Effect Of Self-Paced Online Modules As Support For Classroom Instruction On Student Outcomes Of Grade 10 Miriam College High School Students

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The Asian Conference on Education 2017
Official Conference Proceedings

Abstract
The affordances of technology provide teachers innovative teaching methods (Wong, 2015; Parnell and Bartlett, 2012). In Miriam College High School (MCHS), an exclusive all-girls school in the Philippines, the academic programs (Science curricula), people (students, teachers), processes (procurement) and physical plant (Wi-Fi connectivity) have been shaped by e-learning. The 1:1 ratio of student-to-tablet PC and focused faculty training are aimed at optimizing lesson delivery modes by enabling teachers to provide students with self-paced, online, multimedia learning materials coupled with traditional classroom instruction. Through this, students acquire knowledge using various forms of media while learning essential 21st century skills. Six sections of Grade 10 MCHS students taking up Science were examined to compare student outcomes based on lesson delivery modes. Three sections served as the traditional F2F classes, while the remaining three sections as the BL classes. The BL classes were instructed to access self-paced online modules prior to the actual discussion of the topics. At the end, every student accomplished three metacognitive questions. Mann-Whitney U-Test was performed on the scores earned by each student in the two groups (quick checks, quizzes and forms). Results showed statistically significant differences in the performance of the two classes in their total quick check scores, which implies that the online modules were able to aid student retention of Science content knowledge for immediate assessments. However, the test statistics revealed insufficient evidence to provide a statistically reliable difference on total quiz and form scores.

Keywords: Face-to-Face (F2F), Blended Learning (BL), Student Outcomes, Self-paced Online Modules

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Introduction

Student engagement has long been pointed out as the main culprit for the trend of decreasing student satisfaction of those in the secondary and higher education context. Having academically purposeful activities that entice student learning and personal development is one important factor that leads to an increased level of engagement with whatever it is that they are studying (Kuh, 2001). According to Gunuc (2014), student engagement and academic performance have a significant relationship, such that the higher the degree of student engagement leads to an increase in academic performance. Thus, interventions and innovations aimed at improving the level of student engagement are prolific topics for research, which leads to creating engaging learning environments for students.

Designing learning environments aimed at increasing student engagement entails the use of instructional design principles. Combining classroom face-to-face interaction and online learning environments creates a new terrain called a Blended learning environment. The findings of Boyle, et. al. (2003) suggest that by incorporating novel and meaningful elements in both classroom instruction and the online environment show marked improvements in students' passing rates. However, the team emphasized that in order for this method to work, factors like proper module organization, ample tutorial support and availability of adequate online resources should be in place. Dowling, et. al. (2003) investigated on the association of learning outcomes of students given different teaching modules: traditional face-to-face and blended delivery. The results indicated that the blended delivery method is more positively linked to students' final marks and improved learning outcomes.

With recent advancements in the use of technology in education, schools all around the world are transitioning from the fully traditional face-to-face classroom instruction to a blended, or some even fully online, learning approach. In the Philippines, Miriam College High School (MCHS) is one of the secondary schools which has adopted a blended learning approach with the use of mobile devices such as tablet-PC's and iPads, both in the classroom and when the students are outside school. Learning opportunities for synchronous and asynchronous collaboration, as well as self-paced learning, are provided in both classroom and online environments.

Statement of the Problem and Objectives of the Study

The study seeks to determine if there is a relationship between the lesson delivery modes and student outcomes of Grade 10 MCHS students in their Science classes. Specifically, it aims to answer the question:

- Is there is a significant difference in the student outcomes (Total Quiz, Total Quick Check and Total Form scores) of MCHS Grade 10 Students who were exposed to face-to-face learning approach and those who were exposed to blended learning approach (face-to-face classroom instruction with online teaching modules) in their Science classes?

Significance of the Study

Every generation of learners has different learning behaviors. Their learning is deeply affected with the context of education that they are immersed in. Today, one of the major advancements in technology is the internet. This paved way to the online-based techniques in education which, at a certain degree, have replaced traditional teaching and learning (Yiğit & Özden, 1999). Convenience in learning is a major factor among this generation of learners. Because of the development of the internet, students can easily access information whenever and wherever they want to, without being dependent on time and place. This has made the internet an indispensable part of the education in this era.

Moreover, this new education model can enrich the students' learning habits and experiences because many education techniques like presenting, brainstorming, collaborating, and the like, can be conducted online (Sahan, 2016). In this way, it becomes possible for the learners to gain essential learning experiences such as reading, writing, observing, listening, and performing tasks according to Şimşek (2002) as stated by (Kazu and Demikrol, 2014). Yet, online learning can pose a big disadvantage for it limits the students with social and face-to-face interaction opportunities with other learners and with their teacher. This might be one of the disadvantages of online-based learning. However, Laurillard (2002) stated that technological tools should be used to a certain extent in order for learning and teaching to be more effective. Thus, blended learning has emerged. This type of teaching and learning approach is a combination of the strongest aspects of both traditional or face-to-face classroom instruction and online-based instruction (Morgan, 2002).

Many researches had been in support of the blended instruction method because of the following advantages: improvement in pedagogy, increased access to knowledge with increased teacher presence during teaching, improved cost effectiveness and enhanced ease of revision, among others (Osguthorpe & Graham, 2003). Consequently, learners are given more control over their learning pace, selection of resources and time management, thus, improving student's self-regulation (Chung & Davis, 1995). The researches done in the past are more focused on the undergraduate and graduate levels and little had been done to examine the effects of blended learning to students in the basic education level, particularly in the high school level.

Miriam College High School is one of the pioneers of e-learning in the Philippines because of its "E-Learning Tool Project" which was launched in 2012. The project is made to make learning more relevant to the 21st century learners; with increased mobility through the use of tablet-PC and iPad and increased access because of the blended learning method in teaching and learning. According to Chambers (2014), these devices were initially used by some schools as a textbook replacement, only to find out later that these can create a major impact which supplements face-to-face on the students' performance. Hence, the study wants to determine if blended learning with the use of self-paced online modules as supplementary materials for instruction

will have a significant effect on the students' performance in various types of assessment method such as quick check/seatwork, quiz and form/long test.

Scope and Limitations

The study only covered students from selected sections of Grade 10 MCHS population. The students' outcomes will be based on formative and summative types of assessment such as quick check, quiz, and form/long test based from a series of lessons specified in the course outline of Science 10 for the school year 2016-2017.

The researchers implemented the study to their own classes. Thus, teaching style is varied although similar resources such as PowerPoint presentation copies, etc. were available to the students during the face-to-face instruction. It was also accessible to the internet after the instruction.

The same formative and summative assessment materials were given to the students even when the students vary in terms of their learning styles. The study was only be limited to selected topics in Biology to be discussed during the second term.
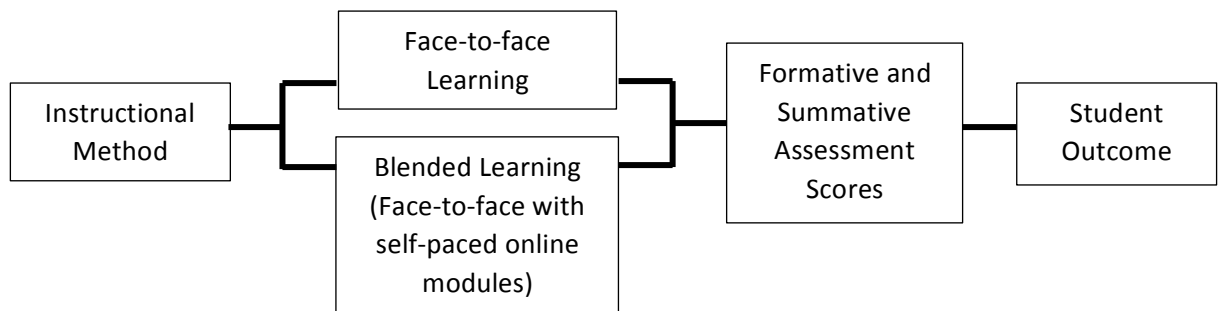
Conceptual Framework

Figure 1. Conceptual Framework of the study

This study wants to determine whether supplementing face-to-face classroom instruction with self-paced online modules will have a significant effect on students' outcomes. To achieve this, the study will use two delivery methods for science lessons: traditional face-to-face classroom instruction (F2F) and blended learning (BL) which is a combination of face-to-face classroom instruction with online teaching modules. After the lesson delivery modes have been rolled out, formative and summative assessments will be in place and students' outcomes from the two groups will be compared to determine if the disparity of scores are statistically significant.

Hypotheses and Definition of Terms

The following are the hypotheses of the study:

H_O: There is no significant difference in the student outcomes (Total Quiz. Total Quick Check and Total Form scores) of MCHS Grade 10 Students who were exposed to face-to-face learning approach and those who were exposed to blended learning approach (face-to-face classroom instruction with online teaching modules) in their Science classes.

H_A: There is a significant difference in the Total Quiz, Quick Check and Form scores of MCHS Grade 10 Students who were exposed to face-to-face learning approach and those who were exposed to blended learning approach (face-to-face classroom instruction with online teaching modules) in their Science classes.

Definition of Terms

- Face-to-face Learning (F2F) – also known as the traditional classroom where "the instructor and the learners are in the same geographical location at the same time" (Redmond, 2011)
- Blended Learning (BL) – these are structured opportunities to learn, which use more than one earning or training method, inside or outside the classroom (Pankin, Roberts, & Savio, 2012)
- Online Module – also known as e-learning module which is "made up of chunks of information used to educate or inform; it may include texts, images, videos, quiz's, questionnaires, PDFs, and any other resources that can be delivered from a wide variety of platforms and learning and content management systems" (Learning pool, n.d.)
- Students' Outcomes – formative and summative assessment scores from quick checks/seatwork, quizzes, forms/long tests
- Quick check – a type of formative assessment consists of 5 to 10 items administered immediately after a lesson to check for immediate recall of concepts discussed.
- Quiz – a type of formative assessment consists of 25 to 30 items involving few topics which aims "to monitor student learning to provide ongoing feedback that can be used by instructors to improve their teaching and by students to improve their learning" (Carnegie Mellon University, 2015).
- Form - a type of summative assessment consists of 45 to 50 items involving several lessons which aims "to evaluate student learning at the end of an instructional unit by comparing it against some standard or benchmark" (Carnegie Mellon University, 2015)

Research Design

The Posttest-Only Design with Nonequivalent Groups was used in the study. The researchers administered several formative assessments, of varied weights, and two summative assessments to determine student outcomes by the end of the unit covered in Grade 10 mainstream Science class.

Six out of 13 sections from Grade 10 were selected to participate in the study. The sections were divided into two groups: three sections served as the control group, otherwise known as the group exposed to face-to-face learning approach only and the other three sections were assigned to be the experimental group which was exposed to blended learning approach (face-to-face classroom instruction with self-paced online modules).

This design is appropriate since students were already blocked into sections for the school year. One teacher handled the F2F classes while another one for the BL classes. Although different in terms of the teacher involved in the two set-ups, teaching materials are products of collaborative work between the teachers involved and thus, the learning experience of the students are essentially the same. Moreover, the students were not notified ahead that they underwent an experiment to avoid distractions in the academic setting.

Since the study seeks to find if the two groups created have significantly different outputs/scores, it made use of an analysis of differences. Shapiro-Wilk Test was performed to determine if the scores of the two groups have normal distribution. This will then decide whether the researchers will use a parametric (t-Test for Independent Samples) or a non-parametric (Mann-Whitney U-Test) test on the data obtained from the two groups.
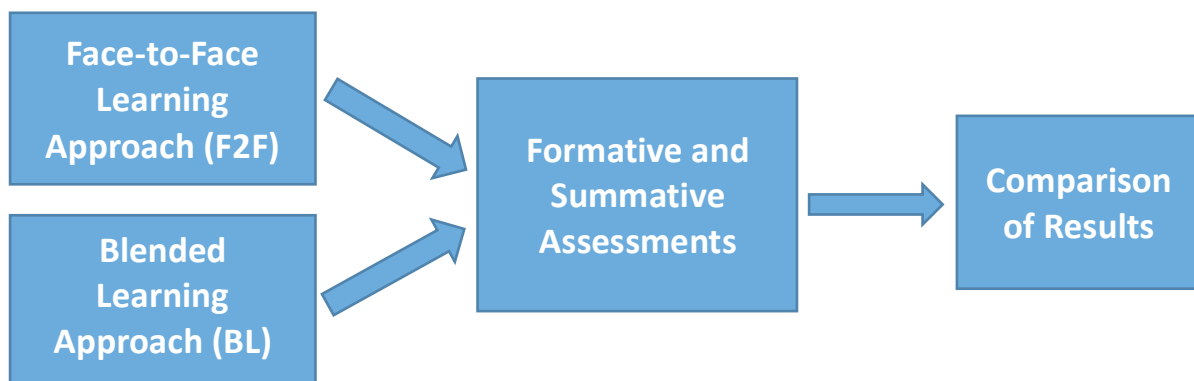

Figure 2. Diagram of the research design

Participants

The primary participants are six Grade 10 Science classes ranging from 32-39 students per class. These 6 sections summing up to 217 students came from a batch of 13 sections with 465 students who are taking up mainstream Science classes. The

school follows a heterogeneous sectioning scheme with efficient profiling from the school's Guidance Counseling and Research Team, assuring that the composition of each class are of similar aptitudes.

The sample size is statistically viable as it agrees with computations using Slovin's equation. The sample population was selected via convenience sampling as these are the very sections under the supervision of the proponents of the study. Participants are all females studying at Miriam College High School with ages ranging from 14 to 17 years old and are all taking up Grade 10 Science.

Instrument

To obtain rich and comprehensive data, the following instrument was used in the study:

Self-paced Online Modules

The researchers designed a website for the self-paced online modules covering selected topics in Science under the Second Term of school year 2016-2017. Module 1 covered Topics 1 and 2 which includes the lesson on Biomolecules (Carbohydrates, Fats/Lipids, Proteins, Nucleic acids) while Module 2 covered Topics 3 and 4 which includes the lesson on Heredity: Inheritance and Variation (DNA Replication, Transcription, Translation and Mutation).

Different Forms of Assessment

The researchers administered different forms of assessment in the form of formative – quick checks/seatwork and quizzes – and summative assessment. This ran for six weeks during the duration of the lesson content covered in the first and second summative assessments for the term.

Procedure and Treatment of Data

Experimentation

All six sections took the same lessons in Science under their assigned teachers, the only difference lies on the lesson delivery modes; three of the six sections had face-to-face classroom instruction as the sole lesson delivery mode, while the other three had a mixed delivery mode, combining face-to-face classroom instruction and the utilization of online lesson modules.

Students were required to access the self-paced online modules as part of a reading assignment prior to actual classroom discussion. After reading the assigned lesson, students are expected to answer metacognitive questions and turn in an output.

All groups took the same formative and summative assessments as topics covered in the entire unit of lessons were taught. The experiment was expected to create two

groups: the face-to-face (F2F) learning group (control group) and the blended learning (BL) group (experimental group).

Post Experiment

Data were placed in SPSS and MS Excel for statistical analyses. Data was subjected to Test for Normality to determine if there is a normal distribution of scores; this will determine whether to use a parametric or a nonparametric statistical test.

To test the null hypotheses, the mean scores of each student per type of assessment used in both the control and experimental groups were tested for significant difference with the lesson delivery mode using t-Test or U-Test for independent samples. At the end of the research, the students are to be notified that they had been subjected to a lesson delivery mode experiment and that the results would be presented to them.

Conclusions

Results and Discusion

Table 1 shows the distribution of students per lesson delivery mode. Out of the total population of 217 participants in the study, 108 of them (49.77%) were subjected to a blended learning (BL) approach in lesson delivery mode while the remaining 109 students (50.23%) were given the face-to-face lesson delivery mode (F2F).

Table 1. Distribution of Students per Lesson Delivery Mode

Groups	Number of Participants
Face-to-face (F2F)	109
Blended learning (BL)	108

To determine whether to use a parametric or a non-parametric test, a test for normality was ran on the test scores obtained from the study.

Table 2. Shapiro-Wilk Test for Normality

Groups	Statistic	df	Sig.
Total Quiz	.947	217	.000
Total Quick Check	.958	217	.000
Total Form	.953	217	.000

Table 2 shows the scores obtained per assessment type were not normally distributed since all the p-values are less than .05. Hence, a non-parametric statistical test, particularly Mann-Whitney U-Test was used to further analyze the data.

*Table 3. Descriptive Statistics of the
students' total quiz scores for all topics
covered*

Groups	F2F	BL
Mean	103.57	102.84
Standard Error	1.68	1.38
Median	108	105.75
Mode	121	106
Standard Deviation	17.52	14.33
Sample Variance	306.78	205.39
Range	88	61
Minimum	40	68
Maximum	128	129

F2F group's Total Quiz Scores shown in Table 3 ranged from 40 to 128 (*M = 103.57, SD = 17.52*), skewness of -0.94 and kurtosis of 0.54 (*SE = 1.68*) while the BL group scores ranged from 68 to 129 (*M = 102.84, SD = 14.33*), where W (217) = .947 which indicated a distribution that is not normal.

*Table 4. Descriptive Statistics of the
students' total quick check/seatwork scores
for all topics covered*

Groups	F2F	BL
Mean	39.48	42.19
Standard Error	0.87	0.71
Median	40.40	44
Mode	48	44
Standard Deviation	9.01	7.42
Sample Variance	81.12	54.94
Range	38	31
Minimum	16	23
Maximum	54	54

F2F group's Total Quick Check Scores shown in Table 4 ranged from 16 to 54 (*M = 39.48, SD = 9.01*), skewness of -0.59 and kurtosis of -0.14 (*SE = 0.87*) while the BL group scores ranged from 23 to 54 (*M = 42.19, SD = 7.42*), where W (217) = .958 which indicated a distribution that is not normal.

*Table 5. Descriptive Statistics of the
students' total form scores for all topics
covered*

Groups	F2F	BL
Mean	74.28	74.01
Standard Error	0.99	0.91
Median	77	75
Mode	82	81
Standard Deviation	10.37	9.45
Sample Variance	107.59	89.28
Range	43	41
Minimum	47	48
Maximum	90	89

Lastly, Total form scores, as shown in Table 5 for the F2F group ranged from 47 to 90 (*M = 74.28, SD = 10.37*), skewness of -.73 and kurtosis of -0.13 (*SE = 0.99*), while the BL group scores ranged from 48 to 89 (*M = 74.01, SD = 9.45*), where W (217) = .953, which indicated a distribution that is also not normal.

All the scores indicated above for each assessment type, were not normally-distributed. As such, a nonparametric Mann-Whitney U-Test was used to further analyze the data.

*Table 6. Mann-Whitney U-Test for Independent Samples Results for total scores in
assessments under Modules 1 and 2*

	Group	N	Mean	SD	U	p
Total Quiz	F2F	109	103.58	17.52	5428.00	0.322
	BL	108	102.84	14.33		
Total Quick Check	F2F	109	39.34	9.08	4873.00	0.028
	BL	108	42.19	7.41		
Total Form	F2F	109	74.28	10.37	5663.00	0.629
	BL	108	74.01	9.45		

Table 6 shows computed p-values of total scores in quizzes and forms are greater than the alpha level (.05). This revealed an insufficient evidence to show a statistically significant difference in the scores of students subjected to face-to-face learning and blended learning approach.

Meanwhile, total scores of quick check/seatwork had a computed p-value less than the alpha level (p = .028 < .05), showing a sufficient evidence that there is a statistically significant difference in the scores of students who were subjected to face-to-face learning and those who were given a blended learning approach.

The total quick check scores, with $p = .028$, is indicative that the self-paced online modules were helpful to the students who were exposed to it, since students under this group had higher mean scores ($M = 42.19$) than that of the face-to-face group ($M = 39.34$) as shown in Table 6. Since the BL group was able to access the self-paced online modules prior to the actual classroom discussion, students were more familiar with the terms and concepts thus helping them perform better in quick checks/seatwork.

All other forms of assessment used in the study, aside from the one aforementioned, had p-values greater than the alpha (.05), and thus suggest no significant difference in the scores obtained by the two groups (see Appendix L).

The findings agree with a similar study done by McLaughlin, et. al. (2015) entitled "*The Impact of Blended Learning on Student Performance in a Cardiovascular Pharmacotherapy Course*" which made use of two groups – face-to-face and blended learning group – and testing for difference in student performance. They found out that students who accessed all online modules performed better in the examinations provided than those who did not. It was also noted that the students who accessed the modules had strongly agreed that foundational content learned prior to class greatly enhanced their learning.

It also coincides with the study of Kazu and Demirkol (2014), where they observed that there was no significant difference in the individual pre-test and final test scores of two groups of high school students (blended learning group and traditional learning group). However, the average of the final test scores were significantly different between the two groups, where the blended learning group outperforming the traditional learning group. The same trend is seen in the study where individual quick check scores showed no significant difference between the two groups but average of the total quick check scores had significant difference, with the blended learning group outscoring the face-to-face group.

These suggest that the self-paced online modules had positive effects on the quick check/seatwork scores of those exposed to it (blended learning group), since the Mann-Whitney U-Test revealed a statistically reliable difference on the total quick check scores of the blended learning group ($M = 42.21$) and the face-to-face group ($M = 39.34$). This can lead us into stating that the students in the blended learning group were more familiar with the terms and concepts, since they were able to access the self-paced online modules prior to the actual classroom discussion, which then helped them perform better in their quick checks/seatwork.

Implication And Recommendations

In summary, based on the data gathered and the results of the statistical tests, there is a significant difference in the Total Quick Check scores of students who were exposed to face-to-face learning and blended learning approach. This agrees with analogous studies that had already been conducted by Kazu and Demirkol (2014) and McLaughlin, et. al., (2015). Thus, the following null hypotheses (H_{o2}) was rejected.

However, there was insufficient statistical evidence to reject the other null hypotheses (H_{o1} and H_{o3}) which suggest that there was no significant difference in the scores obtained by the two groups.

Because of the variability of the results, it can be suggested that blended learning approach greatly affects total quick check performance of the students. This explains that students in a blended learning environment would achieve a higher accumulated quick check scores than those who only received the face-to-face classroom instruction, since it aids in immediate recall of concepts. This can further imply that blended learning can be an effective approach in the long run, especially when students would diligently read and understand the self-paced online modules before the face-to-face classroom session with their teacher.

On the other hand, there is insufficient evidence to prove that there is a significant difference in the Total Quiz and Form scores of the students. This might be accounted to the breadth of the scope of topics covered in these forms of assessment. Even if the online module provided the students with information and practice through online simulations, diligence on the part of the students to study several topics for a quiz or a form greatly affects their performance.

For similar studies in the future, the researchers would recommend conducting a Focus Group Discussion (FGD) to consult the students, and the faculty alike, of their perceptions regarding the use of blended learning approach in the classroom vis-à-vis their performance on different assessments given to them.

Moreover, further similar studies can also include a survey on the evaluation of the blended learning approach at the end of the study. This would aid in identifying the strengths and weaknesses of the approach to the students' performance. They can also look into possible correlations between student engagement and student outcomes in classes where a blended learning approach is employed.

Another recommendation for future studies would be a longer period of observation time and more modules and topic coverage, since the students in blended learning group only accessed two modules considering a handful of topics. One factor that might have affected the similarity of scores is the preference and intrinsic motivation of the students to use the online module. The proponents prevented this by making sure that the students in the blended learning group accessed the self-paced online modules by asking them to create outputs than involved metacognitive questions.

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Redmond, P. (2011). From face-to-face teaching to online teaching: Pedagogical transitions. In*From face-to-face teaching to online teachi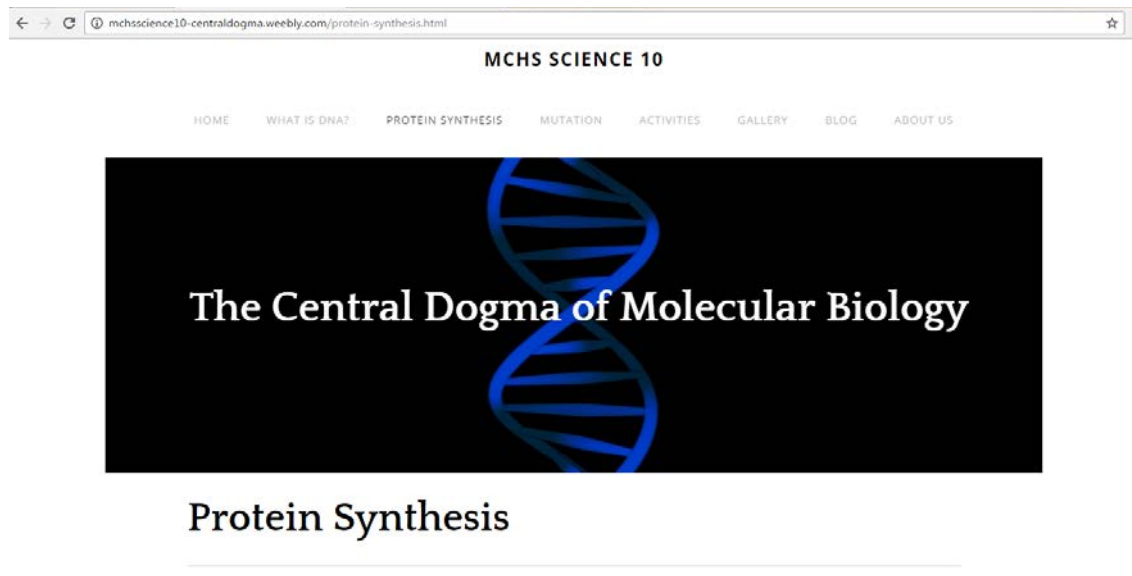ng: pedagogical transitions* (pp. 1050-1060). Retrieved from http://www.ascilite.org/conferences/hobart11/downloads/papers/Redmond-full.pdf

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Appendices

Appendix A. Screen shot of Module 1 on Biomolecules found in the link http://mchsscience10-biomolecules.weebly.com/

Appendix B. Screen shot of Module 2 on Biomolecules found in the link http://mchsscience10-centraldogma.weebly.com

Appendix C. Screen shot of the instructions sent to the Edmodo page of classes under the BL group.

Appendix D. Screen shot of the instructions for the Reading Assignment with metacognitive questions posted to the Edmodo page of classes under the BL group.

Me to ■ Florentino Science 10 SY16-17,
■ Mnemosyne Science 10 SY16-17, ■ Veneracion Science 10 SY16-17

Hi Girls!

please take time to read the contents of this webpage:

http://mchsscience10-centraldogma.weebly.com/mutation.html

and go over the entire module on gene mutation

In line with this reading assignment, I'd like you to create your "padlet" entries in response to this guide question:

1. What new information did you discover about gene mutation?
2. PAP of an image that best describes/represents what gene mutation is for you

Here is the link/code to your PADLET BOARDS:
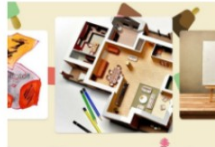
Mnemosyne: padlet.com/kenanquitco/ud8jqu8h2y3l
Florentino: padlet.com/kenanquitco/swm6p8rtdf3f
Veneracion: padlet.com/kenanquitco/bxngpiwinq1s

NOTE: Please make sure that you write your names at the end of your entries

Cheers!
-Sir Jai Less...

NOTE: Please make sure that you write your names at the end of your entries

Cheers!
-Sir Jai Less...

padlet.com

Like (6) • Reply • Share • Follow   Nov 12, 2016

Type a reply...

Appendix E. Screen shot of the instructions for the Padlet online activity posted to the Edmodo page of classes under the BL group.

Unlike genetic mutation, chromosomal mutation is the abnormality in a chromosome's structure. In addition to this, it occur during cell division wherein linked genes either get lost, joins another chromosome, or even break apart.

The picture below shows a child born with Jacobsen syndrome. It was caused by the genetic material from chromosome 11 is missing. People who are affected by this have difficulties in the development of motor skills, speech, and learning, and have very distinct facial features.

10 MARA DIANZON

Gene mutation and chromosomal mutation are both classified as types of genetic mutation. However, in order to differentiate these two, gene mutation basically happens when there comes a permanent change in the DNA sequence, while chromosomal mutation occurs when there is a change affecting the structure of the chromosome, may it be part or whole.

A widely known human disorder brought about by chromosomal mutation is down syndrome, wherein it affects the person physically and mentally. Down syndrome is the outcome when one has a problem involving their chromosome 21, in terms that one may have an additional copy of genetic material in it. People with down syndrome may show a small mouth giving the appearance of a large tongue, upward slanting eyes, as well as a single deep crease across the center of their palm.

22 ALLYSON MEILY

The difference between a gene mutation and a chromosomal mutation is a gene mutation changes a small scale alteration in a gene and a chromosomal mutation changes a large scale alteration in a gene.

An example of a human disorder is Wolf-Hirschhorn syndrome. It is a syndrome caused by the deletion of the distal short arm of chromosome 4. The disorder's major features include a characteristic facial appearance, delayed growth and development, intellectual disability, and seizures.

25 PERALTA, LEXINNE

Appendix F. Screen shot of output in the Padlet online activity submitted by the some students from the classes under the BL group.

Quick Check:

1. This is known to be the building blocks of carbohydrates.
2. This type (group) of sugar is composed of 6 carbon atoms.
3. This is a monomer of carbohydrate which is found in milk.
4. What is the other name for glucose which is also known as the blood sugar?
5. This disaccharide is formed in a combination of glucose and fructose molecules.

Appendix G. Screen shot of Quick check questions for Topic 1 Biomolecules.

QUICK CHECK 4 (SIZE 4)

1. The scientist who took an x-ray photo of a DNA.
2. This group of nitrogenous bases have double rings.
3. DNA is coiled tightly to form chromosomes and are wrapped around _____.
4. Watson and Crick described the DNA as _____.
5. It is a characteristic of DNA in which one strand runs from 5' end to 3' end and the other strand runs from 3' end to 5' end.

Appendix H. Screen shot of Quick check questions for Topic 2 DNA Structure and Replication.

NAMES	1-without; 2-with	T1_QUIZ	T1_QC	T2_QUIZ	T2_QC	Form 1	T3_QUIZ	T3_QC	T4_QUIZ	T4_QC	Form 2	TOTAL QUIZ	TOTAL QC	TOTAL FORM
		30	30	35	10	50	35	10	30	5	45	130	55	95
	1	23.0	21	25.0	8	38.0	31.0	7	27.0	3.0	36.0	106	39	74
	1	24.0	18	26.0	10	42.0	32.0	7	19.0	5.0	40.0	101	40	82
	1	24.5	26	30.0	10	42.0	34.0	10	30.0	4.0	43.0	118.5	50	85
	1	29.0	23	32.0	10	45.0	35.0	10	29.0	5.0	41.0	125	48	86
	1	16.0	10	21.0	3	35.0	24.0	2	20.0	2.2	26.0	81	17.5	61
	1	30.0	11	35.0	6	28.0	31.0	7	27.0	5.0	39.0	124	29.4	67
	1	22.0	21	31.0	9	40.0	34.0	8	29.0	5.0	38.0	116	43	78
	1	25.0	21	29.0	10	39.0	35.0	10	28.0	5.0	35.0	117	46.9	74
	1	13.0	8	23.0	6	20.0	17.0	3	21.0	4.0	31.0	74	21.3	51
	1	20.0	12	21.0	9	35.0	29.0	8	28.0	5.0	39.0	98	33.7	74
	1	15.0	15	28.0	9	40.0	27.0	7	25.0	4.0	37.0	95	34.5	77
	1	26.0	20	29.0	10	41.0	25.0	6	28.0	3.0	38.0	108	39	79
	1	25.0	25	32.0	10	38.0	32.0	10	17.5	5.0	39.0	106.5	50	77
	1	21.0	19	27.0	8	43.0	32.0	8	28.0	5.0	35.0	108	40	78
	1	27.0	23	33.0	10	45.0	32.0	10	30.0	5.0	42.0	122	48	87
	1	13.0	18	29.0	6	43.0	25.0	6	27.0	3.0	37.0	94	33	80
	1	15.0	15	25.0	7	36.0	29.0	4	20.0	1.0	32.0	89	26.7	68
	1	15.0	12	15.0	3	28.0	20.5	1	18.0	3.0	33.0	68.5	19	61
	1	27.0	22	33.0	10	43.0	31.0	8	30.0	5.0	40.0	121	45	83
	1	27.0	18	31.0	9	40.0	33.0	9	30.0	5.0	42.0	121	41	82
	1	29.0	18	28.0	7	43.0	31.0	6	30.0	5.0	40.0	118	36.33	83
	1	14.0	14	29.0	8	30.0	31.5	8	29.0	4.0	41.0	103.5	34	71
	1	28.0	18	29.0	10	44.0	31.0	9	30.0	4.0	39.0	118	41	83
	1	24.5	24	31.0	9	46.0	29.0	8	30.0	4.0	39.0	114.5	45	85
	1	14.0	14	25.0	10	38.0	27.5	7	27.0	5.0	39.0	93.5	36	77
	1	25.0	20	30.0	10	42.0	32.0	8	28.0	5.0	41.0	115	43	83
	1	14.0	25	27.0	8	36.0	25.0	9	18.0	5.3	34.0	84	47.6	70
	1	12.0	11	30.0	9	39.0	24.0	10	25.0	5.0	34.0	91	33.5	73
	1	24.0	23	33.0	9	46.0	34.0	8	30.0	5.0	41.0	121	45	87
	1	22.0	21	31.5	10	40.0	32.0	9	29.0	5.0	42.0	114.5	45	82
	1	28.0	19	30.0	9	40.0	32.0	10	27.0	5.0	40.0	117	43	80
	1	18.0	18	23.0	10	31.0	32.0	10	23.0	4.0	33.0	96	42	64
	1	27.0	27	32.0	10	44.0	33.0	10	30.0	4.0	43.0	122	51	87
	1	14.0	10	18.0	5	33.0	16.0	3	23.0	1.0	30.0	71	19	63
	1	25.0	28	31.0	9	43.0	29.0	8	29.0	4.0	41.0	114	49	84
	1	20.0	20	29.0	4	35.0	27.5	8	26.0	4.0	35.0	102.5	36.5	70
	1	22.0	20	30.0	9	39.0	32.0	7	29.0	4.0	27.0	113	40	66
	1	25.0	28	32.0	8	40.0	34.0	10	30.0	5.0	42.0	121	51	82
	1	24.0	26	31.0	7	44.0	30.0	8	28.0	3.0	39.0	113	43.7	83
	1	11.0	18	25.5	5	29.0	26.0	7	28.0	4.0	36.0	90.5	33.5	65
	1	19.0	15	27.0	7	33.0	25.0	6	17.0	4.0	29.0	88	32.3	62
	1	22.0	21	29.5	7	36.0	28.0	4	28.0	5.0	32.0	107.5	37	68
	1	23.0	22	31.0	9	45.0	29.0	6	30.0	5.0	35.0	113	42	80
	1	27.0	27	31.0	10	46.0	34.0	10	30.0	5.0	42.0	122	52	88
	1	22.0	26	25.0	8	39.0	31.5	9	20.0	4.0	34.0	98.5	47	73
	1	20.0	18	27.0	4	35.0	31.0	8	23.0	3.0	32.0	101	32.5	67
	1	25.0	28	29.0	7	41.0	34.0	9	28.0	4.0	37.0	116	48	78
	1	28.0	28	27.5	8	43.0	27.0	8	29.0	5.0	36.0	111.5	49	79
	1	25.0	26	33.0	10	48.0	34.0	10	24.0	5.0	40.0	116	51	88
	1	28.0	18	28.0	9	38.0	27.0	8	28.0	3.0	36.0	111	38	74
	1	18.0	21	19.0	7	31.0	14.0	8	17.0	4.0	29.0	68	40	60
	1	23.0	25	28.0	10	43.0	27.0	8	30.0	5.0	37.0	108	47.5	80
	1	19.0	21	19.0	9	38.0	31.5	5	28.0	4.0	36.0	97.5	38.5	74
	1	11.0	22	25.0	9	22.0	29.0	7	11.0	3.0	31.0	76	40.5	53
	1	25.0	20	22.0	8	39.0	31.0	8	22.0	3.0	39.0	100	39	78
	1	24.0	14	34.0	9	42.0	28.0	10	28.0	5.0	45.0	114	38	87
	1	16.0	15	19.0	2	22.0	18.0	5	10.0	5.0	31.0	63	27	53
	1	28.0	24	31.0	8	44.0	34.0	9	23.5	5.0	39.0	116.5	46	83
	1	29.0	30	32.0	10	47.0	34.0	9	30.0	5.0	43.0	125	54	90
	1	16.0	13	13.5	3	38.0	30.0	4	16.0	5.0	32.0	75.5	24.5	70
	1	25.0	20	31.5	9	38.0	32.0	9	29.0	3.0	35.0	117.5	40.5	73
	1	17.0	13	21.0	1	31.0	22.0	3	28.0	3.0	28.0	88	20	59
	1	19.0	12	20.0	2	30.0	14.5	2	21.0	0.0	34.0	74.5	16	64

Appendix I1. Individual and total assessment scores of students subjected
to face-to-face learning approach.

1	25.0	21	27.0	8	42.0	26.0	8	24.0	1.0	33.0	102	38	75
1	27.0	27	33.0	10	37.0	34.5	8	30.0	5.0	40.0	124.5	50	77
1	24.0	23	27.0	8	41.0	31.0	5	30.0	5.0	41.0	112	41	82
1	12.0	21	18.0	4	28.0	27.5	6	12.0	5.0	26.0	69.5	36.3	54
1	26.0	30	33.0	10	46.0	35.0	9	30.0	5.0	41.0	124	54	87
1	25.0	21	29.5	9	40.0	31.0	7	24.0	4.0	28.0	109.5	41	68
1	26.0	26	31.5	9	41.0	32.0	10	26.0	4.0	39.0	115.5	48.7	80
1	28.0	23	27.0	8	38.0	26.0	4	23.0	5.0	32.0	104	40.3	70
1	26.0	28	31.0	10	43.0	29.0	10	29.0	5.0	43.0	115	52.8	86
1	30.0	28	33.0	10	42.0	35.0	9	30.0	5.0	43.0	128	52	85
1	28.0	22	32.0	8	43.0	32.0	8	26.0	5.0	39.0	118	42.5	82
1	14.0	18	18.0	9	30.0	26.5	5	18.0	4.0	37.0	76.5	36	67
1	11.0	20	29.0	5	27.0	26.0	4	22.0	3.0	33.0	88	32.3	60
1	25.0	28	33.0	10	46.0	32.0	9	28.0	5.0	39.0	118	51.5	85
1	12.0	15	10.0	2	25.0	11.0	2	7.0	3.0	22.0	40	22	47
1	25.0	21	34.0	8	37.0	30.0	8	29.0	4.0	37.0	118	41	74
1	30.0	16	27.0	8	40.0	31.0	7	28.0	5.0	37.0	116	35.7	77
1	24.0	24	24.0	10	43.0	31.0	9	30.0	5.0	40.0	109	48	83
1	30.0	30	30.0	10	45.0	29.0	9	30.0	5.0	44.0	119	54	89
1	24.0	25	28.0	7	42.0	29.0	3	29.0	5.0	36.0	110	39.5	78
1	25.0	26	26.0	9	44.0	26.0	8	23.0	5.0	34.0	100	48	78
1	21.0	16	35.0	7	35.0	33.0	8	28.0	4.0	39.0	117	35	74
1	19.0	22	27.0	3	32.0	21.0	2	22.0	3.0	33.0	89	30.3	65
1	20.0	20	32.0	8	37.0	31.5	9	25.0	4.0	39.0	108.5	41	76
1	17.0	16	20.0	6	26.0	25.0	5	13.0	2.0	32.0	75	29	58
1	26.0	26	35.0	10	36.0	32.0	9	30.0	5.0	41.0	123	50	77
1	28.0	20	34.0	10	45.0	35.0	10	30.0	5.0	44.0	127	45	89
1	12.0	13	26.0	7	35.0	17.0	5	28.0	5.0	32.0	83	30	67
1	16.0	20	34.0	9	39.0	21.0	8	16.0	4.0	37.0	87	41	76
1	22.0	26	33.0	10	40.0	28.0	7	22.0	5.0	36.0	105	48	76
1	15.0	11	29.0	6	27.0	17.0	3	9.0	4.0	21.0	70	24	48
1	30.0	26	31.0	9	46.0	34.0	9	30.0	4.0	43.0	125	48	89
1	23.0	14	25.0	8	24.0	17.0	7	20.0	5.0	24.0	85	34	48
1	25.0	20	29.0	10	46.0	32.5	9	29.0	5.0	36.0	115.5	43	82
1	22.5	17	29.0	6	34.0	24.0	3	20.0	4.0	35.0	95.5	30.3	69
1	18.0	16	25.0	5	35.0	29.0	2	27.0	4.0	38.0	99	26	73
1	16.0	19	25.0	7	31.0	30.0	7	29.0	5.0	36.0	100	38	67
1	27.0	26	29.0	9	41.0	31.0	8	30.0	5.0	38.0	117	48	79
1	13.0	14	23.0	7	29.0	26.5	4	26.0	2.0	29.0	88.5	27	58
1	27.0	26	31.0	8	43.0	34.0	9	29.0	5.0	39.0	121	48	82
1	24.0	19	35.0	10	43.0	34.0	8	30.0	5.0	41.0	123	42	84
1	22.0	21	24.0	6	36.0	30.5	6	19.0	5.0	34.0	95.5	38	70
1	28.0	18	26.0	9	43.0	26.5	5	28.0	3.0	40.0	108.5	35	83
1	18.0	16	23.0	5	28.0	25.0	5	23.0	3.0	32.0	89	29	60
1	24.0	22	34.0	8	43.0	29.0	5	18.0	4.0	36.0	105	39	79
1	17.0	14	28.0	4	27.0	17.0	2	24.0	5.0	34.0	86	24.5	61

Appendix I2. Individual and total assessment scores of students subjected to face-to-face learning approach.

NAMES	1-without; 2-with	T1_QUIZ	T1_QC	T2_QUIZ	T2_QC	Form 1	T3_QUIZ	T3_QC	T4_QUIZ	T4_QC	Form 2	TOTAL QUIZ	TOTAL QC	TOTAL FORM
		30	30	35	10	50	35	10	30	5	45	130	55	95
	2	25.0	21	28.0	8	40.0	29.0	6	24.0	5	38.0	106	40	78
	2	19.0	24	19.5	10	30.0	19.5	5	20.0	5	34.0	78	45	64
	2	27.0	24	24.0	10	35.0	28.0	8	30.0	5	33.0	109	47	68
	2	13.0	25	27.0	10	36.0	22.0	7	28.0	4	31.0	90	46	67
	2	29.0	24	31.0	8	44.0	33.0	10	30.0	5	43.0	123	47	87
	2	24.5	20	30.0	8	39.0	26.0	7	25.0	5	34.0	105.5	40	73
	2	24.0	26	29.0	8	42.0	33.0	8	27.0	5	38.0	113	47	80
	2	27.5	23	33.0	10	37.0	22.0	8	26.0	3	34.0	108.5	44	71
	2	24.0	28	29.0	9	42.0	32.0	5	28.0	3	35.0	113	45	77
	2	27.0	28	32.0	10	43.0	32.0	9	29.0	5	42.0	120	52	85
	2	26.0	25	29.0	7	37.0	35.0	9	30.0	5	39.0	120	46	76
	2	26.0	25	28.0	8	42.0	27.0	8	27.0	5	40.0	108	49	82
	2	27.0	26	32.0	10	47.0	29.0	8	30.0	5	41.0	118	49	88
	2	28.5	28	31.0	9	43.0	27.0	8	28.0	5	41.0	114.5	50	84
	2	23.5	22	26.0	8	43.0	26.0	7	24.0	5	39.0	99.5	42	82
	2	24.0	22	27.0	9	40.0	30.0	9	29.0	3	35.0	110	43	75
	2	23.0	25	32.0	8	41.0	22.0	7	28.0	5	31.0	105	45	72
	2	28.0	29	27.0	9	44.0	27.0	9	30.0	5	37.0	112	52	81
	2	23.5	27	28.0	8	38.0	23.0	5	28.0	5	36.0	102.5	45	74
	2	24.5	22	31.0	10	42.0	27.0	7	26.0	5	35.0	108.5	44	77
	2	23.0	18	28.0	8	39.0	26.0	6	25.0	5	34.0	102	37	73
	2	22.0	22	27.0	6	44.0	27.0	5	30.0	5	39.0	106	38	83
	2	19.0	18	24.0	7	43.0	29.0	6	28.0	5	27.0	100	36	70
	2	14.0	20	27.0	7	34.0	23.0	9	29.0	4	35.0	93	40	69
	2	18.5	19	29.0	6	39.0	25.0	7	29.0	5	33.0	101.5	37	72
	2	15.5	22	27.0	8	44.0	32.0	8	30.0	4	39.0	104.5	42	83
	2	17.5	18	31.0	7	33.0	22.0	6	23.0	5	37.0	93.5	36	70
	2	27.0	26	31.0	9	38.0	31.0	7	28.0	5	41.0	117	47	79
	2	18.0	23	32.0	9	42.0	33.0	3	27.0	5	41.0	110	40	83
	2	20.5	14	25.0	8	40.0	30.0	4	27.0	5	35.0	102.5	32	75
	2	26.5	28	33.0	10	43.0	34.0	8	30.0	5	43.0	123.5	51	86
	2	24.0	22	32.0	10	41.0	33.0	10	26.0	5	42.0	115	47	83
	2	16.0	22	26.0	6	35.0	22.0	4	25.0	1	34.0	89	33	69
	2	24.0	24	30.0	8	40.0	25.0	8	30.0	4	31.0	109	44	71
	2	27.5	27	29.0	8	40.0	31.0	9	30.0	5	40.0	117.5	49	80
	2	22.0	20	22.0	6	34.0	24.0	4	20.0	5	35.0	88	37	69
	2	21.0	20	22.0	4	27.0	22.0	3	29.0	3	30.0	94	30	57
	2	22.5	26	31.0	9	40.0	30.0	4	29.0	5	33.0	112.5	44	73
	2	19.0	18	22.0	5	28.0	21.0	4	23.0	4	23.0	85	31	51
	2	13.0	23	23.0	9	33.0	26.0	4	21.0	0	26.0	83	36	59
	2	30.0	29	32.0	8	44.0	30.0	5	28.0	5	44.0	120	47	88
	2	25.0	26	30.0	9	41.0	30.0	10	25.0	5	38.0	110	50	79
	2	20.5	25	30.0	9	39.0	34.0	4	28.0	5	30.0	112.5	46	69
	2	27.0	27	22.0	8	44.0	29.0	10	27.0	5	37.0	105	50	81
	2	24.0	15	17.0	9	28.0	18.0	6	19.0	4	32.0	78	34	60
	2	21.0	21	26.0	9	44.0	27.0	9	24.0	5	30.0	98	44	74
	2	15.0	17	25.0	8	26.0	23.0	7	21.0	2	32.0	84	34	58
	2	30.0	29	35.0	10	47.0	35.0	10	29.0	5	42.0	129	54	89
	2	25.5	21	32.0	10	42.0	31.0	9	30.0	5	43.0	118.5	45	85
	2	27.0	29	26.0	9	45.0	33.0	9	27.0	5	40.0	113	52	85
	2	25.0	24	25.0	9	43.0	34.0	8	23.0	3	29.0	107	44	72
	2	25.0	17	22.0	10	44.0	27.0	7	26.0	5	40.0	100	39	84
	2	25.0	26	31.0	10	44.0	31.0	7	28.0	5	41.0	115	48	85
	2	27.5	25	32.0	10	46.0	31.0	10	30.0	5	41.0	120.5	50	87
	2	16.0	20	32.0	6	37.0	22.0	5	25.0	3	36.0	95	34	73
	2	20.0	19	29.0	9	40.0	21.0	5	22.0	0	33.0	92	33	73
	2	17.0	17	23.0	5	30.0	26.0	5	24.0	2	34.0	90	29	64
	2	26.0	27	28.0	10	47.0	32.0	10	30.0	5	39.0	116	52	86
	2	25.0	24	29.0	10	43.0	30.0	9	25.0	5	38.0	109	48	81
	2	17.0	24	27.0	7	34.0	23.0	2	20.0	5	32.0	87	38	66
	2	25.0	21	24.0	8	36.0	20.0	6	21.0	4	33.0	90	39	69
	2						29.0							38	75
	2	22.5	15	28.0	6	37.0	23.0	4	28.0	5	35.0	101.5	30	72
	2		18	23.0	6	39.0	23.0	4	22.0	5	28.0	83	33	67
	2	15.0	13	20.0	7	36.0	22.0	3	22.0	3	34.0	79	26	70
	2	26.5	22	32.0	9	39.0	29.0	8	27.0	4	40.0	114.5	43	79
	2	18.0	14	25.0	2	38.0	20.0	4	23.0	1	36.0	86	23	74
	2	29.0	27	30.0	10	43.0	31.0	9	26.0	4	38.0	116	50	81
	2	30.0	27	34.0	7	43.0	34.0	9	29.0	3	39.0	127	46	82
	2	28.0	27	23.0	9	44.0	27.0	9	26.0	4	34.0	104	49	78
	2	26.0	18	8.0	7	26.0	26.0	6	22.0	1	35.0	82	32	61
	2	16.0	18	31.0	4	31.0	17.0	2	17.0	4	22.0	81	28	53
	2	26.0	28	31.0	8	44.0	33.0	10	30.0	5	42.0	120	51	86
	2	28.0	26	25.0	9	41.0	31.0	7	30.0	5	35.0	114	47	76
	2	16.0	20	20.0	10	32.0	20.0	6	21.0	4	35.0	77	41	67
	2	13.0	20	19.0	2	31.0	23.0	2	17.0	0	27.0	72	24	58
	2	29.0	24	31.0	9	32.0	27.0	8	24.0	5	38.0	111		71

Appendix J1. Individual and total assessment scores of students subjected to blended learning approach.

Appendix J2. Individual and total assessment scores of students subjected to blended learning approach.

Case Processing Summary

Mann-Whitney Test
 Ranks

	Group	N	Mean Rank	Sum of Ranks
	Without Module	109	106.10	11565.00
T1_QUIZ	With Module	108	111.93	12088.00
	Total	217		
	Without Module	109	92.82	10117.50
T1_QC	With Module	108	125.33	13535.50
	Total	217		
	Without Module	109	114.38	12467.50
T2_QUIZ	With Module	108	103.57	11185.50
	Total	217		
	Without Module	109	110.06	11997.00
T2_QC	With Module	108	107.93	11656.00
	Total	217		
	Without Module	109	107.81	11751.00
FORM1	With Module	108	110.20	11902.00
	Total	217		
	Without Module	109	122.03	13301.50
T3_QUIZ	With Module	108	95.85	10351.50
	Total	217		
	Without Module	109	114.41	12470.50
T3_QC	With Module	108	103.54	11182.50
	Total	217		
	Without Module	109	106.06	11560.50
T4_QUIZ	With Module	108	111.97	12092.50
	Total	217		
	Without Module	109	104.61	11403.00
T4_QC	With Module	108	113.43	12250.00
	Total	217		
	Without Module	109	113.86	12411.00
FORM2	With Module	108	104.09	11242.00
	Total	217		
	Without Module	109	113.20	12339.00
TOTAL_QUIZ	With Module	108	104.76	11314.00
	Total	217		
	Without Module	109	99.71	10868.00
TOTAL_QC	With Module	108	118.38	12785.00
	Total	217		
	Without Module	109	111.05	12104.00
TOTAL_FORM	With Module	108	106.94	11549.00
	Total	217		

Appendix K. Mann-Whitney U-Test Mean Rank and Sum of Ranks of the two groups

Test Statistics[a]

	T1_QUIZ	T1_QC	T2_QUIZ	T2_QC	FORM1	T3_QUIZ	T3_QC	T4_QUIZ	T4_QC	FORM2	TOTAL_QUIZ	TOTAL_QC	TOTAL_FORM
Mann-Whitney U	5570.000	4122.500	5299.500	5770.000	5756.000	4465.500	5296.500	5565.500	5408.000	5356.000	5428.000	4873.000	5663.000
Wilcoxon W	11565.000	10117.500	11185.500	11656.000	11751.000	10351.500	11182.500	11560.500	11403.000	11242.000	11314.000	10868.000	11549.000
Z	-.685	-3.822	-1.272	-.256	-.282	-3.078	-1.288	-.700	-1.158	-1.149	-.991	-2.192	-.483
Asymp. Sig. (2-tailed)	.494	.000	.204	.798	.778	.002	.198	.484	.247	.251	.322	.028	.629

Appendix L. Results of Mann-Whitney U-Test comparing the mean scores of individual and total assessments per group.