course evaluations demonstrated some appreciation of the extra information learned in FOCUS sessions but also some frustration over a lack of consistency between the lecture portion of the class and the FOCUS activities in addition to the extra time required for FOCUS sessions. The QEP implementation committee worked to address the inconsistencies that were frustrating for students and improve the FOCUS sessions in response to that feedback.

In solicited feedback, students also identified diverse preferences regarding the types of activities done in FOCUS sessions. The escape room, for example, was listed as many students’ favorite activity, while many other students listed the escape room as their least favorite activity. Additionally, some students reported feeling that the peer learning greatly improved their understanding of the content as well as their sense of community and perseverance in the class, while other students expressed disdain for working in partners or groups. As this was expected because not all students learn the same way, the QEP coordinator worked to provide a balance of activities within each course so that the majority of students would find at least some helpful and enjoyable learning components in the FOCUS sessions.

Qualitative feedback also addressed the model of the project as experienced by students. Students expressed frustration over required time commitments in addition to the time required each week for lecture attendance. They also reported confusion over the model of two different instructors and the interconnectedness of that design. Many students, however, did express a desire to use the FOCUS materials as a review for exams, indicating that they found the material helpful in comprehending content in line with learning outcomes.

Discussion

This QEP incorporated knowledge on student factors and pedagogy to redesign two biology classes known to be a barrier to student success at one institution. Student factors such as college preparedness, previous coursework and foundation in STEM knowledge, soft skills such as time management and metacognition skills, and confidence in academic ability are important considerations when designing an approach to increase student success (Ramsey & Baethe, 2013; Sithole et al., 2017; Noel-Levitz, 2018). Additionally, innovative pedagogy is an essential component to student success in response to a changing student population (Sithole et al., 2017). Building on these themes from existing research, this project continuously developed in response to new knowledge and feedback. Though the project did not meet all of the metrics of success initially laid out, it did have many positive outcomes. The institution learned from its investment in the project and can use the acquired knowledge to continue developing new ways to increase student success.

The results of the project were complicated by the effects of the pandemic on both instructional delivery during the time of the project and the preparedness of students coming into college after the return to normal instruction. Additionally, this project has shown that some changes to the model and implementation may be more successful than others. One such lesson learned regarding implementation was that garnering the support of faculty in the initial design should have been a key component to the model of the project. While the institution did seek broad-based support in designing the project, the members of the committee who designed the project were not necessarily the faculty who would be most directly affected by the implementation. Faculty engagement in “decision-making and free expression of ideas” is closely “related to . . . transparency” and is a significant factor in faculty agency, which is important in faculty support for organizational change (Campbell & O’Meara, 2014, p. 54; Ronco, 2012). The literature has shown that faculty are more open to change when leaders involve them in the change (Welsh & Metcalf, 2003). Faculty often become frustrated when they are only involved in the implementation of change and not the decision-making process regarding it (Ketcheson & Everhart, 2002). In this case, the faculty who were involved in the design were not the same faculty who were involved in the implementation. This hindered the success of the project at the beginning and created a barrier that the QEP coordinator had to overcome by building trust and collegiality with those faculty members. The department ultimately benefited because this work to overcome the barrier built cooperation within the department.

Creating cohesion within the class is also an essential component to the success of such a project. Student openness to instructors, assignments, and classroom policies is extremely dependent upon the seamless operation of the class. A possible adjustment to the design of the project would be to have the active learning and metacognition built into the regular class time so that it is not seen as being so separated from the rest of the class. The QEP coordinator could still design such activities and be a departmental resource for ideas, materials, and design of them, but the coordinator would go into the lecture time along with the instructor to deliver the activities. This may make the activities more attractive to the students and the students less skeptical of the design of the activities or their impact on their grade. For example, when the diagnostic questions were given in a FOCUS session, students' motivation to perform to the best of their ability might have been reduced, which may be reflected in the scores. If these were given as part of a regular assessment in the class, students may be more motivated to perform to their highest potential.

Ensuring a culture of active learning and student success across disciplines is also essential to the success of such a project. The environment of an organization can "either facilitate or frustrate faculty . . . agency" and, therefore, faculty support for institutional goals (Campbell & O'Meara, 2014, p. 70). In order for such a project to work, faculty must support it as it requires effort on their part and also impacts their students' perception of the importance of the project. Students must expect a culture of active learning to be receptive to such a project. If this type of work is expected of the student in only one class, one hour per week, it merely draws resentment. However, if the students come to expect active learning and assignments that require higher-order thinking and peer learning because they see it across classes, they will approach these learning activities and assignments with much more willingness and dedication in order to get the most out of it.

Some of the lessons learned from the project point to tactics that would be beneficial to continue in some form or adapt to a new project. Students reported an increasing appreciation for the FOCUS sessions as the semesters went on in response to changing delivery, activities, and approach as the QEP coordinator and instructors learned more about student preferences through feedback and experimentation. Research has shown that education is a service industry and must, therefore, be responsive to the changing needs of its customers, which in this case is the students (Migliore, 2012). Efforts to constantly improve pedagogy and embed active learning and metacognitive strategies serve to benefit students. In addition, the project's unintended successes of building cohesion in the courses, collegiality in the department, and awareness of the need for innovation were very valuable.

One major limitation of this project was the interruption of its implementation by COVID-19. This factor greatly impacted engagement with students and faculty by the intended means. Another limitation of this study is that it only looks at one institution in the southeastern United States; consequently, the applications of this study may not be widely applicable. There were, however, still many lessons to be learned from the work that was done. All the lessons learned from this project, whether strategies of implementation that could be done differently to improve the success or strategies with students that worked well, could be used in the future in other areas of higher education. Other disciplines can use aspects of this project to increase student engagement in class, faculty collaboration and innovation, and student development of skills and knowledge. Other institutions can also use the lessons learned from this project when designing institutional initiatives. In particular, the nature of involvement of faculty in such projects, the perception of students of the impact of the project on their learning and experience as well as the support and direction of the project, and the assessment of culture and environment in order to select appropriate projects are all important considerations highlighted by this project.

Implication for Future Practice

While the QEP was not necessarily successful as measured by the original metrics, it had several unintended yet positive outcomes. The BIOL 1020 instructors agreed upon a content inventory to bring consistency to the course across instructors, the ULM community learned much about the benefits of active learning, and several biology faculty members who attended a Yale Summer Institute conference on scientific teaching are working to share this information across the campus to other faculty and departments.

One of the most valuable lessons the institution—particularly the School of Sciences—has learned from the QEP experience is the importance of an agreed upon, consistent list of learning objectives and student learning outcomes for a particular course. The FOCUS sessions helped to highlight areas of these courses where material may need to be explored among all the instructors responsible for that course. The QEP also highlighted for the institution the great opportunity that exists to improve its students' critical thinking skills. As a valued skill among professional schools and employers, critical thinking skills cannot be undervalued and must be cultivated in university students. The QEP facilitates the understanding of innovative ways to successfully develop these skills. The QEP also created a stimulus to explore through webinars and conferences the vast collective creativity and information that exists among other faculty and universities across the country. Additionally, the QEP prompted us to learn more about the ways that we not only teach but also assess students. When looking at student performance in a course compared with performance on the diagnostic questions, instructors were able to examine whether our class assessments were a good measure of the course outcomes students should learn from a course.

This review also provided some insight into the level of thinking skills that are encouraged in our students based on the design of assessment instruments. The QEP has taught us that it may be more difficult than first anticipated to build critical thinking skills in our students at this point in their educational process. However, it also provided the opportunity to learn more about diverse ways to encourage these skills. The QEP, coupled with the necessary changes brought about by the pandemic, created an impetus to explore and learn more about innovative methods of pedagogy, better practices of diversity and equity in the classroom, and more impactful methods to encourage critical thinking. Since different modalities can be used in face-to-face sessions, more success has been noted when compared to online FOCUS sessions. This success is related to the student–instructor and student–student connections that occur in face-to-face groups.

The work done on the QEP has been contagious in creating a more learner-centered environment within the Biology Department as instructors have begun collaborating on ways to improve courses, integrate active learning, and explore ways to improve student success, but it has been a learning process and one that still needs time to grow.

One of the most obvious lessons to come out of this QEP is that one hour a week with a separate instructor may not be enough to see the gains aspired to with the goals of this QEP both in critical thinking skills and content knowledge. A different model of integration of active learning and metacognitive skills across the curriculum could potentially be more effective than the model explored here.

The work done for our QEP has helped illuminate the increasing and changing needs of the students who are entering our institution. The success of the QEP as it was originally designed, however, was also hindered by the abrupt and continuing changing of the studnets. The students we serve today are very different from any group of students in the past and have a diverse set of needs that must be met for them to be successful in college. In conjunction with other initiatives at our institution and within our system, the QEP has begun the work of providing additional services to our students, but we have also discovered in the process that there is still a lot of work to be done and a lot to be learned about the best way to do that. Particularly, building skills such as critical thinking and problem solving is increasingly important for our graduates. The lack of success in significantly improving our students' performance on the CAT Test indicates that something more than introducing these skills and concepts in one class, one hour a week must be done to facilitate this progress. Our institution is beginning to work on building competencies such as the ones that were the focus of the QEP project into general education courses in order to impact more students in a successful way. By looking at the information we have gained through the work on the QEP, including valuable student feedback, the implementation team can work with other initiatives on campus to improve student success.

Other institutions can learn from the lessons of this project by examining the needs of students with an awareness that their needs and desires are changing and then developing projects with the input of faculty. These projects should be part of the culture of the institution and should be designed in a way that creates the least confusion and disruption for students. Focusing on student engagement with the learning process and the development of soft skills can benefit both students, faculty, and institutions when implemented in a way that is cohesive with the environment and student body affected by the project.

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Appendix I

Biology 1014 Diagnostic Questions

FOCUS Diagnostic Questions BIOL 1014

1. Which of the following is not a function of the hypothalamus?
    a. Endocrine control
    b. Body temperature control
    c. Control of appetite
    d. Cardiovascular control
    e. Unconscious swinging of the arms while walking

2. Epithelial tissue:
    a. has a large amount of extracellular matrix between cells
    b. has a rich blood supply
    c. serves as protection and a strong barrier for many organs of the body
    d. A and C
    e. all of the above

3. A stronger, above-threshold stimulus on a muscle
    a. Causes a stronger action potential
    b. Causes more frequent action potentials and recruitment of more motor units
    c. Does not affect the force of the muscle contraction
    d. will cause the muscle to not contract at all due to tetany
    e. All of the above

4. During surgery, a branch of a patient's facial nerve was accidentally cut on one side of the face. After the operation, the lower eyelid and the corner of the patient's mouth dropped on that side. What muscles were affected?
    a. Orbicularis
    b. Levator anguli
    c. Zygomaticus major
    d. All
    e. None

5. Professional divers are subject to increased pressure as they descend to the bottom of the ocean. Which of the following are true regarding this activity?
    a. The cardiovascular system is responsible for equalizing pressure between the internal and external environments
    b. The most common complication involves a collapsed lung due to an imbalance in internal and external pressure
    c. The increased pressure can lead to damage to the ear and hearing loss because the auditory tubes normally open to equalize pressure
    d. All are true
    e. None are true

6. Tertiary neurons in the dorsal column/medial lemniscus system have cell bodies:
    a. with projections that terminate in the somatosensory cortex
    b. that would cause a loss of recognition of two-point discrimination if damaged
    c. that are located in the thalamus
    d. that receive information from joints, tendons, and muscles on the opposite side of the body
    e. all of the above

7. Night blindness is caused by ______________.
    a. A lack of cones
    b. A lack of iodopsin
    c. A lack of rhodopsin
    d. a & b
    e. a, b, & c

8. Buffers:
    a. help resist a change in temperature by dilating blood vessels
    b. help maintain homeostasis of the system by resisting a big change in pH
    c. help balance H^+ ions using a reaction with carbonic acid and bicarbonate ion
    d. B and C
    e. all of the above

9. Molecules that move by diffusion:
    a. will never cross the plasma membrane
    b. require energy input for transport
    c. will move from an area of higher concentration to an area of lower concentration
    d. will move from an area of lower concentration to an area of higher concentration
    e. A and D

10. Which of these events is expected if the parasympathetic division is activated?
    a. Secretion of water saliva increases
    b. Air passageways dilate
    c. Heart rate decreases
    d. A and C
    e. All of the above

11. The most inferior part of the brain is the ________.
    a. Pons
    b. Medulla
    c. Midbrain
    d. Cerebellum
    e. Diencephalon

12. The pelvic cavity:
    a. is separated from the thoracic cavity by the diaphragm
    b. is separated from the abdominal cavity by the mediastinum
    c. is encased by the pelvic bones
    d. is superior to the abdominal cavity
    e. all of the above

13. What movement of the elbow is necessary to pull open a door at the grocery store that opens inward if you are standing on the inside?
    a. Pronation
    b. Supination
    c. Rotation
    d. Flexion
    e. Extension

14. Which of the following is true regarding contraction in skeletal muscle?
    a. Potassium opens sodium channels causing depolarization of the sarcolemma
    b. Potassium comes out of the sarcoplasmic reticulum to unlock troponin
    c. Myosin becomes shorter to cause the muscle to contract
    d. G actin monomer active sites are always exposed so myosin can always bind
    e. G actin monomer active sites are exposed when calcium binds with troponin

15. Which of the following is true regarding the negative feedback mechanism for blood pressure?
    a. Receptors in blood vessels detect changes in blood pressure
    b. Receptors in blood vessels compare actual blood pressure to optimal blood pressure range
    c. Control center will tell heart to beat faster in response to increased blood pressure
    d. A negative feedback mechanism will increase the deviation from a normal blood pressure range.
    e. The brain would be the effector in the negative feedback control of blood pressure.

16. Which of the following is true regarding the shape and arrangement of the vertebrae?
    a. The vertebral foramen allow the spinal cord to pass through the vertebrae
    b. The intervertebral notches allow spinal nerves to pass out of the spinal cord
    c. The spinous processes project posteriorly and can be felt down the midline of the back
    d. All are true
    e. All are false

17. Which of the following is the function of the Na^+/K^+ pump?
    a. Generates an action potential;
    b. Transports Na^+ into & K^+ out of a cell membrane;
    c. Regulates opening/closing of Na^+ channels;
    d. Maintains Na^+/K^+ concentration gradients across the cell membrane;
    e. None of these

18. An inhibitory postsynaptic potential
    a. Causes an action potential in the postsynaptic cell
    b. Causes an increased amount of neurotransmitter to be released from the presynaptic cell
    c. Causes a hyperpolarization in the postsynaptic cell, making AP less likely
    d. A and B
    e. All of the above

19. Blood calcium
    a. Increases as osteoclast activity increases
    b. Is not affected by formation and decomposition of bone
    c. Decreases as osteoclast activity increases
    d. Increases as calcitonin is released
    e. All of the above

20. Which of the following is true about the events that occur at the neuromuscular junction?
    a. After the action potential reaches the presynaptic neuron, acetylcholine diffuses across synaptic cleft
    b. After acetylcholine diffuses across synaptic cleft, an action potential reaches the presynaptic neuron
    c. After an action potential is produced on the muscle fiber's plasma membrane, acetylcholine diffuses across the synaptic cleft
    d. A lack of acetylcholinesterase will cause relaxation of the muscle
    e. A postganglionic somatic motor neuron synapses in a ganglion before the action potential

Biology 1020 Diagnostic Questions

1. Thymine makes up 36% of the nucleotides in a sample of DNA from an organism. What percentage of the nucleotides in this sample will be guanine?
    a. 14%
    b. 18%
    c. 28%

   d. 36%
   e. It cannot be determined from the information provided

2. Organelles are to cells as cells are to:
   a. Organs
   b. Organelles
   c. Organ systems
   d. Organisms
   e. Tissues

3. You are a scientist studying the expression of a gene involved with aging. Your hypothesis is that when you age, the transcription of this gene decreases and results in your body beginning to age. Which of the following pieces of data would support this hypothesis[AW1] ?

A. You see a decrease in the number of tRNAs used at the ribosome.
B. You see an increase in the number of amino acids added to the polypeptide chain.
C. You see a decrease in the number of mRNAs produced from this gene.
D. You see a decrease in the number of ribosomes that use the mRNA.

4. Which of the following are true concerning lipids?
   a. Phospholipids and triglycerides both have fatty acid tails and a glycerol backbone
   b. Phospholipids and triglycerides are both strictly hydrophobic
   c. Phospholipids and triglycerides are both primarily used to store energy
   d. A and C are both true
   e. All of the above are true

5. Starch:
   a. Is made up of amino acid monomers
   b. Is a monomer that makes up a glucose polymer when strung together
   c. Is made up of glucose monomers
   d. Is a lipid
   e. None of the above

6. Active transport:
   a. Only moves large molecule into or out of a cell
   b. Causes the production of ATP within a cell
   c. Increases the concentration of solutes outside a cell
   d. Moves substances against their concentration gradient
   e. Only occurs via a uniport mechanism

7. Evaluate the following statements for accuracy:
   1. Electron transport is a mechanism used in cellular respiration and not photosynthesis.
   2. Plant cells are not equipped for the use of electron transport chains.
   3. Photosynthesis eliminates the need for oxidative phosphorylation to take place.

   a. All statements are FALSE.
   b. All statements are TRUE.
   c. A is the only TRUE statement.
   d. A and B are TRUE statements.
   e. C is the only TRUE statement.

8. An example of one of the ways a pH buffer helps to maintain homeostasis is to:
   a. reduce the H+ concentration if pH decreases.
   b. reduce the H+ concentration if pH increases.
   c. reduce the OH- concentration if pH decreases.
   d. increase the H+ concentration if pH decreases.
   e. increase the OH- concentration if pH increases.

9. Do photosynthetic plants have mitochondria?
   a. No, chloroplasts produce ATP as well as glucose.
   b. Yes, to convert glucose into starch.
   c. Yes, but plant mitochondria have a completely different internal structure.
   d. No, plants do not need to make proteins.
   e. Yes, to regenerate ATP needed to power various cell activities if needed.

10. Why is there a need to produce Okazaki fragments on the lagging strand, but not on the leading strand of DNA?
   a. There is not enough cellular DNA ligase for bonding Okazaki fragments together if they were produced from both parental strands.
   b. The two parental strands of DNA are antiparallel and DNA polymerase makes DNA in the 5’ to 3’ direction only.
   c. The leading strand opens first, and so Okazaki fragments are not needed. The lagging strand unwinds second resulting in the need to produce Okazaki fragments.

d. It is substantially more efficient to make several shorter strands rather than one longer strand of DNA.

11. Which of the following are true?
    a. Cellular respiration and photosynthesis both start with glucose to produce energy
    b. Cellular respiration and photosynthesis both end with glucose as an energy product
    c. Cellular respiration and photosynthesis both use an electron transport chain to create a hydrogen ion concentration gradient
    d. Cellular respiration and photosynthesis are the same process but one is in humans and one is in plants
    e. None of the above are true

12. Which of the following describes an exergonic reaction?
    a. combining glucose molecules together to form glycogen
    b. plants producing glucose from CO2
    c. forming proteins from individual amino acids
    d. cells catabolizing glucose into CO2
    e. the movement of ions through a membrane channel

13. Which of the following statements are the correct?

1. DNA replication produces a strand of RNA from template DNA.
2. DNA replication uses several different proteins including DNA helicase, DNA topoisomerase, DNA polymerase, and DNA primase.
3. Transcription uses DNA to make a strand of RNA.
4. Transcription requires, among other things, RNA polymerase, DNA primase, and DNA helicase.
5. Translation makes RNA from DNA.
6. Translation uses tRNA to assemble amino acids into proteins according to the template provided by mRNA.

    a. Statements 2, 3, and 6 are correct
    b. Statements 1, 4, and 5 are correct
    c. Statements 2, 4, and 6 are correct
    d. All of the statements are correct
    e. None of the statements are correct

14. If a body cell was found that contains 2 nuclei instead of the normal one, which of the explanations below would be true?

a. Cytokinesis occurred without mitosis.
b. Mitosis occurred without cytokinesis.
c. The cell remained in interphase continuously.
d. Meiosis and mitosis both occurred.
e. None of the above.

15. Which description(s) below correctly describes[AW2] prometaphase of mitosis?
1. Each chromatid is attached to opposite kinetochore microtubules.
2. Each replicated chromosome has fully condensed and become visible.
3. The nuclear membrane has broken down.
4. The single centrosome has just begun to move from its original position.
5. Sister chromatids become entangled with other chromatids.

a. Only one statement is correct.
b. Two statements are correct.
c. Three statements are correct.
d. Four statements are correct.
e. All statements are correct.

16. What would happen if the gametes a person produced always had the same homologous chromosomes?
a. Siblings who had the same two parents would be identical.
b. The gametes would not be capable of reproduction.
c. Dominant traits would eventually stamp out all recessive traits.
d. All of the above are true
e. None of the above are true

17. For hair, D (dark hair) is dominant to d (blonde or red) and C (curly) is dominant to c (straight). Two parents have children together with the following hair types. Which of the following could be the parents' genotypes based on the children's phenotypes?
A boy with dark, curly hair
A girl with red, curly hair
A girl with dark, straight hair
A boy with red, straight hair

a. DDCC and DDCC
b. ddcc and ddcc
c. DdCc and DdCc
d. A and B
e. B and C

18. Transcribe the following DNA sequence: 3’-TGACAGATTTAGC-5’
    a. 5’-ACTGTCTAAATCG-3’
    b. 3’-ACUGUCUAAAUCG-5’
    c. 5’-ACUGUCUAAAUCG-3’
    d. 3’-ACTGTCTAAATCG-5’

19. A few animals can digest cellulose _____
    a. easily because it is made of glucose.
    b. with an exergonic reaction.
    c. using an enzyme produced by their own bodies.
    d. because it is a source of quick energy.
    e. only if they have certain microorganisms in their digestive system to break it down it first

20. Pyruvate is
    a. Product of glycolysis
    b. Product of Krebs Cycle
    c. Electron carrier molecule
    d. Reactant in photosynthesis
    e. Reactant of the Krebs Cycle

Appendix II

Course description for Biology 1014: Anatomy and Physiology I

Introduction to anatomy and physiology, including cells, tissues, organs, and the integumentary, skeletal, muscular, and nervous systems. Non-majors only. (3 credit hours)

Course description for Biology 1020: Principles of Biology

A course designed for those students majoring in a science-related field. Course content deals with scientific methodology, DNA and the genetic code, cell structure and cell development. (3 credit hours)

Appendix III

Mission Statement of University of Louisiana Monroe for Spring 2019

“The University of Louisiana Monroe seeks students who find value in our programs and prepares them to compete, succeed, and contribute in an ever-changing global society through a transformative education.”

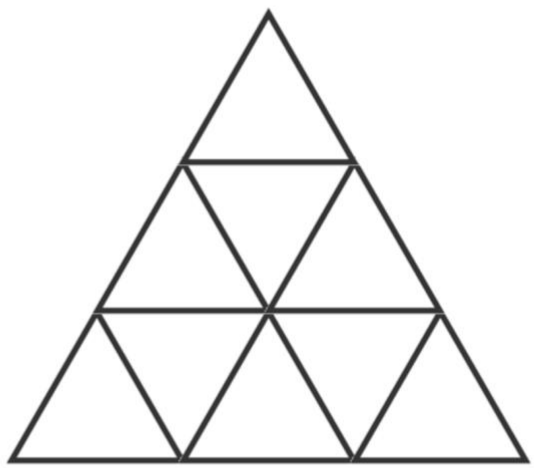
Vision Statement of University of Louisiana Monroe for Spring 2019

“The University of Louisiana Monroe will be recognized among the top 200 universities in the nation for excellence in teaching, research, and innovation, with an emphasis on the health sciences.”

Appendix IV

Example instructions for content and metacognition active learning

Instructions for Autonomic Nervous System Puzzles:
In your packet of materials, you will find a set of 9 triangles. On the sides of each triangle are questions and answers to questions. You must arrange the triangles to form a pyramid shape as shown below so that each question matches with the correct answer. In the center of each triangle, there is a letter in bold. When you have correctly matched each question and answer and formed the pyramid, put the bold letters in the correct places on this pyramid.



Next, you will find a set of 16 questions with instructions to circle a particular letter in your answer. When you answer the questions and circle the correct letters, the letters will make a phrase. You will then enter that phrase in the blanks below. You must provide an answer to each question and the correct phrase for full credit.
Sample questions: 1. What is a fruit that can be red or green and grows on trees? Circle the third letter. A p p l e

P____ ____ ____ ____ ____   ____ ____ ____ ____

Instructions for Growth Mindset Activity:
I am going to read a set of statements. If you agree, stand up. If you disagree, stay seated.
Example Statements: I can learn anything if I work hard.
I’m not good at math.
Some people will always be able to make an A because they are just smart
I am comfortable making mistakes because I learn from them.

This is followed by a lesson on fixed mindset and growth mindset and the ideas of attribution, effort and action, and learning how to learn.