**Textbook Transformation Grant: Final Grant Report**

**Digital textbook for Principles of Chemistry I Course**

# General Information

**Date: 05/15/2022**

**Grant Round: 18**

**Grant Number: 557**

**Institution Name(s): Perimeter College Georgia State University**

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**Course Name(s) and Course Numbers:**

**Spring 2022**

**CHEM 1211-014 CRN: 14337 (Dr. Dutta)**

**CHEM 1211-004 CRN: 15273 (Dr. Atteya)**

**CHEM 1211-002 CRN: 15403 (Ms. Jain)**

**CHEM 1211-016 CRN: 14336 (Dr. Mc. Closkey Campbell)**

**Fall 2021**

**CHEM 1211-020 CRN: 86538 (Dr. Dutta)**

**CHEM 1211-006 CRN: 85271 (Dr. Atteya)**

**CHEM 1211-002 CRN: 86264 (Ms. Jain)**

**CHEM 1211-022 CRN: 86539 (Dr. Mc.Closkey Campbell)**

**Semester Project Began: Fall 2020**

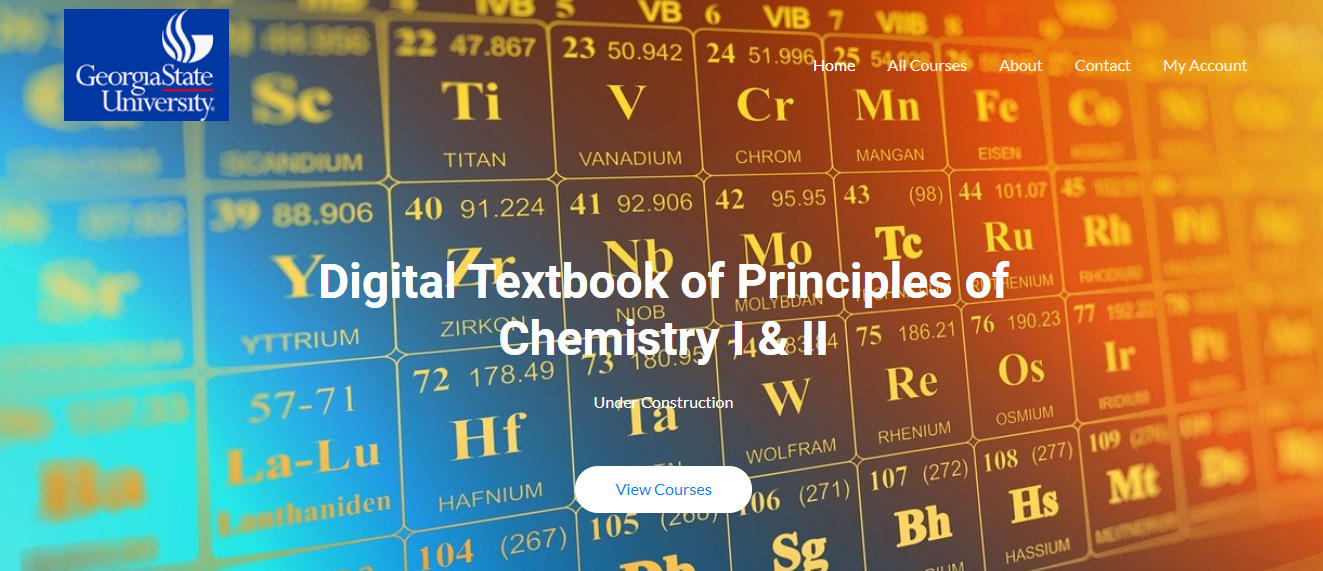
**Final Semester of Implementation: Spring 2022**

**Total Number of Students Affected During Project:114**

# Narrative

The goal of this project is to develop a supplemental digital textbook for students taking Principles of Chemistry I course that supports the tenets recommended by vision and change to integrate core concepts and competencies throughout the curriculum, focus on student-centered learning for all students and employ relevant, interactive, effective, collaborative, outcome-oriented, engaging learning materials. The outcome is highly positive, encouraging and satisfying. The link to the .pdf file of the written book is:

<https://drive.google.com/drive/folders/11bfq9AXCb18Irlkf0ikv_2oJnwp9pdvn?usp=sharing> and the URL of the ebook is: <https://gsuprincipleschemistry.org>.



CHEM 1211 course is science major gateway chemistry course for students who seek higher studies and professional career in STEM field, it is the first science course of their program of study based on fundamental principles of General Chemistry. The course covers a huge amount of materials with in-depth concepts and numerical problems over variety of topics at Perimeter College GSU. This course has very high withdrawal rate and low success rate possibly due to vast materials covered and the level of challenges presented to students.

Total 60 students participated in the implementation of eBook study during Fall’21 and 54 students in spring’22. One group used the eBook as supplemental resource and another group was considered as “control” group using standard printed textbook. All students took nationally standardized exam for final exam and performed very well on the exam. This study has been approved by Institutional Review Board (IRB) of Georgia State University, Perimeter College.

GLOBAL PANDEMIC and IMPACT on eBook:

Thought on creation of this eBook started when the world was “normal” and students and teachers used to have an “educational environment”. But the team didn’t stop when Pandemic hit and we all had to make a transition to “new world of education”

For the students, the most immediate impact has naturally been that the temporary cessation of face to face teaching at Perimeter GSU, undergraduates who are about to finish their college degree, in a completely new situation, without a clear idea of how long it will last, immediate impacts on daily life, costs incurred and financial burdens and, of course, learning continuity and restriction on mobility.

Teachers are also impacted significantly at the workplace and professionally. First, the fact that not all faculty members have strategies for the ONLINE teaching. Also, the most evident impact on teachers is the expectation, if not the demand, of the continuity of teaching activity using a virtual modality.

On the other hand, remote learning [**may not work**](https://www.chalkbeat.org/2020/6/26/21304405/surveys-remote-learning-coronavirus-success-failure-teachers-parents) for many financially challenged students. Remote instruction is far from ideal for any student, and some teachers lack the skills needed to teach remotely in an effective way. In a [**national survey**](https://www.forbes.com/sites/dereknewton/2020/03/26/most-teachers-say-they-are-not-prepared-to-teach-online/?sh=179143277f2c) of more than twelve hundred K-12 teachers conducted by **[ClassTag](https://home.classtag.com/" \t "_blank)** in March 2020, more than half (56.7 percent) of the teachers who responded said they are “not prepared to facilitate remote learning,” while a somewhat smaller percentage (42.8 percent) said they alone are responsible for deciding which remote/online tools they use. We know teachers are in need of support, yet not enough attention has been paid to helping them learn how to teach online.

.Although this eBook was implemented in classroom when classes are back to traditional face to face set up but still long term effect of pandemic was present in every phase of education.

**While preparing this report, one must understand the teachers’ mentality and students’ acceptance to an eBook which was offered to them when impact pandemic was at its peak and everyone is fatigued and at end of their “normal” zone of teaching and learning.**

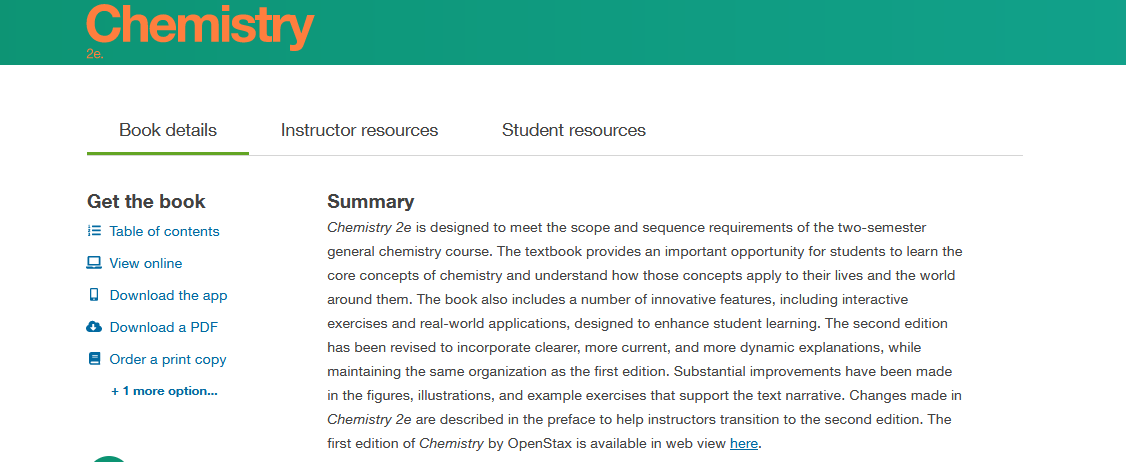
**Creation**: The thought of writing an ebook came into PIs mind from the classroom teaching experience. Students these days are very busy in an open access institution with multiple responsibilities, and knowledge they acquire in a different format, mostly visual and compact way. Traditional textbooks do a great job with detailed descriptions, diagrams and explanation of all the course materials but average students’ attention span can’t connect to them and they tend to look for most important information from the textbook.

In this process, they miss important links between the materials and learn the materials as a bunch of information only. Students in general are uncomfortable by the details of scientific methods and instead of understanding and enjoying the materials, they tend to memorize the assessment materials or easily get overwhelmed by the huge amount of materials presented to them.

The second burning factor is the skyrocketing price of the current textbooks. Most access institution students are in desperate need for financial aid when they join college and some of them drop out of college just because they can’t afford the high cost of college education. They simultaneously do three, four jobs for their living and don’t get enough time focus on their study materials. This is the primary reason behind making this ebook absolutely free of cost. Students would feel less burdened and focus on learning if other issues are removed from their head.

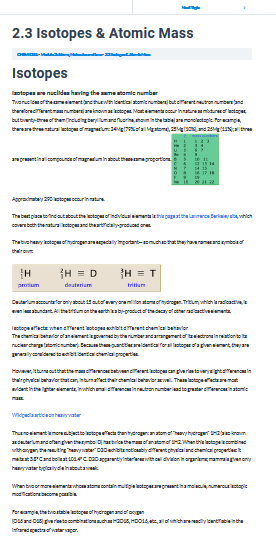
There is a need to teach these students effectively so they don’t feel pressurized by the volume of the content and showing scientific topics in a way that they can figure out easily at the same time no financial barrier should keep them off from learning. PI discussed these issues with other faculty members who were not hesitant to share their similar experiences. After they kindly agreed to write the textbook for absolutely free of cost, an application to the Textbook transformation grant (ALG) was submitted. The goal is not trying to eliminate any benefits of using the standard textbooks but only to satisfy the need of the modern generation of students by getting interested and involved in high standard education and enhance their success rate.

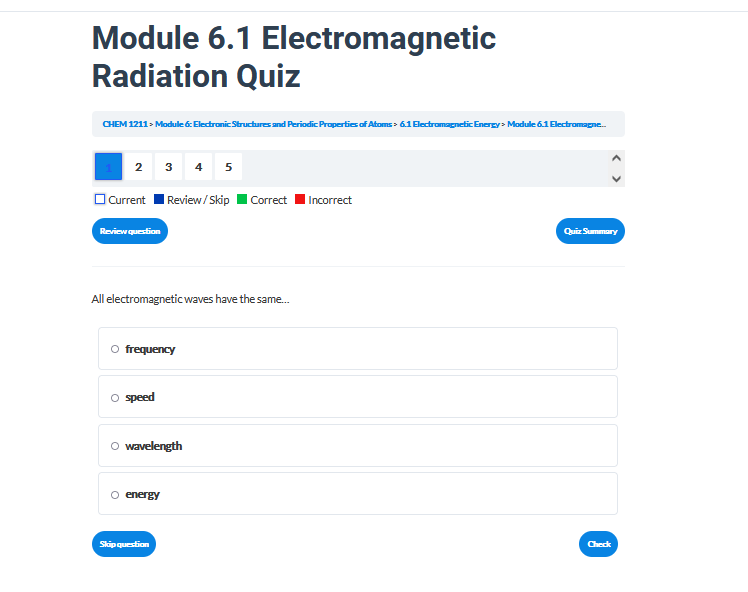
The reference standard to create this ebook is Online Textbook for General Chemistry courses by Openstax. <https://openstax.org/>



The basic structure of chapter organization of Openstax has been followed in this ebook. Additionally, this ebook has been written with shorter descriptive text and lot of videos and few simulations. All the text materials are compiled, power point presentations are created by grant members. They used Creative common licensed materials for images and resources that are available for free and ready to share and use. Other open access resources that are not openly licensed, such as YouTube videos, are linked from the text. Chemistry simulations on College Chemistry topics are very popular nowadays as it helps visual learners to understand the materials in an easy way. It also encourages them to be a self-learner as students can play with the variables within the activity and see the cause-effect relationship. There are several standard simulations sites are available and created by different universities and organizations. This ebook also has several short quizzes based off each topic and one cumulative chapter quiz that help to summarize and test the concepts and numerical problems of each chapter. Also, there are practice questions-answers at the end of each sections as learning check practice questions.

**Sample Content and Quiz from the eBook**





Project work started after the kick off session in fall’20, PI met virtually with other two co-PIs and research staff periodically and discussed the learning objectives of all the chapters, organization part of the eBook. The bulk part of the course was written during the semester break and in fall’20. By the spring’21, initial construction of course materials was complete.

The content of the ebook is written following the standard course curriculum created for this course. The rigor and depth have been maintained at the appropriate level necessary for the students to crave for the knowledge as well as succeed in this course. Apart from the electronic .pdf copy, a website was created for the students to make the content accessible from mobile device and provide a user friendly, interactive way to promote learning. The website contains content materials, short quizzes, summary pages and one cumulative quiz for every chapter as self-assessment test.

Initial phase of the project was challenging due to creating new materials, uploading them on the website and testing continuously before publishing the materials. Gradually the work became easier and technical part got settled down with continuous exploration and debugging the problems. The ebook has been delivered on WordPress digital platform which is university approved digital system for communicating with students and faculty members. A learning Management System (LMS) was set up on the platform to put the materials together. LearnDash WPLMS is used by several institutions and faculties in Academia as it builds nicely the structure of a course with review, batches and other options to teach a course. Different plugins were downloaded for extra features like quizzes, Power point slides etc. The PI appreciates the feedback and contribution from other instructors for all the suggestions to improve the materials and technical aspect of the ebook.

The ebook has been used as only textbook for classroom teaching in two different sections across the different campuses at Perimeter College in fall’21 and spring’22.. Students performance on quizzes, exams have been recorded, final exam and course grade have been collected for all the courses. Data for one section were collected as “Control” as it was using standard textbook in their course and another section of this course has used ebook as “reference” or supplemental ebook.

PI continuously worked with all the instructors teaching using the ebook during the transformation period. Any typos, finding open source materials, missing values were corrected. Students appreciated the layout of course materials, the way materials are presented and the quizzes. Course completion rate was very high. Students’ performance were also recorded for quizzes, exams periodically throughout the semester and comprehensive final exams. Online analysis was performed for the final exam which was nationally standardized ACS exam given face to face. The final outcome was satisfactory. Students responded to three surveys that were conducted in class at different time of the semester. All the responses are very positive indicating the success of this new way of presenting course materials and learning technique.

An application was submitted in October 2020 to GSU IRB to study of effect of using the ebook in classroom and it was approved. The institutional review board asked PI to revise the informed consent form that was given to the students to get their consent. It was made sure that students would receive extra credit points for using the ebook and no other harm or benefits were associated with this project. PI and other grant members presented the project idea at college faculty development day in spring’21 as well as two local meetings (GSU panel of discussion on OER & NISOD Fall’21 virtual conf.) in Fall 2021, Ga Academy of Science Conference. The abstract of this project has been selected as NISOD weekly Innovation abstract.

The main lesson learned was how-to create concise material, create and use Creative Commons Licensed materials to successfully teach this science major chemistry course. The most challenging part of writing the ebook was time limit to complete the project. Since all the project participants are full time teaching faculty occupied with many other professional responsibilities, preparation period was too short to complete a full course textbook writing. In future, the team would like to work on the materials before grant period starts. More preparation before applying for the grant would be immensely helpful.

From the students’ perspective, the website of the ebook not only serves as a learning resource but it is also used as a unique teaching site. Better organization and layout of materials and would be helpful to them. The team realized that registration or login credential may not necessary for students and faculty to access the eBook. Therefore, no login info was required but only general student usage data were collected from the backend of the web portal.

Contribution of Research Staff members: **Librarian & Instructional Designer: Mary Ann Cullen & Jeremy Speeds-Scwartz**

Librarian: Locating OER Licensed Materials:

Librarian member of the team helped in locating OER materials as required in the grant procedures. Finding OER/library/freely available materials for the course was a challenge since there were not many resources available for all the content materials. Librarian also contributed in preparing/presenting the results for conference, report, publication, organizing materials into a LibGuide format – as a final product of all the working document for the team, advising about copyright issues and OERs in general.

Contribution of Instructional Designers (ID): Interactive Walkthroughs

The PI and other team members constantly worked with ID to prepare multiple interactive Quizzes covering all the topics of the course, to help students understand the concept in a lively way and playing them on Playposit software in icollege that made it more rewarding, providing sense of success and accomplishments.. A separate page on MS Teams was created for keeping the work progress and group discussion regarding building these interactive quizzes, ID also contributed in preparing/presenting the results at a conference, publication

# Quotes:

So far more than fifty students feedback has been recorded on the ebook website. Some mixed responses were obtained. Here are some quotes written by the students using the ebook.

“I prefer paper book, but it's good to have this as an option”

“The only issue with the ebook is that its hard to access without being signed in to

icollege. Also, its easier to access under content in iCollege.”

“It was alright.”

“The experience I have had using the e‐book has been very helpful. It helps me get

a full grasp of the content I am learning in class.”

“very good”

“I personally dont use it as often as i should but it should be helpful.”

“It is handy to have an online textbook. Convenient”.

“Using the E‐book was difficult at times as it was a bit confusing and choppy.”

“However it was overall a good all‐encompassing source.”

“It was okay, but I prefer using icollege since it is too much text for me.”

“It was good to interact with and learn with it.”

# Quantitative and Qualitative Measures

## 3a. Uniform Measurements Questions

*The following are uniform questions asked to all grant teams. Please answer these to the best of your knowledge.*

**Student Opinion of Materials**

**Was the overall student opinion about the materials used in the course positive, neutral, or negative?**

Total number of students affected in this project: \_\_\_114\_\_\_\_\_\_\_

* Positive: \_\_\_\_83.3%\_\_\_\_\_ % of \_\_\_\_42\_\_\_\_ number of respondents
* Neutral: \_\_\_0.0\_\_\_\_ % of \_\_\_\_42\_\_\_\_ number of respondents
* Negative: \_\_\_16.7%\_\_\_\_ % of \_\_\_42\_\_\_\_\_ number of respondents

**Student Learning Outcomes and Grades**

**Was the overall comparative impact on student performance in terms of learning outcomes and grades in the semester(s) of implementation over previous semesters positive, neutral, or negative?**

*Student outcomes should be described in detail in Section 3b.*

Choose One:

* \_X\_\_Positive: Higher performance outcomes measured over previous semester(s)
* \_\_\_ Neutral: Same performance outcomes over previous semester(s)
* \_\_\_ Negative: Lower performance outcomes over previous semester(s)

**Student Drop/Fail/Withdraw (DFW) Rates**

**Was the overall comparative impact on Drop/Fail/Withdraw (DFW) rates in the semester(s) of implementation over previous semesters positive, neutral, or negative?**

**Drop/Fail/Withdraw Rate:***Depending on what you and your institution can measure, this may also be known as a drop/failure rate or a withdraw/failure rate.*

\_\_\_20.1%\_\_\_\_% of students, out of a total \_\_\_88\_\_\_\_ students affected, dropped/failed/withdrew from the course in the final semester of implementation.

Choose One:

* \_\_×\_ Positive: This is a lower percentage of students with D/F/W than previous semester(s)
* \_\_\_ Neutral: This is the same percentage of students with D/F/W than previous semester(s)
* \_\_\_ Negative: This is a higher percentage of students with D/F/W than previous semester(s)

3b. Measures Narrative:

The study of the effect of using the ebook was divided in both qualitative and quantitative parts. To start with the analysis, average GPA of students participating in the study was determined and found to be 2.96. Students registering for this course come with a minimum to negligible background in science. In the beginning of the transformation period in fall’21 and spring’22, a consent form was given to students to officially recognize them for this study. There were total 114 consents forms were collected. PI confirmed that students’ data would be completely confidential and extra points would be provided for participating in this study.

**Qualitative Analysis**

1. **Surveys:** There were three survey questionnaire forms filled out by the students periodically throughout the transformation period fall’21 and spring’22. The first survey was conducted to determine the attitude, background skill set and motivation. The study shows that some students have taken it as a college course before but didn’t succeed. All of them were motivated to do well.in this course. Students’ population is well diverse and split in higher achiever, medium or underachiever which is typical for this course at Perimeter College.

2nd survey is about classroom activities, perception and expectations. Survey results on perception shows that mot students expect that they would pass the course with grade “A”. It indicates that students are motivated by challenging but rewarding nature of the course and a positive learning experience can help them to succeed and build a professional career in STEM field.

Classroom activities were mainly solving questions on white board and practicing learning check problems. Blended method of teaching worked well for these students with digital content. No major change in delivery or design were applied during the transformation period. In supplemental resource section, PowerPoint with voice over narration was used and students enjoyed that part. Overall instructors taught in their usual method and students used the ebook to complete the course assessments. Some instructors had standard online homework program or self-created set of assignments as homework. There was no issue with students having difficulties to comprehend the materials from ebook to complete the course assignments. Students indicated that they were engaged and worked hard to succeed. Several tools they used for learning were power point slides, chapter quizzes from the ebook.

Some students mentioned:

* I expect to have greats grades in this course and also have a better understand of chemistry”

 ”I am hoping to pass chem 1 with a good grade and have a good foundational knowledge to carry me through other chem courses.

* It was self explanatory”
* “I personally do not prefer using an electronic book. Overall I don't feel like it negatively impacted my ability to learn but it isn't my preference”
* “The book has been helpful, but sometimes it is confusing and seems unorganized.”
* “I prefer paper book, but it's good to have this as an option.”

“It was great but can definitely be better. Module 9 for example, doesn't let me take the quizzes. it won't tell me if my answers are wrong or right. Maybe a technical problem. The content is great. Good job to the authors!

The final survey about the experience of the ebook was extremely positive. Many students mentioned that the ebook covered more in depth that was not discussed in class. Students mentioned that the materials are simplified for better understanding, easy to follow. All eBook surveys are attached to the final report.

The course got highest rating of 5 on most of the survey forms. Students mentioned they found about the interactive quizzes on website was extremely helpful and effective resources to prepare for the exam and other course assignments. Several of their feedback already have been mentioned above under “Quotes” section. Only few students had reservation using the eBook specifically due to server issue and not aligning the test questions with the materials presented in eBook. Though we didn’t get 100% of the students indicating they would recommend the ebook to other students but the overall acceptance rate was very high.

This additional survey below was inspired by another survey conducted by a group conducting research on OER materials and was given students in spring’22 only. This survey already contained suggested responses and students’ agreement on that response was studied. The results are listed below. It shows that 68.1% students are concerned about purchasing textbook while registering for class. Also, they prefer shorter videos in eBook rather than longer explanation type concept video.

|  |  |  |
| --- | --- | --- |
| **Question** | **Suggested Response** | **Yes** |
| **When registering for a course, I am \_\_\_\_\_\_ about the cost of the printed textbook.** | At least somewhat concerned | 68.1% |
| **How frequently did you use the eBook?** | Sometimes or more often | 86.4% |
| **Reading the eBook was \_\_\_\_\_\_.** | Average or better | 77.2% |
| **In comparison to other college textbook, rate the overall level of the quality of the eBook.** | Somewhat same or better | 90.9% |
| **I feel comfortable using Web-based or online resources for my college courses** | Somewhat comfortable | 90.9% |
| **How often did you see the videos in the eBook?** | Sometimes or more often | 59.1% |
| **How helpful did you find the interactive walkthroughs in eBook?** | Somewhat helpful | 86.4% |

1. **Multimedia**:
2. Tutorial Walkthrough: Total 22 walkthroughs were created using Playposit program. Although participation was low, average grade obtained was 33.3%, but students appreciated this interactive part of the eBook and recommended more multiple choice questions instead of open response type. Considering the length of this report, detailed walkthough grade report has been attached to final report as supporting document.
3. A link to sample video on balancing equation and QR code linking to the list of quick links have been pasted below.

* <https://gsuprincipleschemistry.org/wp-content/uploads/2021/08/hot_dog_chem_v07b-1.mp4>
* Quick Links list: https://sites.gsu.edu/jspeedschwartz/chem-oer-textbook-llinks

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Qr code

Description automatically generated

1. **Students Usage Data:** Using the Analytics program by Learndash LMS system built in the web portal, following data were extracted for a 45 days period ( 1st Jan 2022-14th Feb 2022). Data show that users logged in frequently and went through web resources. There is no specific data obtained about the identity of the users since no registration portal was open to see the number of times students visited the page. Original format of data from website is attached to this report.

|  |  |  |
| --- | --- | --- |
| Total Sale | Orders | Product Sold |
| £0.00 | 0 | 0.0 |
|  |  |  |
| Visitor | Views |  |
| 166 | 966 |  |

**Quantitative Analysis**

**Quizzes and Exams:** All instructors gave their own unit exam and they all used end of chapter quizzes from ebook except one section that was considered to be the control section. Two sections were considered for using eBook only (described as Class A and Class-D respectively.) In control section, exam performance was same compared to previous semester, denoted by Class-C in this report. This group of students were not exposed to the ebook materials. Another section of students using the eBook for reference only is included in this study as Class-B (supplemental) group. For convenience, exam and quiz average for two eBook sections have been combined and average values are reported. Final exam analysis for two eBook sections have been observed and presented separately. The inclusion of performance of this “control” class in this study method was intended to keep this way to examine whether traditional textbook can improve students’ performance compared to ebook.

It was found that although quiz grade slightly improved from 86.9% to 88% from fall’21 to spring’22 and exam average showed a similar range between 79.95-85.2% for ebook using students. It is evident from the data that students who used standard textbook and prepare for the exam, perform at the same level as students using other sources to succeed in this course. Control section didn’t use any quiz in their course.

Below are tabular form of percentage data showing quizzes and exam average for all the courses used in fall’21 and spring’22 implementation phase.

|  |  |  |
| --- | --- | --- |
| **Quiz Average** | **Fall’21** | **Spring’22** |
| **Class-A(eBook)** | 86.9% | 88.1 |
| **Class-B( Supplemental)** | 83.0% | 70.82 |
| **Class-C(control)** | N/A | N/A |

|  |  |  |
| --- | --- | --- |
| **Exam Average** | **Fall’21** | **Spring’22** |
| **Class-A(eBook)** | 85.2% | 79.95 |
| **Class-B(Supplemental)** | 76.4% | 72.69 |
| **Class-C(control)** | 74.3% | 87.00 |

From the data, it is evident that exam averages are either same or slightly below the previous semester average after using the ebook except for the control group. It is interesting to see how one group of students performed well using the ebook in one term but performed different in another term whereas other group using ebook as supplemental stayed nearly same for both term. Reasons could be difference in students’ population, access to the digital content or the lack of sufficient time for a particular group of students. In contrast, groups who used the ebook quizzes (part of the course grade), performed relatively well on unit exams with average grades dropped from 85.2% to 79.95% whereas quiz grades went up to 88.1% from 86.9%. .It may indicate that some groups were able to retain the information for a short span for quizzes whereas some students took time to grasp the materials to perform well on the tests.

Another important factor is that assigned textbook readings are a common requirement in undergraduate courses, but students often do not complete reading assignments or do not do so until immediately before an exam. This may have serious effects on learning and course performance. Instructors assign textbook readings for a variety of reasons, most commonly because it is often impossible to present all necessary course material during class time. Regularly scheduled quizzes on reading material may increase completion of reading assignments and therefore course performance. This study reflects the effectiveness of compulsory, mastery-based, chapter quizzes as a means of improving exam and course performance. Completion of quizzes was related to both better exam and course performance. The study includes recommendations for the use of quizzes in undergraduate courses.

**Final exam:** Nationally standardized ACS ( GC90FY) exam is used to evaluate students’ performance in this course. There are total 70 Multiple choice type questions in the exam. The same exam was used as final exam for both fall’21 & spring’22 semesters. In this report the detailed final exam analysis will be presented with DFW comparison study from previous years. Considering the vastness of the materials covered in this course, results of three main learning objectives topics: 1) “Measurement”, 2) “Stoichiometry” and 3) “Bonding” will be discussed in this report. From each topic, two questions were chosen randomly among other questions on the same topic of the exam. Percentages of correct responses on chosen questions have been presented in tabular form.

For “measurement” topic, two different questions that reflect understanding and numerical problem solving ability of students involving basic measurement in chemical science (questions #6 & #11) have been considered in this report. Results below show the average percent correct response for those two questions.

Overall, for questions with harder numerical problems, ~69-86% students correctly answered the questions including class A & D. It may be concluded that the traditional book didn’t help the students enough to perform any better on harder numerical problems where they need to apply the Algebra skill and concept of certain/uncertain digits and dimensional analysis. Instructor led classroom teaching is most effective tool in this case.

|  |  |  |
| --- | --- | --- |
| **Final exam: Learning Objective#1(Measurement Q# 6,11)** | **Fall’21** | **Spr’22** |
| **Class-A(eBook only)** | 72.58 | 69.14 |
| **Class-B(Supplemental)** | 83.83 | 74.25 |
| **Class-C(Control)** | 79.41 | 89.29 |
| **Class-D(eBook#2)** | 86.36 | 64.29 |

The second learning objective was chosen as Stoichiometry. Chemical reaction Stoichiometry is another very important concept in this course and two question #18 and #20 of the exam are about deeper concept on this topic. Results show where some groups fail to understand the concept of stoichiometry but some students did gain deeper understanding on the concept. Solving problems on stoichiometry could be challenging irrespective of traditional and non-traditional format of reading and the results confirm the fact.

|  |  |  |
| --- | --- | --- |
| **Final exam: Learning Objective#2( Stoichiometry)**  **Q#18, 20** | **Fall’21** | **Spr’22** |
| **Class-A(eBook only)** | 45.16 | 30.00 |
| **Class-B(Supplemental)** | 52.94 | 36.37 |
| **Class-C(Control)** | 55.89 | 53.57 |
| **Class-D(eBook#2)** | 40.91 | 39.29 |

The third objective that was chosen for analysis is the Electronic Structure Theory of “Bonding”. This concept is relatively complex and very important for the students to build the foundation of this course and results are presented below based on students’ performance on question# 60 and #68. Results show some group of students performed well (56.45%) on those questions but other group showed slight decrease (40.0%) from previous semester. Class-D data fall under the same bracket of percent correct response. Both “Stoichiometry” and “Bonding Theory” concepts are vital in this course and although use of ebook didn’t make drastic positive impact on students’ performance but overall it can be considered as effective in understanding the concept.

|  |  |  |
| --- | --- | --- |
| **Final exam: Learning Objective#3(Electronic Structure Theory) Q#60, 68** | **Fall’21** | **Spring’22** |
| **Class-A(Only eBook)** | 56.45 | 40.00 |
| **Class-B(Supplemental)** | 66.18 | 65.16 |
| **Class-C(Control)** | 64.71 | 67.86 |
| **Class-D(eBook#2)** | 45.46 | 50.00 |

For all the topics, overall spring’22 results were less impressive compared to fall’21 specifically for bonding theories. One reason could be aftereffect of prolong online instructions for students who are currently taking college level courses. Most of them have been used to with online instruction method due to pandemic and they need get adjusted with face to face learning method and adaption to the materials along with the pace of delivery of the materials.

Overall final exam results were positive. Average mean percentage ranges from 35% to 50% which is relatively close to mean value of this nationally standardized exam according to composite norm statistics. Here is the summary table for all the groups on fall’21 & Spring’22 final exams.

\*Final Exam Statistics:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Fa’21** | **% Mean Score** | **Highest score** | **Lowest score** | **Standard deviation** |
| **Class-A(ebook)** | **49.5** | **52** | **13** | **10.48** |
| **Class-B(Supplemental)** | **59.2** | **60** | **18** | **10.58** |
| **Class-C(Control)** | **55.3** | **65** | **22** | **13.74** |
| **Class-D(eBook#2)** | **43.64** | **51** | **14** | **13.99** |
| **Spring’22** | **% Mean Score** | **Highest score** | **Lowest score** | **Standard deviation** |
| **Class-A(ebook only)** | **46.3** | **64** | **15** | **12.83** |
| **Class-B(Supplemental)** | **49.7** | **57** | **18** | **9.52** |
| **Class-C(Control)** | **55.9** | **60** | **16** | **12.45** |
| **Class-D(Ebook#2)** | **38.5** | **44** | **12** | **9.30** |

**Success Ratio:** Usually the success rate of this course is low due to several factors including students’ background, retention and adequate time and proper resources to learn the materials. It was found that ebook groups students had success rate in the range of 75-93.3%. Overall withdrawal rate is low below 5% to high 16% for eBooks users including two sections in both term. Students withdraw for varied reason other than being unsuccessful in the course. Higher D/F percentages compared to“W” percentage means underachieving students didn’t withdraw from the course and completed the course regardless about the final outcome. This reflects the long-term benefits of students learning and retention rate using an effective method of teaching with the helpful resources appropriate to modern age.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Success Rate in Fall’21** | **ABC** | **DF** | **Success rate** | **Success Rate in Spring’22** | **ABC** | **DF** | **Success rate** |
| **Class-A(eBook)** | 30 | 2 | 93.3% | **Class-A(eBook)** | 20 | 6 | 76.9% |
| **Class-B(supplemental)** | 32 | 3 | 90.6% | **Class-B(supplemental)** | 4 | 0 | 100% |
| **Class-C(control)** | 13 | 10 | 23.1% | **Class-C(control)** | 6 | 1 | 85.7% |
| **Class-D(eBook#2)** | 11 | 1 | 90.9% | **Class-D(eBook#2)** | 12 | 4 | 75% |

\*Comparison of overall DFW rate in each course:

|  |  |  |
| --- | --- | --- |
|  | **DFW Fall’21** | **DFW Spring’22** |
| **Class-A(eBook)** | 9.1% | 31.0% |
| **Class-B(supplemental)** | 13.5% | 16.7% |
| **Class-C(control)** | 53.6% | 18.8% |
| **Class-D(ebook#2)** | 15.4% | 25% |

\*Data Source: IPORT (Office of Institutional Effectiveness), may include course performance in total including consented students

**DFW:** According to the available records, DFW rate has been improved by the application of the ebook. The average DFW rate combining fall’21 & spring’22 is 20.1^%. At the college-wide level, it may be observed that DFW rate has decreased from spring’19-Fall’21 pre/post pandemic period.

**DFW Rate study by Dr. Michael Nelson (CCC Chemistry Course Committee chair of Perimeter GSU, Project Reviewer)**

Here is the college wide DFW data analyzed by Dr. Nelson for last 3 years in pre/post pandemic phases including summer terms. The data clearly shows that eBook team was successful to lower the college wide DFW rate and helped more in students success and retention..

|  |  |
| --- | --- |
| **CHEM 1211** | **Overall % DFW** |
| **Sp19** | 32.2 |
| **Su19** | 28.5 |
| **Fa19** | 37.1 |
| **Sp20** | 26.1 |
| **Su20** | 22.4 |
| **Fa20** | 39.4 |
| **Sp21** | 41.5 |
| **Su21** | 26.3 |
| **Fa21** | 28.2 |

**Overall conclusion**: Although a certain percentage of ebook students didn’t perform per expectation, overall all groups of students performed well. eBook using students performed well on nationally standardized ACS exam and all learning outcome results were satisfactory to move on and continue with this digital textbook in future classes. Control group of students also did well in every category of course assignments. It may indicate that traditional textbook has a definite value in teaching and learning and it will continue to maintain the same impact in student performance. Alternately, when correct materials and appropriate strategies are applied with modern technique of teaching, students perform at the same level and learning can be enjoyed and enhanced.

Overall, this ebook project’s future prospect is very bright. This project has immense impact on the students and institution. More and more students are interested in OER resources and a free of cost textbook can really help students with limited financial help. The fear of coming to class without book is eliminated. Students can access course materials anywhere, anytime. For students who don’t have proper network service to afford digital information, a .pdf file has been provided for printing off the materials and downloading. Traditional teaching has been adopted using this ebook appropriately. Our team is already preparing other General Chemistry Course materials based on OER resources.

Learning outcome for the faculty member also very important in this project. Faculty members learned how to use modern methods in teaching using simulations, creating shorter videos for more pointed topic discussion, and concept charts. Also, creating and scheduling interactive practice tests, quiz helped students to organize with their study materials and keep them focused throughout the semester.

1. Sustainability Plan

Chemistry course committee of Perimeter College has agreed to approve this course materials as a standalone open source resource to use it in future. This ebook is being successfully implemented on all the campuses in AY 21-22. One of the big advantages of digital textbook that it can be updated any time needed. Course grades and student information will be transferred to grant office and will be safely archived.

There were five strategic plans for sustainability of this ebook that were considered while writing the ebook. They were mentioned in the grant proposal. The plans have been executed well to make this project sustainable.

1. **Questions and responses:** Questions and responses are the most fundamental and important activities in classroom, and a great way to grasp the understanding level of each student on specific learning contents. This digital textbook has sample questions and answers at the end of each chapter to support students learning. Instructor can use them to check instant class response for a particular topic after explaining the concept in class. Also students can post feedback after taking quizzes and reading the materials.
2. **Monitoring students based on learning data:** To monitor students’ participation level and to provide feedback, instructors can periodically check student learning activity data. The website of the ebook: <https://gsuprincipleschemistry.org> can be really helpful in monitoring. An Analytics program is used in the ebook which can provide information about total number of attempt, most viewed topic etc. that would enable instructor to evaluate the progress of the students effectively.
3. **Assessment:** To support assessment, many alternatives to traditional assessment types that can be used to broaden the scope of the instructor’s classroom assessment activities. Answering the questions from simulations and grades of end of chapter quiz data can help instructors to effectively evaluate a students’ performance. This digital textbooks will support alternatives as well as traditional types of assessment.
4. **Experimental learning and Active Learning:** Involving students with in-class activities is a pedagogical method intended to promote active learning. This digital text-book supports the creation of various activity-based teaching through simulations and videos than can be perceived as experimental learning or learning by doing. Printed books can never provide this facility.
5. Future Affordable Materials plan

Currently, Our team is preparing to work on ebook for Gen Chem II to complete the sequence. All the typos, answers to the questions in the current ebook will be revised. Separate quizzes for grading and more homework assignment or questions for practice purposes will be used. The ultimate goal is completely eliminating the cost of Undergraduate Chemistry textbooks for both non-science and science major courses at Perimeter College This work was presented at Georgia Academy of Science conference in April Spring’22 and can be presented complete work in next year.

Another future plan is create a modified site and eventually integrate the ebook with college LMS system. There is a D2L version of the ebook which requires review and modifications. There are several bugs and restrictions in-built on the website that can be fixed. It would be easier for instructors to teach if the eBook when integrated to institution’s D2L learning management system. Work is in progress for this process.

**Acknowledgement:** The grant members would like to thank dept. of Physical Science, Perimeter College Dr. Mike Nelson(Reviewer), Dr. Paulos Yohannes(Associate Dean of Research), Dr. Solomon Fesseha(Dept. Chair, Phys. Sc.) for their support and encouragement. All the help from Perimeter Grant office is much appreciated. PI would like to thank the dept. administrative secretary Ms. Connie Fickenscher for providing data about students GPA. This ebook is dedicated to the students of the Perimeter College who makes the institution proud with their great performances and shine with the glory of true knowledge.

1. Future Scholarship Plan:

Work previously published or presented:

1. Spirng 2021: Perimeter College Faculty Development Day
2. Fall 2021: Teaching Matters Conference, Gordon College
3. Fall 20221: GSU Open Access Week, a Panel Discussion by the GSU professors
4. Fall 2021: NISOD Fall Virtual Conference
5. Spring 2022: Georgia Academy of Science Annual Conference

Future Plan: Spring 2023: Georgia Academy of Science Annual Conference & Fall 2022 Teaching Matter Conference

1. Photograph

**From left: Dr. Antara Dutta (P.I.). Dr. Maher Atteya (Co PI) and Dr. Ahmed Baosman ( co PI).**

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**Contributing member: Dr. Jose Gonzalez Roman & Shalini Jain**

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**Research staff-members: Mary Ann-Cullen & Jeremy Sprreds-Scwartz**

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**PI would like to extend special thanks to Dr. Candice Campbell for het contribution with the data and support.**

**Photographs of students working in classroom:**