Contents lists available at Science-Gate

International Journal of Advanced and Applied Sciences

Journal homepage: http://www.science-gate.com/IJAAS.html

The effectiveness of MOODLE as a LAN-based instructional teaching-learning material

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ARTICLE INFO

Article history:
Received 4 August 2017
Received in revised form
9 December 2017
Accepted 20 December 2017

Keywords:
MOODLE
COLLES
Participatory action research
Combined preferred and actual form
Data mining

ABSTRACT

This study aimed to probe on how Modular Object-Oriented Dynamic Learning Environment (MOODLE), as an e-learning tool, improved the academic performance of the students who are enrolled in Electronic Spreadsheet with ICT (CS22) subject and how it affected the teaching performance of faculty by using it as a platform for teaching-learning material. The researchers assumed that there is a significant difference between traditional and blended MOODLE implementation as an instructional teaching-learning material. The researchers followed interpretive research design that combined elements of participatory action research, experimental design, and data mining. The student's midterm and final grade were used as the baseline factor to gauge the effectiveness of blended MOODLE implementation. The researchers, therefore, conclude that MOODLE is beneficial to the teachers as instructional material. However, students are not receptive to using MOODLE based on the results gathered. Lastly, identify new data patterns generated during the data mining procedures in assessing the effectiveness of the students' academic performance.

1. Introduction

Southern Christian College (SCC) is one of the educational institutions located in Midsayap, Cotabato, Philippines. SCC has been continuously innovating to provide the best quality training for students and to develop the best graduates who can compete not just locally but also globally. The College of Computer and Information Sciences (CCIS) faculty uses different teaching strategies. Some teachers use the traditional mode of instruction while others apply the blended mode. Traditionally, the teacher uses test papers during examinations. On the other hand, the college utilizes the blended mode. It is called "blended" because it is a combination of the use of the traditional way and using of Modular Object-Oriented Dynamic Learning Environment (MOODLE) software in giving examinations and quizzes, submission of projects, and downloading of resource materials and handouts. The MOODLE provides organize interface for e-learning. MOODLE offers robust features and functionalities for teachers and learners to use. It is open-source e-learning software. Thus, an educational institution can customize this according to their needs. It allows the teachers to create online courses which students can access as a virtual classroom. Typically, MOODLE home page includes lists of participants consisting faculty and students and a calendar with course schedule and lists of assignments. Also, MOODLE offers features for conducting online quizzes where it automatically checks the objective types of exams.

The CCIS faculty conducted a study about its effectiveness as a teaching strategy and how it can affect the student learning capability. To truly compare the difference, the researchers concentrated on CS22-Electronic Spreadsheet with ICT (Information and Communications Technology). This study assesses the effectiveness of MOODLE in the academic performance of students and its impact on the faculty in the College. In performing the evaluation, the researchers used data mining procedures selected from clustering algorithm.

The primary objective of this research study is to determine the effectiveness of MOODLE as a LAN-Based Instructional Teaching-Learning Material for Faculty Teaching Performance and Student's

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https://doi.org/10.21833/ijaas.2018.02.016
2313-626X/

Academic Performance in Electronic Spreadsheet with ICT. Specifically, this study determined:

1. The better method of instructional material between the traditional way or blended method;
2. The impact of MOODLE to the teachers using it in their respective classes; and
3. The new data patterns generated in assessing the effectiveness of the students' academic performance.

The respondents were composed of two sections of college students who were currently enrolled in the CS22 subject under the same teacher in the 2nd semester, the school year 2016-2017. The CCIS Faculty who handled at least two sections of CS 22 was also part of the study. The two sections of respondents were of the same number. The quizzes/exams were done inside the laboratory during the study. Assignments, projects, and hand-outs were downloaded. A developed teachers' module was made to have uniform lessons, quizzes, exams, hands-on activities and assignments for the students. MOODLE was deployed in Local Area Network.

Based on the research questions, the following hypothesis was formulated: There is no significant difference between traditional and blended MOODLE implementation as an instructional teaching-learning material.

Based on the study entitled "The Effect of Web-Based Learning Management System on Knowledge Acquisition of Information Technology Students at Jose Rizal University" (Ebardo and Valderama, 2009) presents that MOODLE, as LMS, adds learning and knowledge in their assessment result.

The Constructivist On-Line Learning Environment Survey (COLLES) consists of 24 statements grouped into six scales (Taylor and Maor, 2000).

These scales are (i.) relevance which poses an inquiry on the significance of an on-line learning to student's professional practices, (ii.) reflection which gives emphasis to the student's critical reflective thinking stimulated by an on-line learning, (iii.) interactivity which highlights the extent of students on-line engagement in rich educative dialogue, (iv.) tutor support which investigates on how well tutors enable students' participate in on-line learning, (v.) peer support which probes if fellow students are sensitive and encouraging enough in providing on-line support, and (vi.) interpretation which examines if both students and tutors make good sense of each other's on-line communications.

There are three forms of the COLLES: (i) a preferred form, (ii) an actual form, and (iii) a combined preferred and actual form.

Timing and purpose are the two determinants to choose which of the three COLLES forms to administer. Typically, the preferred form is administered at the beginning of the semester, after a couple of weeks to pass allowing students become familiar with the on-line learning requirements. Then, in the final week of the semester, the combined form (preferred and actual) is administered. The COLLES contains a five-point Likert-type response scale – Almost Never (1), Seldom (2), Sometimes (3), Often (4), Almost Always (5) (Taylor and Maor, 2000).

"A Study Concerning the Use of MOODLE at Kanda University of International Studies" proves that more than 90% of survey respondents, an average or above value. MOODLE as a beneficial educational tool for teachers (Yates and Delgado, 2008).

Grades and GPA are used to gauge the academic achievement of students for institutions as stated in the "Defining and Measuring Academic Success" (York et al., 2015).

The Data Mining In Course Management Systems: MOODLE Case Study and Tutorial" (Romero et al., 2008) is where the research theoretical framework is based on where teachers can obtain a general view of student's data by utilizing visualization techniques such as plots and graphs. The researchers utilized data mining techniques such as clustering to determine the exact group of students into clusters, classification to classify student's characteristics and association rule mining. to determine the relationship between students' characteristics and other attributes.

2. Materials and methods

The Fig. 1 illustrates the conceptual framework of this study. The researchers gathered the electronic data that contained the class performance of college students officially enrolled in CS 22 in the second semester of the school year 2016-2017. There were separate electronic data for the CS 22 class who used MOODLE in the classroom activities which was referred to as the Blended method and for the CS22 class who used the usual pen-and-paper, referred to as a Traditional method. The researchers got the scores of the students in quizzes, assignments, lab exercises, and exam scores for midterm and final term as well as their respective midterm and final grades as the source of data. The Blended dataset was taken from the class using MOODLE in the class activities while the Traditional dataset was taken from the class who used pen and paper. Questionnaires following the COLLES standard survey format were used for evaluating the impact of MOODLE for the instructors who used it in their classes. All data taken from these sources became inputs for the data mining and data interpretation of this research.

The research process included collecting and preprocessing the data by converting both blended and traditional datasets from CSV to ARFF file. The researchers performed data mining using the clustering method with the k-means algorithm. The researchers also used a scatter plot for the visualization of clusters resulting from the data mining. Lastly, the research outputs were the discovery of clusters of students in blended and traditional methods, interpretation of COLLES line

graph from the survey of teachers who used MOODLE in their classes, and interpretation of data patterns in a scatter plot for both blended and traditional datasets.

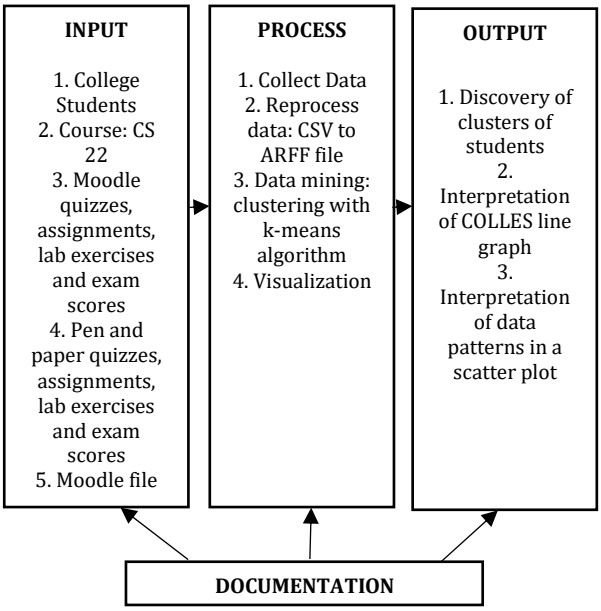


Fig. 1: Conceptual framework

3. Research design and methodology

This study followed interpretive research design (Guba and Lincoln, 1989) in which the researchers combined elements of participatory action research, experimental design, and data mining. In order to optimize credibility and reliability, the researchers used multiple sources of data, consistent engagement, and member checks. They modified the agile process (Sadeh et al., 1995). With this, they embarked on the following methods iteratively: (i) formulate design principles on data/requirements gathering; (ii) put the design into practice; (iii) collect and analyze data; and (iv) apply algorithms in data mining the MOODLE. The results of this approach should be evident on MOODLE's effectiveness in CCIS' implementation.

The researchers monitored the main aspects of the online learning environment of the CS22 subject using the COLLES survey instrument. The COLLES survey has been integrated into MOODLE as part of a generic survey module that automatically proves easy-to-read graphs and charts. In this study, the faculty involved used the third forms – combined preferred and actual form in conducting the survey.

The participatory and experimental research design was coupled with the involvement of CCIS faculty teaching CS22 subjects and students of Southern Christian College who enrolled on the said subject. One teacher must handle two sections for CS 22 classes. Each section had a minimum of 20 students and maximum of 36 students in the class. On the conduct of requirements gathering, the faculty administering CS22 classes took the COLLES combined preferred and actual form survey at the end of teaching semester, after allowing a couple of days to pass while computing all students' result scores with the on-line learning tool. Also, during this phase, the faculty strictly monitored the attendance, term tests, quizzes, assignments and hands-on activities of the students. Each faculty conducted a blended MOODLE utilization on one class and another class for the traditional method. On a blended MOODLE utilization, the attendance was checked, and the lecture was given by the teacher face-to-face while the quizzes, term test, assignment, hands-on activity submission and resources downloading is done using MOODLE. On a traditional method, the teacher conducted classes without the use of MOODLE. Thus, the quizzes, term tests, and assignments were done with pen and paper. The researchers had designed and created a CS 22 module containing the lectures, quizzes, assignments, term tests and hands-on activities covering the Excel's 2016 File, Home, Insert, Page Layout, Formulas, Data, Review and View tabs for the entire semester. All faculties teaching CS 22 used the same module for the content delivery. Hence, the teachers worked on the uniform timeframe for the term tests, assignments, quizzes and hands-on activities for both blended MOODLE utilization and traditional method. This was strictly observed to avoid biases on the data gathering and interpretation of results of the tests, assignments, quizzes and hands-on activities for both blended MOODLE utilization and traditional method. This was strictly observed to avoid biases on the data gathering and interpretation of results.

In the Blended method, questions in quizzes and the choices for Multiple Choice and Matching Type of tests was shuffled. Also, teachers set an electronic time limit for each quiz or exam and the time could be viewed by the students on their individual computer screens. If a student missed answers a particular question, he or she was notified before submitting the exam or quiz. Once the quiz or exam was submitted, the students could immediately view the results including their corresponding scores, the correct answers, and grade percentage.

The end of the semester marked the end of the data collection and analysis phase. With this, the researchers embarked on the next phase that focused on applying algorithms in data mining.

The researchers used the k-means algorithm with a value of 3 clusters of students. Cluster 0 represented students with a low number of assignments submitted and very few quizzes done with either passed or failed remarks. Cluster 1 represented students with a high number of quizzes done with passed remarks, a low number of quizzes failed, and a high number of assignments submitted. Lastly, cluster 2 represented the students with values somewhat smaller than cluster 1 but greater than cluster 0. The teacher used this information in order to group students into three types: very active students (Cluster 1), active students (Cluster 2) and non-active students (Cluster 0).

Data preprocessing was performed wherein CSV dataset was converted to ARFF format before the

researchers began the data mining process in Weka. They collected the electronic class records of faculty members teaching the course CS 22, to preprocess the Blended and Traditional datasets.

Fig. 2 shows a spreadsheet of the electronic class record in CS22 that contains the raw scores of students in their quizzes, assignments, hands-on exercises, attendance, and exams for both midterm and final term. The datasets were taken from the computed total quizzes, total assignments, total hands-on exercises, total attendance, midterm exams, final exams, midterm grades and final grades of students for both blended and traditional methods.

	Student's Name	Quizzes 10%							Assignment 5%							Laboratory Exercise 40%												
	Surname, Firstname I.	**30**	**24**	**20**		**74**	**TOTAL**	**TOTAL**	**60**	**89**	**32**		**181**	**TOTAL**	**TOTAL**	**30**	**100**	**60**		**190**	**TOTAL**	**TOTAL**	**5**	**5**	**5**	**5**	**5**	**5**
							SCORE	%						SCORE	%						SCORE	%						
1	Alianza, Roldan A.	14	0	14		28	0.38	6.89	0	77	32		109	0.60	4.01	10	0	0		10	0.05	21.05	5	5	0	5	5	5
2	Andres, Jessyle May C.	16	0	18		34	0.46	7.30	30	52	0		82	1.11	5.27	29	0	0		29	0.15	23.05	5	0	5	5	5	5
3	Antatico, Crystal Jade G.	24	0	18		42	0.57	7.84	40	88	32		160	2.16	7.91	30	0	60		90	0.47	29.47	5	5	5	5	5	5
4	Antatico, Niel Ryan C.	24	0	16		40	0.54	7.70	60	74	29		163	2.20	8.01	10	0	59		69	0.36	27.26	0	5	5	5	5	5
5	Awayan, Jessa C.	24	16	16		56	0.76	8.78	60	87	32		179	2.42	8.55	30	93	60		183	0.96	39.26	5	5	5	5	5	5
6	Bedona, Frence Shervin R.	20	10	18		48	0.65	8.24	30	69	0		99	1.34	5.84	27	88	50		165	0.87	37.37	5	5	5	5	5	0
7	Borres, Corvary A.	22	0	0		22	0.30	6.49	0	0	0		0	0.00	2.50	26	0	0		26	0.14	22.74	5	5	5	5	5	5
8	Braza, Darryl Jade N.	0	0	0		0	0.00	5.00	60	0	0		60	0.81	4.53	26	0	0		26	0.14	22.74	0	5	0	5	0	5

Fig. 2: The electronic class record in CS 22 in the spreadsheet

Hence, the selected data was consolidated in a separate spreadsheet for preprocessing as shown in Fig. 3. The researchers then exported the data in this spreadsheet as a CSV file to be converted to ARFF format using the ARFF-Viewer of Weka.

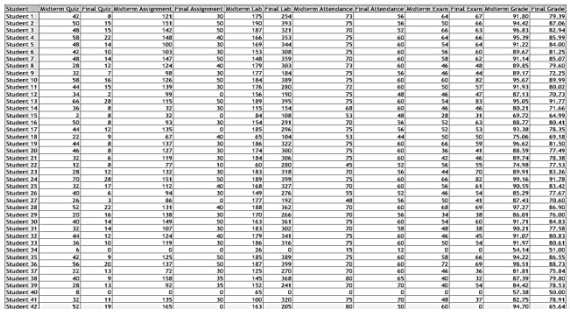


Fig. 3: Snapshot of selected data in a spreadsheet for preprocessing

To convert CSV datasets in ARFF format, the researchers used the ARFF-Viewer, one of the tools used in Weka for data file conversion. The Blended and Traditional CSV datasets as shown in Fig. 4 were opened in the ARFF-Viewer window shown in Fig. 5 and these datasets were saved as ARFF format.

Fig. 6 shows ARFF datasets opened in a text editor on which the researchers can distinguish ARFF datasets from CSV datasets because metadata of attributes (column of data) is specified. In the ARFF datasets generated, the metadata showed a directive that started with the symbol (@) and that there was one for the name of the dataset @RELATION Blended Dataset and @RELATION Traditional Dataset. There was a directive to define the name and datatype of each attribute (e.g., @ATTRIBUTE 'Final Grade' numeric), and there was a directive to indicate the start of the raw data (e.g., @DATA).

Fig. 7 shows the Weka Explorer window on which the researchers performed other data preprocess by loading the Blended ARFF datasets first, then examined the statistical values of each of its attributes. The statistical results for each of the selected attribute were also shown, specifically the corresponding Minimum, Maximum, Mean and Standard Deviation values.

Fig. 8 shows the Weka Clusterer window on which the researchers performed the data mining process specifically the Clustering method using the k-means algorithm to identify clusters of very active, active and inactive students in both Blended and Traditional datasets. The researchers could see the number of clusters generated in Weka as well as the clustering results in the Clusterer Output.

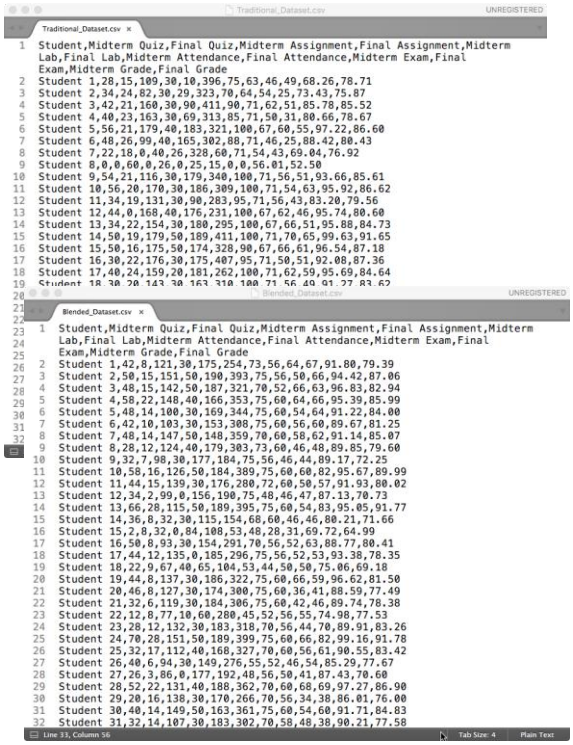


Fig. 4: The blended and traditional datasets in CSV format

4. Results and discussion

By using the Weka software, the researchers were able to find out that blended method produced a higher result in the clustering. In Fig. 9, the resulting cluster showed 50% for Blended and 7% for Traditional in CLUSTER 0, which means that cluster 0 represents students with low number of assignments submitted, very few quizzes done with either passed and failed remarks, low grades in hands-on activities, low result in exams, and low number of attendance.

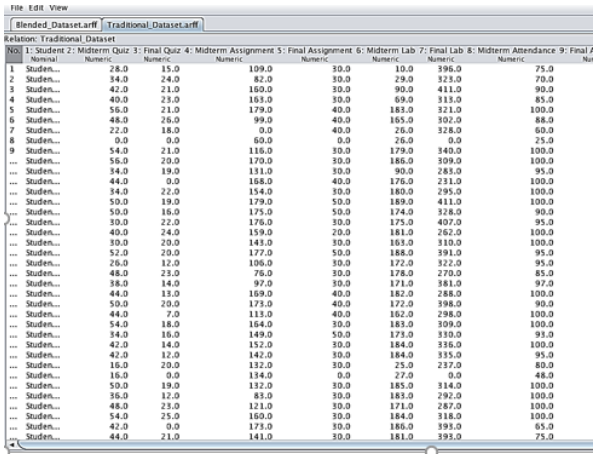
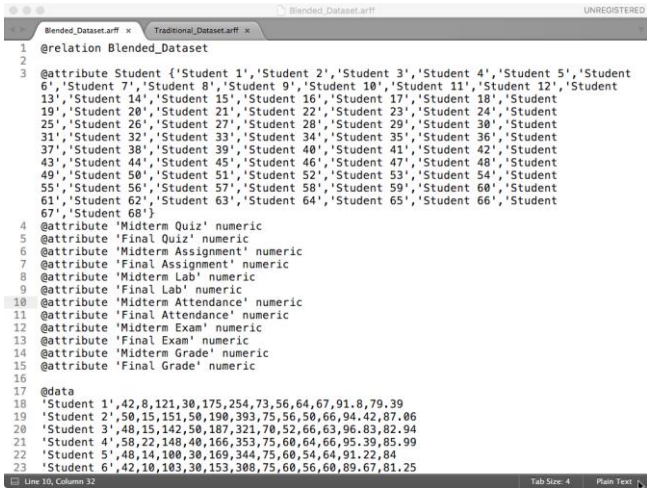


Fig. 5: The CSV datasets loaded to the ARFF-Viewer



```
@relation Blended_Dataset

@attribute Student {'Student 1','Student 2','Student 3','Student 4','Student 5','Student
6','Student 7','Student 8','Student 9','Student 10','Student 11','Student 12','Student
13','Student 14','Student 15','Student 16','Student 17','Student 18','Student
19','Student 20','Student 21','Student 22','Student 23','Student 24','Student
25','Student 26','Student 27','Student 28','Student 29','Student 30','Student
31','Student 32','Student 33','Student 34','Student 35','Student 36','Student
37','Student 38','Student 39','Student 40','Student 41','Student 42','Student
43','Student 44','Student 45','Student 46','Student 47','Student 48','Student
49','Student 50','Student 51','Student 52','Student 53','Student 54','Student
55','Student 56','Student 57','Student 58','Student 59','Student 60','Student
61','Student 62','Student 63','Student 64','Student 65','Student 66','Student
67','Student 68'}
@attribute 'Midterm Quiz' numeric
@attribute 'Final Quiz' numeric
@attribute 'Midterm Assignment' numeric
@attribute 'Final Assignment' numeric
@attribute 'Midterm Lab' numeric
@attribute 'Final Lab' numeric
@attribute 'Midterm Attendance' numeric
@attribute 'Final Attendance' numeric
@attribute 'Midterm Exam' numeric
@attribute 'Final Exam' numeric
@attribute 'Midterm Grade' numeric
@attribute 'Final Grade' numeric

@data
'Student 1',42,8,121,30,175,254,73,56,64,67,91.8,79.39
'Student 2',50,15,151,50,190,393,75,56,50,66,94.42,87.06
'Student 3',48,15,142,50,187,321,70,52,66,63,96.83,82.94
'Student 4',58,22,148,40,166,353,75,60,64,66,95.39,85.99
'Student 5',48,14,100,30,169,344,75,60,54,64,91.22,84
'Student 6',42,10,103,30,153,308,75,60,56,60,89.67,81.25
```

Fig. 6: The ARFF datasets showing the metadata of attributes

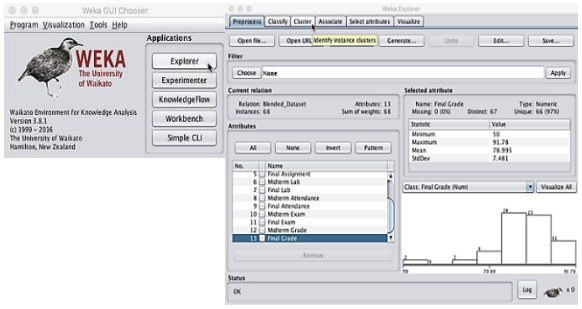


Fig. 7: The Weka explorer window

It also presents 35% of students were in Blended and 31% in traditional for CLUSTER 1, which means a high number of quizzes done with passed remarks, low number of quizzes failed, a high number of an assignment submitted, a high number of passed hands-on activities, the high result of exams and high number of attendance.

Fig. 9 Cluster results in Blended Method (left) and Traditional Method (right) term test exams, and the high number of attendance. Moreover, CLUSTER 2 showed 15% for Blended and 62% for Traditional which means that students who are grouped in this cluster had lower scores compared to Cluster 1 but had greater scores than CLUSTER 0. The result did not necessarily mean that the students grouped in CLUSTER 0 failed but they just received low results.

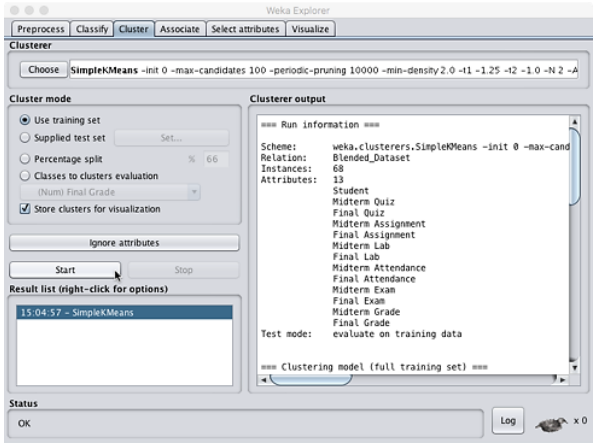
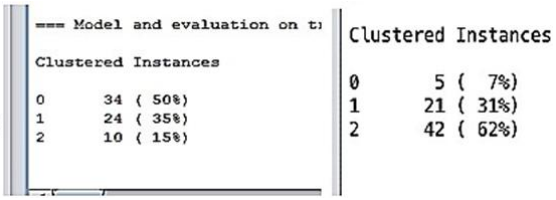


Fig. 8: The Weka Clusterer window



```
=== Model and evaluation on t

Clustered Instances

0       34 ( 50%)
1       24 ( 35%)
2       10 ( 15%)
```

```
Clustered Instances

0        5 (  7%)
1       21 ( 31%)
2       42 ( 62%)
```

Fig. 9: Clusters result

The source of data was from the CS22 class in Southern Christian College 2nd semester SY 2016-2017. The data were composed of 4 sections handled by two instructors. Both instructors handled one traditional method and one blended method. The class size was 138 (68 students in blended class and 70 students in the traditional class) from B1, B2, B4, and L sections composed of 2nd-4th year BSBA, BSED, BEED, BSTheo, AB, BLIS, and BSSW students.

Fig. 10 shows the COLLES survey result, the x-axis represents the criteria and y-axis represent the five-point Likert-type response scale for the preferred and actual survey. The mean result for relevance is 4.88 which mean that almost always; on-line learning was relevant to teachers' professional practices. The mean result of reflective thinking is 4.63 which mean that online learning almost always stimulated teachers' critical reflective thinking. The mean for interactivity is 4.38 which mean teacher engaged in rich educative on-line dialogue often. The mean for Tutor support is 4.50 which mean that teachers enable students to participate in on-line learning almost always. The mean for peer support is 4.50 which means that sensitive and encouraging support was almost always provided on-line by fellow teachers is almost always. Lastly, the mean of interpretation is 4.50 which mean that students and teachers made good sense of each other's on-line communications almost always. Hence, the researchers could justify that MOODLE had a positive impact on the teachers using it in their respective classes.

Lastly, the researchers were able to visualize the data patterns of clusters of students who were grouped separately in Blended and Traditional datasets using the attributes, Students in the x-axis and Final Grade in the y-axis. The researchers utilized the Scatter plot as visualization technique of

clustering datasets. This process is called pattern recognition (Bishop, 2006).

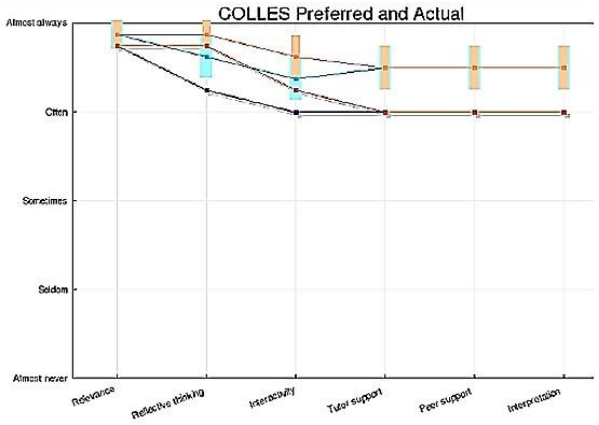


Fig. 10: COLLES preferred and actual survey

The x-axis represents the students, and the y-axis represents the Final Grade for Blended and Traditional Datasets as shown in Fig. 11 and Fig. 12 respectively. In the scatter plot, every single point represents a student, and the positioning of each point represents the scale of a student's final grade. In visualizing the data patterns of both Blended and Traditional datasets, the class performance of students varied based on their Final Grades. Most students in the blended method got final grades between 70 to 91. However, most students in the traditional method got final grades between 71 to 93. Additionally, there were four students (instances) and ten students (instances) who got final grades below 75 in the traditional and blended methods respectively. Therefore, based on the data patterns recognized, the researchers inferred that the clusters in the Blended method were distantly scattered which indicates that the students mostly adjusted to using MOODLE as the technology for learning as most of them were first-time users which could be a factor to their academic performance. The data pattern visualized in the Traditional method were closely clustered which means that the students were indeed used to the traditional way of learning.

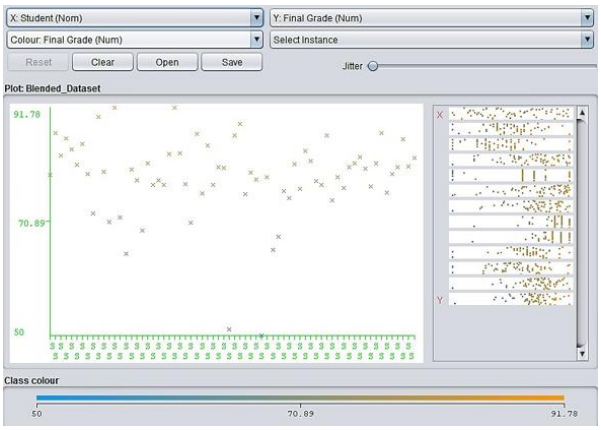


Fig. 11: The clustering scatter plot for blended dataset

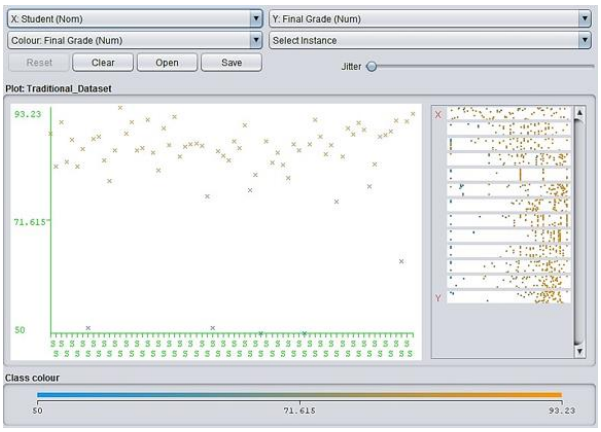


Fig. 12: The clustering scatter plot for traditional dataset

5. Conclusion

The new data pattern discovered in the Blended method had clusters that were distantly scattered which means most students were likely adjusting to MOODLE as a technology used for learning material. Also, in the traditional method, the data pattern discovered is closely clustered, which means, that students are used to the pen and paper way of learning.

The researchers, therefore, conclude that MOODLE is beneficial to the teachers as instructional material. However, students are not that receptive to using MOODLE based on the results gathered.

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