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Electronic teaching resources for university cell biology supports improved student learning outcomes

Running Title: Electronic resources for university cell biology teaching

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ABSTRACT

An optional electronic resource (e-resource) requiring subscription, was offered to 2nd year students studying university Cell Biology. An online survey attitudes identified cost, the relative (lack) ease of use and a “general preference”, as primary reasons for not utilising the e-resource. The ability to access graphics, videos and animations, as well as practice questions, were all seen as positive features. Of the 44 e-resource students a performance increase of 10% (73%, and 63%, *P-value*=0.004) was seen compared to those that didn't (90). Within the e-resource cohort, academic performance in the previous year, when other online resources were not optional, less of a differentiation was apparent, suggesting difference were not attributable to individual academic aptitudes. Overall an increase in academic performance was seen in students that used the optional e-resource. These findings will be presented to assist new students in deciding how to approach their learning in Cell Biology.

Keywords: e-resource, cell biology, online learning, e-textbook, university students.

1. INTRODUCTION

E(electronic)-textbooks and e-resources are gaining in popularity for the teaching of university modules, including in the life sciences. Students are known to be hesitant regarding the accessibility

and user feel of these resources, compared to print textbooks. The concerns of students as well as their perceived advantages of e-resources need to be considered. These concerns can then be weighed against the performance of student in summative assessment, comparing those access these resources and students that don't.

1.1 The use of electronic resources in learning

There are two primary advantages that should be considered in regards to supplementing lecture content with electronic material which is directly associated with the prescribed textbook. Firstly, it provides students with direct access to the textbook as an e-textbook, and secondly and potentially more importantly, it provides a more interactive and student driven learning process.¹

The use of e-textbooks in university teaching has been a topic of analysis and discussion in many studies.^{2,3} Limitations reported by students in their uptake of e-textbooks include a "preference" for hardcopy print material, and a general inexperience or trepidation with the electronic interface. Students can be concerned that e-textbooks are difficult to use and don't provide the intuitive feel of a print textbook.⁴ An overall doubt regarding the effectiveness of an e-textbook is also a key issue with students, with usefulness one of the strongest indicator for a student in subscribing and using the resource.¹

The potential interactivity of an e-textbook is another central feature that sets it apart from a traditional print textbook. The ability to allow the lecturer to annotate the text, and the capacity to provide quizzes, are both prime examples of how an e-textbook can be more interactive.⁵ These electronic features allow the design of after class activities, with features that can be either formally assessed or not. Additional characteristics of e-textbooks that could provide students with a more effective learning experience include the ability to click on a word they don't understand and be taken to a definition.⁶ These links can also send students to animations, hyperlinks and other supplementary data or other materials. It is, however, important to note that online resources may only provide a

defined period of access, and while cheaper than a print textbook, they do not have the longevity that a physical book provides.

Strategies to promote and improve e-textbook use have been discussed in the recent publication of Gerhart and colleagues.⁴ There can be a preconception by academic administrators that e-textbooks and print textbooks are identical in scope, and that students will only be concerned about the costs associated with the decision on which platform is to be used. Two models have been proposed outlining the use of e-textbooks, or more specifically why uptake is not higher.⁴ Firstly, ease of use and price are considered positive indicators, while “internet self-efficacy” and concerns about the environment were not viewed as issues. The second model put forward is the concept of “task-technology fit” (TTF) which considers whether the subject matter and the applications that the e-textbook can provide, are compatible. Furthermore, student acceptance or consideration of TTF is influenced by four factors; substitution or replacing the print textbook, habit or what the students were used to doing from past experience, “hedonic motivation” or how much satisfaction they gain from e-textbook usage, and finally “facilitating conditions” which is associated with the premise that the student will be confident in using the technology or interface.

It is apparent that the use and acceptance of e-textbooks are increasing in university teaching. How these resources are incorporated by academics, and how this facilitation can engage students are important areas for education. To best address these issues it is important to understand the motivating factors for students, in order to change their attitudes to e-textbooks. With this information it is easier to incorporate these kind of resources into the curriculum.

2. METHODS

2.1 Participants

All student details and results were anonymised before analysis. The online survey was also anonymised, while details from the online e-resource once collected individual names were not

retained. No ethical issues are related to the selection and treatment of subjects associated with this paper.

2.2 Online e-resource uptake for teaching in undergraduate second year cell biology class

The use of optional online content, requiring subscription, was assessed, both in terms of student attitude to take up and the academic outcomes of the students. This resource was linked to the prescribed textbook for the combined classes Cell Biology 1 and Cell Biology 2, during the 2017/18 academic year. Cell Biology I is a single semester module ran during semester I only and consisted of 17 students. The Cell Biology II module ran the entire academic year, with 117 students enrolled. The below analyses combines both modules (134 students) and follows their use of the online e-resource for semester I only. Content is the same for the two modules during Semester I. The same piece of continuous assessment, a computer multiple choice question class test, was used to gauge student outcomes and performance.

The module(s) recommended textbook was available at the university bookshop. An online subscription for a reduce price was offered, which is referred to in this analysis as the e-resource, since it incorporated an e-textbook plus online supplementary materials. The e-resource included a 1 year access to the textbook as an e-textbook, and access to online only resources, such as video, animations, and quizzes for self-directed learning. An additional option was presented to students that wanted to purchase the physical textbook with online access for a nominal cost. On the first day of the semester, myself and the other module coordinator included in our module introduction the option of the e-resource. A representative of the publisher was also present and gave an overview of the e-resource. Value added features of the e-resource including concept quizzes, directed reading as indicated in lectures, are all highlighted to students upon logging-in. The further features of *Animation Activities*, *Analyse the Data Activities* and *Visualisations* were also discussed in the initial module orientation. Not all of these features were used in every lecture, or by every lecturer teaching on the module. It was a decision of the module coordinators that no formal assessment would be associated with this e-resource, even though extensive quiz facilities were available and could be used by the student for

independent learning. This decision was made due to the increased costs for students, as both the textbook and e-resource are optional. The module coordinators and School supported e-resources access and participation by providing initial instructions regarding its registration and use; as well as regular reminders throughout the semester of its availability and value. Finally, the textbook was available in the library for students wanting more information for any point presented in a lecture which refers to the textbook directly.

Statistical tests used have been reported for similar studies and comparisons.⁷

The data used in this study can be accessed by contacting the corresponding author.

3. RESULTS AND DISCUSSION

3.1 Student survey of attitude to the optional e-resource

A total of 44 students (33%) took up a subscription of the e-resource, from the combined classes of 134 students. To gauge both the motivations for student take up and non-engagement with the e-resource, an online survey was provided to all students via email. Online third party results were collected on 6/12/17. The survey was designed to be anonymous, but questions were structured to gain information from both subscribers and non-subscribers of the e-resource. A total of 24 responders were gathered in the survey, representing 18% of the combined student class. Seven questions were asked, and most responses took on average 2 minutes to complete. Questions and answer response rates are presented in Table 1. The answers were provided in multiple choice format, although students were provided with an option to provide additional comment.

While this was an anonymous survey, the specific Q1 could differentiate between registered and non-registered students and their options regarding the e-resource. Of the 24 responders the percentage of registered students at 37.5% was higher when compared to the total registration rate of the entire class (generated from the e-resource) of 30.6%. This could reflect that registered students were more

engaged with the module due to their investment in terms of time and money associated with using the e-resource, and were more prepared provide feedback when requested.

Most of the reasons (Q2) provided for not using the e-resource were associated with preference, however a large proportion of responses were also associated with cost at 32%. Support to improve accessibility and participation, for additional resources, such as e-resources, is an ongoing issue and a common theme in academia. It was interesting that the decision to not assign any continuous assessment linked to the e-resource was not a significant factor. Other responses provided by the students included (sic and paraphrased for succinctness)- “had already bought the textbook”, “didn’t seem like it would be very relevant to the way we were assessed”, “I prefer reading from a textbook and being able to make notes around the text.” “Simply prefer hardcopies” “Bad experience with last year’s online system”, and “Problem with pricing and setup from the bookstore”.

Improvements which may convert more students (Q3), overwhelmingly was a reduction in price. The details of how many students bought the print textbook could not be ascertained since multiple sources in addition to the University bookshop are available. However, in comparing the costs, the e-resource is significantly cheaper. The other main positive indicator was further incorporation of the e-resource into a smaller group sessions. The facility for tutorials in the current modules is not feasible due to the time and resource requirements of biological sciences to provide laboratory or practical sessions. However, for third year modules or other subjects this would be an application for an e-resource that would allow more student engagement.

Expanding further on the point of small group sessions (Q4), and the incorporation of the e-resource, positive feedback was provided under all of the categories suggested, with no additional topics or applications brought forward. Problem solving, Q&As, analysis and discussion of “broad concepts” were all well considered by the students, and would be areas that could be included for different modules with smaller student numbers.

Regarding the most popular or well received features of the e-resource, answers to Q5 indicated the accessibility of graphics and videos, and practice questions, all positively. These are features that should be promoted for future student intakes, and will be likely to encourage additional engagement with the e-resource. Other suggestions of features that were useful included polarising points of view- including “Really easy to search for very specific topics within the book - directs to all pages” and “I didn't, I really struggled to use it.”.

Q6 sort to see how much students used the e-resource. Student usage varied significantly between a few times in total and a generally negative experience, to only when directed. It is worth noting that as an “instructor” individual student’s engagement time could be determined with the e-resource. This engagement with the e-resource could be correlated to student outcomes which is presented and discussed further in this manuscript.

Comments received from Q7 where other suggestions or observations were requested included the following statements- “Was quite difficult to navigate the website so I used it very little, I couldn't find where to access the whole book. Was not worth the price, especially those on only cell biology 1, would not recommend for people only on biology 1 and it should not be suggested we buy it.”; “The software is not user friendly, it is difficult to find relevant sections and switch between sections when revising.”; “Sort the purchasing price out earlier.” These comments further reinforced insights gathered from previous questions.

3.2 Comparison of survey results to the wider literature

A similar study ⁵ discussed surveys performed at the University of Central Florida in 2012, 2014 and 2016. Feedback from ~1000 students was obtained from each year, and sort to explore student attitudes and application in regards to e-textbooks. Key questions and responses included in this study ⁵:

1. "Are you using or used an e-textbook?" Responses across the 3 survey years went from 42%, 60% to 66% yes. A clear trend demonstrating the increase in the usage of this resource.
2. From the latest survey year, "the type of e-textbook features that are used included": *Basic Features* 51%, *PDFs* 37%, *interactive features* 24%, *open textbook* 20%. The basic features included the ability to highlight and annotate the textbook text.
3. "What... factors that would influence students to select an e-textbook rather than a print textbook?" Again focusing on just 2016 responses, the overwhelming factor was a *lower cost* 74%, *ability to access textbook anywhere* 63%, *use e-book offline* 48% and *store many textbooks on one device* 48%.

It is expected that lower cost was a clear indicator of take up, and a response that was mirrored in the current survey in Q3 with 63% of respondents indicating this as an important factor.

4. Asking "Why they had not used an e-textbook" the clearest indicator was "I prefer print", although this is a declining issue going from 38% in 2012 to 17% in 2016.

Again this response was consistent with the current survey as demonstrated in Q2 with 63% of responder citing a dislike to reading this type of material online. In the survey of deNoyellers and Raible⁵, certain negative effects on health were attributed to avoiding online reading when possibly, included headaches and eye strain. These could be issues that can be explored further in QUB students. Improvements in online reading devices in the future may help to circumvent these issues for students.

Another study by the University of Agder² obtained from a student survey highlights some further insights into the behavior and useage of e-book readers in 94 students in 2010-2011. Positive functionality they liked included opening documents, turning pages and zooming. Further, being able to go back to were they left a document and switching between documents were seen as easy and useful features. At the time of the survey 54% preferred paper text and 28% preferred using both at the same time, which is an interesting consideration, and shows that e-textbooks and print textbooks together could be used for student learning. Where e-readers were used was also surveyed, with the

main location indoors, but there were students that also accessed the resource when travelling, in class and “on the bedside”. This use of the e-reader outside the traditional study setup of indoors is a feature that would no doubt differentiate it from print textbook.

3.3 Analysis of Student Academic Outcomes

Using instructor access, it could be seen how much time students that were subscribed to the e-resource used it online. With this information correlation with student outcomes of a multiple choice class test could be made. Furthermore, if a student was registered for the online system and secondly how much time they used the resource could be determined. Figure 1 shows that students that registered for the e-resource performed better on the MCQ class test (P -value = 0.004). This was reflected in the median scores of 73% for registered students versus 63% in non-registered students. It is however, difficult to discern from the data whether the improvement in the student performance was attributed to the e-resources, or if students that are more likely to register for the e-resource are better performing. A more extensive analysis of student performance in modules where an e-resource was not provided might be informative. This additional analysis was not within the remit of the current study.

While there was an indication that the registration of the e-resource was a positive indicator for improved performance, I wanted to see if engagement with the resource was a factor also. To investigate this I was able to access the usage of the e-resource in hours for individual students and correlate this to their performance. As presented in Figure 2, there was a less clear indicator of performance with hours spent. It was however, useful to note that most students used the e-resource for less than 5 hours, with only 3 student accessing for over 30 hours. Further analysis shows that of the 7 students scoring 90% or higher the hours accessed ranged from <1hr to 33.5hrs. Using this same criteria to the first analysis in Figure 1, 6 students that did not-register or 6/93 (6.5%) scored equal to or over 90%, compared to the 7/44 (15.9%) of registered students.

The examination of student study time and outcomes or performance has been extensively reported.^{8,9} In the many studies, the outcomes in relation to hours spent and study strategy have reported varying findings, including improved performance, reduced performance and no difference in performance. In the study by Nonis and Hudson⁸ they characterised the study habits and performance indicators of 216 students studying macroeconomics in the United States. One clearly positive indicator of performance was the length of studying, but only if the student held a high ability to concentrate. This observation is perfectly plausible since if a student is not focusing on the content then no amount of study time will produce a positive outcome. Surprisingly the presumably important parameter of access to a good set of notes and performance, actually presented a negative correlation. This second unexpected result may again reflect how students are using these “good set of notes” and the focus that is needed to get the most from these sort of resources. This was investigated further in the study⁸ where all three parameters when combined produced a positive correlation, i.e., improved performance, study content, and focus or concentration skills.

A question arose from this analysis “*Was student participation in the e-resource an indicator leading to increased academic outcomes, or are students with greater academic outcome more prepared to engage with these resources?*”. To address this issue the academic outcomes of the e-resource registered student cohort was compared to their previous year, with two modules where the purchase of the prescribed textbook and associated e-resource was not optional, and as such could be removed as a parameter in their performance. As shown in Figure 3, less of a difference was seen in the e-resource registered students, with a slight increase seen in one module ($P\text{-value}=0.04$) with an increase of 2% of the total mark, and no difference seen in the second module ($P\text{-value}=0.35$). This finding of the previous academic year where insubstantial when compared to those presented in Figure 1, where differences were more pronounced ($P\text{-value}=0.004$) with an increase to student registered for the e-resource of 10%. These findings collectively would give support to the premise that using the e-resource in Cell Biology I and II, gave students an improved academic performance or outcome.

Our observed improvements in student performance, and that it can be attributed to access to the e-resource, can be compared to other similar studies. Azab and colleagues reported no significant improvements in students based on their access of online lecture materials for 2nd year predoctoral dental students.¹⁰ While another study by Guy *et al.*, saw for anatomy students distinct improvements (16%) when a subset of the group (~50%) accessed online resources including an interactive atlas, questions and concept clips.¹¹ While the improvement in this later study was clear, no statistical analysis was performed.

Learning styles play an import role in how a learning resource or mode of teaching delivery can be most effective to an individual.¹² A distinction is generally made between verbal and visual explanation of, or expansion on, a topic¹³, which are reflected as preferences for learning in individuals. Massa and Myer in 2006¹³ reported that testing of university students with visual or verbal modes of instruction could not be differentiated, and that different instruction modes are not clearly warranted. More recently, it has been suggested that online teaching resources should be designed to support various learning styles.¹⁴ E-resources represent a multimedia option for student learning, and have a better potential to support both visual and verbal learners. As discussed by Hew and colleagues¹⁴ digital technologies have the capability for the “Accommodation of various learning styles”. They expanding on this by noting different learning styles may require support under the areas of “Verbal and visual presentations, Group discussion or Individual learning”. Furthermore they suggest that these requirements can be met through digital technologies (e-resources) by providing “Expository texts, Repeat digital scenarios, or Virtual chat room”. In the current study, the main support provided was additional text and figures via the e-text book, and supplementary animation and videos. It is however clear in light of these previous studies, that additional forms of learning such as, online discussion groups or digital problem solving exercises, would be beneficial. An expanded range of online resources would benefit a wider student body, with different learning styles.

The final point to clarify the result of this study is in relation to the value of e-resources with different academic disciplines. Variations have been reported, ranging from positive to no improvements, in

fields ranging from accounting/business, arts/science, business, economics and mathematics¹⁵⁻¹⁹, and have included optional components of e-resources from specific modules.²⁰ This would indicate that approaches such as those presented here, need to be considered at a module by module basis.

3.4 Conclusions

There are clearly issues associated with student attitudes towards the uptake of an optional e-resource. Financial concerns, effectiveness, and better integration into the curriculum could all be addressed. It was encouraging to receive positive feedback in the survey conducted and, that from this analysis, a clear improvement in student performance when using the e-resource was also reassuring. The use of this type of resource in the Cell Biology modules should be a point for discussion. It is hoped that the analysis presented here will help to provide both quantitative and qualitative evidence to decide the structure of the module in relation to e-resources, such as e-textbooks and interactive components to supplement in class lecture materials.

In light of the benefits e-resources can provide for improved student academic outcomes, increased student access should be supported by universities. Negotiation with publishers should be lead at the highest levels within universities, to ensure lower access costs. Universities are already investing significantly in digital hardware (computers) in libraries. This should be mirrored with increased digital resource access through higher financial commitments directly from universities. An alternative to students directly subscribing to an e-resource, could be university libraries providing access. Digital resources have become particularly prominence in light of the challenges faced during 2020-21 and the pandemic, and will no doubt continue to be grow in importance in educational settings.

FIGURE LEGENDS

FIGURE 1 Comparison of performance between student groups for Cell Biology I/II (2nd Year). A significant difference was seen between the two groups, i.e., registered or did not register (non-registered) for the e-resource. A Mann-Whitney Un-paired Nonparametric T-Test (U-Test) presented a *P-value*=0.004. Median scores (performance) of 73% for Registered (n=44), and 63% for Non-Registered n=90.

FIGURE 2 E-resource registered students, student performance and hours spent using the resource (Cell Biology I/II, 2nd year). No statistically (ns) significant correlation was seen. ($R=0.16$, *P-value*= 0.30)

FIGURE 3 Comparison of performance between student groups in the previous academic year (1st Year). The smaller e-resource 2nd year Cell Biology Registered Cohort was compared to the entire larger class (Whole Class) for two modules in the previous academic year. A statistical difference was only seen in one module (1), with the second not presenting as Non-significant. Mann-Whitney Un-paired Nonparametric T-Tests (U-Test) were used within modules, with Module 1 presenting a *P-value*=0.04, Median scores (performance) of Registered of 69% (n=42), compared to the Whole Class of 67%, n=280. In the second comparison (Module 2) a *P-value*=0.35, Median scores (performance) of Registered of 71% (n=42), compared to the Whole Class of 71%, n=245.

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CONFLICT OF INTEREST

- a. The data used in this study can be accessed by contacting the corresponding author.
- b. No ethical issues are related to the selection and treatment of subjects associated with this paper.
- c. The author has no conflict of interest.

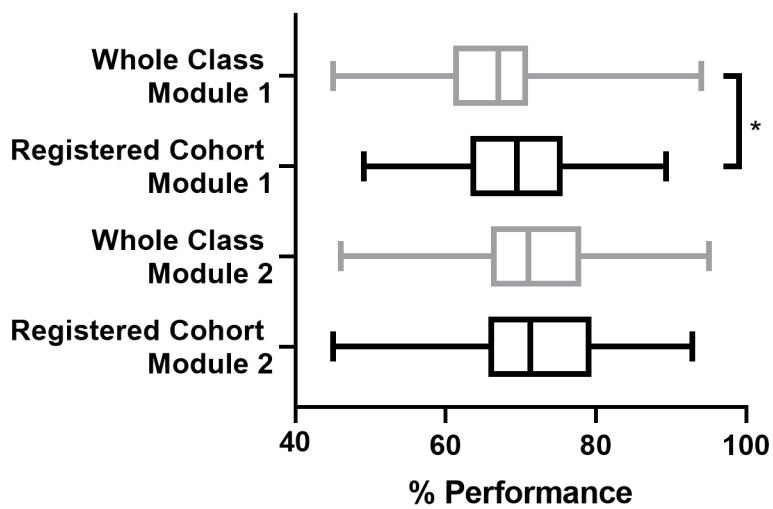
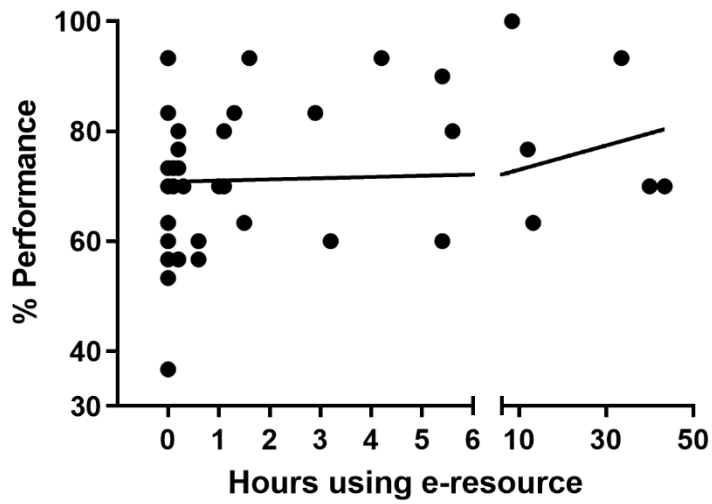
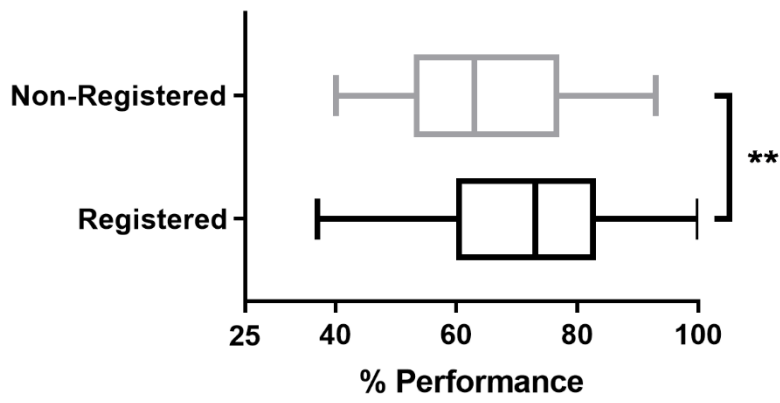


TABLE 1 Responses to survey questions regarding uptake and use of the e-resource.

Survey Questions and Answers [Number declining to answer]	Response %
Q1. Did you subscribe to the online access for the recommended textbook? [0]	
Yes	37.5
No	62.5
Q2. If you did not subscribe to the online resource, what were the reasons? [5]	
Too expensive.	31.6
Don't like reading online.	63.2
Did think it was necessary for my learning.	10.5
Only needed the lecture notes.	26.3
There was no direct continuous assessment assigned to the exercises.	5.3
I found the online learning from 1st year not useful.	47.4
Other	47.4
Q3. Whether you subscribe to the online resource, or not, what features would you like to be improved? [0]	
A lower price.	62.5
A clearer integration of the online resource with the presented lectures.	37.5
There was an assessable component in the online resource.	16.7
It could be used in small tutorial style sessions.	41.7
Other	25
Q4. Would you participate in small group exercises with an online resource as an interface? If it was led by a demonstrator, what exercises would be useful? [0]	
Problem solving, using "real life" data, or case studies.	58.3
Question and answer session, covering the last weeks lecture content.	75
Learning how to analyse data.	58.3
Covering broad concepts within the topics.	58.3
Other	0
Q5. If you did subscribe, which online features did you find useful? [0]	
The e-book for online browsing of the text book.	4.6
That lecturers could assign specific reading that helped me to focus?	18.2
Graphics and videos (animations).	31.8
Case studies that can put what you learn into a broader more relevant context.	4.6
Practice multiple choice questions.	31.8
Other	45.5
Q6. If you did subscribe to the online resource, how often did you use it? [3]	
Based on my own direction and learning objectives.	19.1
When direct reading was assigned.	4.8
Before class test preparation.	4.8
About once a week.	0
2-3 times a week.	0
Every few weeks.	4.8
Only a few times in total, I didn't like it.	33.3
Other	57.1

REFERENCES

1. Chiu TKF. Introducing electronic textbooks as daily-use technology in schools: A top-down adoption process. *Brit J Educ Technol* 2016;**48**(2):524-537.
2. Olsen AN, Kleivset B, Langseth H. E-Book Readers in Higher Education. *SAGE Open* 2013;**3**(2):215824401348649.
3. Hao Y, Jackson K. Student satisfaction toward e-textbooks in higher education. *Journal of Science and Technology Policy Management* 2014;**5**(3):231-246.
4. Gerhart N, Peak D, Prybutok VR. Encouraging E-Textbook Adoption: Merging Two Models. *Decis Sci-J Innov Ed* 2017;**15**(2):191-218.
5. deNoyelles A, Raible J. Exploring the Use of E-Textbooks in Higher Education: A Multiyear Study. *EDUCAUSE Review* 2017;**10** Retrieved from <https://er.educause.edu/articles/2017/10/exploring-the-use-of-e-textbooks-in-higher-education-a-multiyear-study>.
6. Nie M, Armellini A, Witthaus G, Barklamb K. How do e-book readers enhance learning opportunities for distance work-based learners? *Research in Learning Technology* 2011;**19**(1):19-38.
7. Buckley S, Coleman J, Davison I, Khan KS, Zamora J, Malick S, Morley D, Pollard D, Ashcroft T, Popovic C and others. The educational effects of portfolios on undergraduate student learning: a Best Evidence Medical Education (BEME) systematic review. BEME Guide No. 11. *Medical teacher* 2009;**31**(4):282-98.
8. Nonis SA, Hudson GI. Performance of College Students: Impact of Study Time and Study Habits. *Journal of Education for Business* 2010;**85**(4):229-238.
9. Alzahrani SS, Soo Park Y, Tekian A. Study habits and academic achievement among medical students: A comparison between male and female subjects. *Medical teacher* 2018;**40**(sup1):S1-S9.

10. Azab E, Saksena Y, Alghanem T, Midle JB, Molgaard K, Albright S, Karimbux N. Relationship Among Dental Students' Class Lecture Attendance, Use of Online Resources, and Performance. *Journal of Dental Education* 2016;**80**(4):452-8.
11. Guy R, Byrne B, Dobos M. Optional anatomy and physiology e-learning resources: student access, learning approaches, and academic outcomes. *Advances in Physiology Education* 2018;**42**(1):43-49.
12. Pashler H, McDaniel M, Rohrer D, Bjork R. Learning Styles: Concepts and Evidence. *Psychological Science in the Public Interest* 2008;**9**(3):105-119.
13. Massa LJ, Mayer RE. Testing the ATI hypothesis: Should multimedia instruction accommodate verbalizer-visualizer cognitive style? *Learning and Individual Differences* 2006;**16**(4):321-335.
14. Hew A, Perrons RK, Washington S, Page L, Zheng Z. Using digital technologies to deliver scenarios to geographically dispersed stakeholders: Lessons learned from the transportation sector. *Futures* 2020;**120**:102567.
15. Birch E, Williams A. The Impact of Supplementary On-Line Resources on Academic Performance: A Study of First-Year University Students Studying Economics. *International Education Studies* 2013;**6**(1):95-103.
16. Crampton A, Ragusa AT, Cavanagh H. Cross-Discipline Investigation of the Relationship between Academic Performance and Online Resource Access by Distance Education Students. *Research in Learning Technology* 2012;**20**(1).
17. Davies J, Graff M. Performance in E-Learning: Online Participation and Student Grades. *Brit J Educ Technol* 2005;**36**(4):657-663.
18. Perera L, Richardson P. Students' Use of Online Academic Resources within a Course Web Site and Its Relationship with Their Course Performance: An Exploratory Study. *Accounting Education* 2010;**19**(6):587-600.

19. Grabe M, Christopherson K. Optional Student Use of Online Lecture Resources: Resource Preferences, Performance and Lecture Attendance. *Journal of Computer Assisted Learning* 2008;**24**(1):1-10.
20. Ruipérez-Valiente JA, Muñoz-Merino PJ, Kloos CD, Niemann K, Scheffel M, Wolpers M. Analyzing the Impact of Using Optional Activities in Self-Regulated Learning. *IEEE Transactions on Learning Technologies* 2016;**9**(3):231-243.