2013 Hawaii University International Conferences
Education & Technology
Math & Engineering Technology
June 10th to June 12th
Ala Moana Hotel, Honolulu, Hawaii

Does Using Moodle For Learning Enhance Students' Online Interactivities And Their Learning Achievement- Application Of Grey Relational Analysis?

Shun-Jyh Wu
Ai-Lun Wu
St. John's University, Taipei, Taiwan, ROC

DOES USING MOODLE FOR LEARNING ENHANCE STUDENTS' ONLINE INTERACTIVITIES AND THEIR LEARNING ACHIEVEMENT- APPLICATION OF GREY RELATIONAL ANALYSIS?

SHUN-JYH WU

Associate Professor,
Department of Digital Literature and Arts,
St. John’s University, Taipei, Taiwan, ROC.

AI-LUN WU

Assistant Professor,
Department of Digital Literature and Arts,
St. John’s University, Taipei, Taiwan, ROC

DOES USING MOODLE FOR LEARNING ENHANCE STUDENTS' ONLINE INTERACTIVITIES AND THEIR LEARNING ACHIEVEMENT- APPLICATION OF GREY RELATIONAL ANALYSIS?

SHUN-JYH WU[1] AI-LUN WU[2]

[1] Associate Professor,
Department of Digital Literature and Arts,
St. John's University, Taipei, Taiwan, ROC.

[2]Assistant Professor,
Department of Digital Literature and Arts,
St. John's University, Taipei, Taiwan, ROC.

Abstract:

Online learning for students is one of the fastest growing trends in educational uses of technology. Literatures show that online learning could help students to reinforce their abilities and knowledge. The purpose of this study is to investigate students' behavior in the learning system. The study developed online materials for one semester course of application of multimedia for the freshmen students in St. John's University in Taiwan, ROC. Several online forums, quizzes and assignments are designed to include all important topics of the coverage. Grey relational analysis is conducted to help understanding whether students' online behavior is significantly connected with students' learning achievement. We find that the three activities: assignments before mid-term, quizzes after mid-term, and quizzes before mid-term are significantly correlated with students' final grades. Students who get higher evaluation in the assignments and quizzes tends to pay more attention to the class requirements, and thus achieve higher final grade.

Keywords:

Grey relational analysis (GRA); Moodle; Learning Management System (LMS); Online learning; Online course design.

1. Introduction

Online learning for students is one of the fastest growing trends in educational uses of technology. Means, et al [1] systematic search of the research literature from 1996 through 2008 by using the meta-analysis found that, on average, students in online learning conditions performed modestly better than those receiving face-to-face instruction, online learning has become a more acknowledged and even expected in some cases as part of higher education [2]. Most often today instructed learning is enabled through use of a learning management system (LMS) or virtual learning environment, such as Blackboard Learn or Moodle. There are more and more universities using Course Management System (CMS) to bring courses and to facilitate students' learning, however, existing theory on learner-centered practices is quite few [3]. Maor and Volet [4] found that interactivity was an essential and important issue in the successful online learning environment. Moodle is an open-source software that allows educators to create effective online learning sites as CMS, also known as a Learning Management System (LMS) [5]. Martin-Blas and Serrano-Fernandez [6] present an overview of the undergraduate online Physics course that have implemented in the Moodle platform to create an online learning community, the results show that the online Physics course helps students to reinforce their abilities and knowledge. Ingram [7] indicated that Course Management System data can reveal students' effort models. From such measurements, we can understand how CMS systems can help online learning.

In a CMS study, Nickles [8] measured students' average length of visit, total number of visits, total hits on course content file, and total hits on the course assignment page over an entire course. He found that measures of each individual's behavior in the server log are not strongly related to students' final grades and three out of the six measures over the course were significantly negatively correlated with their final grades. Even though students' achievements were not strongly correlated with these measures, the measures of interaction were helpful for the instructor [8-10].

Since the establishment of grey system theory by Deng [11], it was widely applied to various fields [12-27]. Grey relational analysis (GRA) has been one of the most efficient analytical tools [21] for estimating the correlations between various parameters within a grey system, whose operation mechanism is not quite clear. Grey relational analysis was developed based on grey system theory, which is appropriate for solving problem with complex interrelationships between numerous factors and variables [13]. The model examines an order of multiple objects with similitude from an objective. GRA has been applied to a various operations, such as hiring decisions [14], decision-making in stock investments, marketing research [22], medicine, computer science [23, 24], system modeling, social science, geometry, chemistry, management, etc. [25-27]. Due to the effectiveness and robustness of GRA, we applied this model and implemented online materials for one semester course of application of multimedia for the freshmen students in St. John's University in Taiwan, ROC. We developed various learning activities and proposed a new approach for evaluating the correlations between students' interactivities and their final grades using Moodle system. All online activities are collected and combined into this model. GRA results are obtained so that we can understand students' online interactivities and which of these factors are significant with the students' learning achievements.

2. Grey relational analysis (GRA)

This section introduces some important definitions and equations which involved in the current GRA model. Only a brief introduction of GRA model is given. For more details can be found in the references [25-29]. Firstly, the vector space and inner product of vectors in grey relational system are defined, then the metric, Minkowski distance, norm, and grey relational space are introduced as follows.

Definition1. Let the set X be a vector space to apply grey relational analysis, and the vectors x, y are elements of X. The inner product of x and y is defined as follows:

$$\langle x, y \rangle = \|x\|_x, \|y\|_x \cos\theta$$

Where $x, y \in R^n$,

$$x = (x_1, x_2, ..., x_n)^T$$

$$\|x\|_\xi = \sqrt[\xi]{\sum_{i=1}^{n} x_i^\xi}$$

The ξ is content with the vector space axiom. Both axioms are in set theory [27].

Definition 2. The metric between two vectors x, y with the distinguish coefficient ξ is defined as follows:

$$\|x - y\|_\xi = \sqrt[\xi]{\sum_{i=1}^{n} |x_i - y_i|^\xi}$$

Where $\xi \geq 1$. The metric is well known as Minkowski distance [28] or L_P norm [29].

Definition 3. The grey relational grade γ_{ij} is defined as a value obtained by grey relational analysis, which is given for the ordered pair $(X_i, X_j) \in \Gamma$.

Definition 4. The localized grey relational grade γ_{0i} can be defined as follows:

$$\gamma_{0i} = \frac{\Delta_{\max} - \Delta_{0i}}{\Delta_{\max} - \Delta_{\min}}$$

Where

$$\Delta_{0i} = \|x_0 - x_i\|_\xi$$

$$\Delta_{\max} = \max_{\forall i}\{\Delta_{0i}\}$$

$$\Delta_{\min} = \min_{\forall i}\{\Delta_{0i}\}$$

Theorem 1. The globalized grey relational grade γ_{ij} can be represented as follows:

$$\gamma_{ij} = 1 - \frac{\Delta_{ij}}{\Delta_{\max}}$$

Where $i, j = 1,2,....m,$

$$\Delta_{ij} = \|x_i - x_j\|_\xi$$

$$\Delta_{\max} = \max_{\forall i}\max_{\forall j}\{\Delta_{ij}\}$$

3. Data and Results

We developed online materials for one semester course of application of multimedia for the freshmen students in St. John's University Taiwan. The data are collected from the online activities, whose topics cover the introductory review and basic applications of character, audio, video, image processing as well as animations. Several online forums, quizzes and assignments are built up to include all important topics of the coverage. They take the online course every week and are required to learn from the multimedia material, joining discussing forum, and take a short quiz in asynchronous course management system based on Moodle. Each quiz contains 5~10 randomly selected problems. All the source data for online activities are listed in Table 1. All results of activities are sorted into the following: Final Grade, Total Numbers of Post, Total Stay Time in CMS, Pre-course Quiz, Quizzes before Mid-term, Quizzes after Mid-term, Assignments before Mid-term, and Assignments after Mid-term.

The source data of the above-mentioned course activities are sorted and used to calculate the Minkowski distance of *Lp* norm. Table 1 gives these results for all the students. In order to calculate the grey relational norm, the source data must be normalized so that the variables are between 0~1, as listed in Table 2. The grey relational grade Gamma values are computed using current GRA model and compared. The activities are then sorted by grey relational grade Gamma values. The larger number of Gamma represents that the corresponding parameter has more significant relationship with the final grade. Table 3 lists the results based on the sequence of Gamma from 1 to 0, and all activities are grouped into four levels: significantly correlated, well correlated, slightly correlated, and weakly correlated. We find that the three activities: assignments before mid-term, quizzes after mid-term, and quizzes before mid-term are significantly correlated with students' final grades. Students who get higher evaluation in the assignments and quizzes tends to pay more attention to the class requirements, and thus achieve higher final grade. On the other hand, total numbers of post and assignments after mid-term are well correlated with final grades. This means that students who post more in the discussion forums will also get higher evaluation. It is interesting to found that pre-course quiz is just slightly correlated with students' achievement and the total stay time in CMS is weakly correlated. The current outcomes suggest that pre-course quiz and total stay time in CMS could hardly explain the learning achievements of students.

4. Conclusions

Students' online activities in the learning management system Moodle were investigated in this paper. An approach based on grey relational analysis (GRA) was developed and applied to study the correlations between all online activities and students' final grades. We developed online materials for one semester course of application of multimedia for the freshmen students in St. John's University Taiwan. Several online forums, quizzes and assignments are built up to include all important topics of the coverage. GRA model is conducted and corresponding results are obtained so that we could understand which of the interactivities in the online course is significantly correlated with the students' final outcomes. The results are ranked based on Gamma value, and all activities are grouped into four levels: significantly correlated, well correlated, slightly correlated, and weakly correlated. We find that the three activities: assignments before mid-term, quizzes after mid-term, and quizzes before mid-term are significantly correlated with students' final grades. Students who get higher evaluation in the assignments and quizzes tends to pay more attention to the class requirements, and thus achieve higher final grade. It is interesting to found that pre-course quiz is just slightly correlated with students' achievement and the total stay time in CMS is weakly correlated. The current outcomes suggest that pre-course quiz and total stay time in CMS could hardly explain the learning achievements of students. As Sawasdichai and poggenpohl (2003) wrote [31], "User behavior needs to be deeply understood in order to design a system that will allow users to perform their tasks easily." The more we can understand the correlation between students' online activities with their final grades, the better we can design online quizzes as part of the course content.

References

[1] Means, B., Toyama, Y., Murphy, R., Bakia, M. & Jones, K. (2010). U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, *Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies*, Washington, D.C., 2010.

[2] Larreamendy-Joerns, J., & Leinhardt, G. (2006). "Going the distance with online education," *Review of Educational Research* 76, 567-605.

[3] Chou, C., Peng, H., & Chang. C, Y. (2010). "The technical framework of interactive functions for course-management system: Students' perceptions, use, and evaluations," *Computer & Education, 55*, 1004-1017.

[4] Maor, D., & Volet, S. (2007). "Interactivity in professional online learning: a review of research based studies," *Australasian Journal of Educational Technology 23*(2), 269-290.

[5] *Moodle.org.* (n.d.). Retrieved April 13, 2011, from http://moodle.org/

[6] Martin-Blas, T. and Serrano-Fernandez, A. (2010). "The role of new technologies in the learning process: Moodle as a teaching tool in Physics," *Computers & Education* 52, 35-44.

[7] Ingram, A. L. (2005). "Using Web server logs in evaluating instructional web sites," *Journal of Educational Technology System*, *28*(2), 137-157.

[8] Nickles III, G. M (2005). "Identifying measures of student behavior from interaction with a course management system," *Educational Technology System*, 34(1), 111-126.

[9] M. G. Moore, and G. Kearsley, (1996). *Distance education: a system view*, Belmont, CA: Wadsworth. 1996.

[10] Godwin-Jones, R. (2012). "Emerging Technologies Challenging Hegemonies in Online Learning," *Language Learning & Technology* 16(2), 4-13.

[11] J. Deng, (1982). "Control problems of grey systems," *Systems and Control Letters*, vol. 1, pp. 288-294.

[12] F. Ke, and K. Xie, (2009). "Toward deep learning for adult students in online courses," *Internet and Higher Education*, vol.12, pp. 136-145.

[13] C. T. Lin, C. W. Chang, and C. B. Chen, (2006). "The worst ill-conditioned silicon wafer machine detected by using grey relational analysis," *International Journal of Advanced Manufacturing Technology* 31, 388-395.

[14] J. Moran, E.vGranada, J. L. Miguez, and J. Porteiro, (2006). "Use of grey relational analysis to assess and optimize small biomass boilers," *Fuel Processing Technology* 87, 123-127.

[15] D. L.Olson, and D. Wu, (2006). "Simulation of fuzzy multi-attribute models for grey relationships," *European Journal of Operational Research* 175, 111-120.

[16] J. L. Deng, (1988). *Grey System*, China Oceans Press.

[17] M. Nagai, D. Yamaguchi, (2004). *Elements on Grey System Theory and Applications*, Kyoritsu-Shuppan, Tokyo.

[18] K. L. Wen, (2004). *Grey Systems: Modeling and Prediction*, Yang's Scientific Research Institute, Tucson.

[19] K. L. Wen et al., (2006). *Apply MATLAB in Grey System Theory*, CHWA Publisher, Taipei.

[20] S. F. Liu, Y. Lin, (2005). *Grey Information*, Springer, London.

[21] D.Yamaguchi, G.D. Li and M. Nagai, (2007). "Verification of effectiveness for grey relational analysis models," *Journal of Grey System* 10(3), 169-182.

[22] M. L. You, C.W. Wang, and C.K. Yeh, (2006). "The development of completed grey relational analysis toolbox via Matlab," *Journal of Grey System* 9(1), 57-64.

[23] D. Yamaguchi, T. Kobayashi, K. Mizutani, T. Akabane, and M. Nagai, (2004). "Marketing research method based on grey theory considering with consumer's kansei," *Japnanese Journal of Japan Society of Kansei Engineering* 4(2), 101-106.

[24] T. Akabane, D. Yamaguchi, G.D. Li, K. Mizutani, and M.M. Nagai, (2005). "Kansei information processing model applied multi- agent systems based on grey theory," *Japnanese Journal of Japan Society of Kansei Engineering* 5(4), 73-80.

[25] D. Yamaguchi, G.D. Li, K. Mizutani, T. Akabane, M. Nagai and M. Kitaoka, (2006). "A K-means clustering approach based on grey theory," *The 2006 IEEE International Conference on Systems, Man, and Cybernetics* 137, 2291-2296, Taipei.

[26] M.Nagai, D. Yamaguchi, and G.D. Li, (2005). "Grey structural modeling," *Journal of Grey System* 8(2), 119-130.

[27] D. Yamaguchi, G.D. Li, K. Mizutani, T. Akabane, M. Nagai, and M. Kitaoka, (2006). "A realization algorithm of grey structural modeling with MATLAB," *Proc. 2006 IEEE International Conference on Cybernetics & Intelligent Systems*, 528-533.

[28] D. Yamaguchi, G.D. Li, and M. Nagai, (2005). "New Grey Relational Analysis for Finding the Invariable Structure and its Applications," *Journal of Grey System* 8(2), 167-178.

[29] X. Rui, and D.C. II Wunshch, (2005). "Survey of Clustering Algorithms," *IEEE Trans. Neural Networks* 16(3), 645-678.

[30] R.J. Hathaway, J.C. Bezdek, and Y.K. Hu, (2000). "Generalized fuzzy c-means clustering strategies using Lp norm distances," *IEEE Trans. Fuzzy Systems* 8(5), 576-582.

[31] N. Sawasdichai, and S. Poggenpohl, (2003). "User analysis framework," *Visual Language* 37(1), 59-91.

Table 1. Students' online activities and final grades

FINAL GRADE	Total Numbers of Post	Total Stay Time in CMS	Pre-course Quiz	Quizzes before Mid-term	Quizzes after Mid-term	Assignments before Mid-term	Assignments after Mid-term
100.00	48.00	8.37	100.00	61.11	83.47	100.00	83.33
90.00	43.00	8.05	0.00	66.67	64.45	83.33	50.00
94.17	46.00	8.18	80.00	90.28	89.31	100.00	83.33
83.33	27.00	6.77	100.00	68.06	32.22	100.00	50.00
100.00	50.00	10.85	100.00	86.11	92.50	100.00	100.00
76.11	48.00	7.78	90.00	95.83	89.58	100.00	100.00
69.44	28.00	11.47	90.00	87.50	55.83	100.00	83.33
94.17	49.00	8.03	90.00	69.44	81.67	100.00	100.00
93.33	44.00	8.16	90.00	72.22	63.33	100.00	83.33
92.50	54.00	14.85	60.00	86.11	65.83	100.00	100.00
80.00	44.00	32.38	100.00	45.83	47.09	100.00	33.33
78.61	50.00	14.87	90.00	80.55	56.67	76.67	66.67
95.28	42.00	10.00	0.00	87.50	54.17	66.67	83.33
87.78	45.00	7.83	80.00	65.28	69.44	93.33	100.00
63.33	40.00	12.60	0.00	83.33	65.83	83.33	66.67
88.61	51.00	10.41	90.00	62.50	36.11	83.33	50.00
39.44	13.00	0.46	0.00	0.00	0.00	50.00	0.00
100.00	52.00	8.44	100.00	95.83	60.00	91.67	66.67
99.17	49.00	4.45	100.00	63.89	53.61	76.67	66.67
95.56	53.00	8.87	90.00	90.28	68.34	100.00	83.33
98.33	56.00	10.39	100.00	86.11	74.72	100.00	100.00
81.94	38.00	10.02	100.00	95.83	61.94	100.00	50.00
97.50	54.00	24.84	100.00	81.94	92.50	100.00	83.33
85.00	58.00	8.02	100.00	86.11	90.83	100.00	100.00
100.00	55.00	11.06	90.00	58.33	84.58	100.00	66.67
100.00	50.00	13.15	90.00	76.39	92.36	100.00	83.33
100.00	51.00	14.18	100.00	87.50	79.86	93.33	83.33
66.11	69.00	5.84	100.00	62.50	78.06	93.33	66.67
70.28	25.00	12.72	0.00	91.67	41.39	66.67	53.33
90.28	51.00	5.69	100.00	75.00	59.03	83.33	66.67
63.06	37.00	3.29	80.00	27.78	46.95	43.33	0.00
100.00	47.00	10.88	90.00	75.00	78.06	100.00	83.33
67.50	25.00	5.57	0.00	27.78	25.00	0.00	0.00
91.67	55.00	9.25	100.00	86.11	69.44	100.00	93.33
57.78	12.00	2.64	100.00	27.78	41.67	33.33	0.00
99.17	34.00	11.06	90.00	62.50	74.73	93.33	86.67
74.44	24.00	6.79	0.00	44.44	51.67	100.00	66.67
95.83	30.00	3.84	100.00	27.78	30.97	33.33	0.00
53.61	27.00	2.82	0.00	27.78	46.39	66.67	33.33
88.89	47.00	8.41	100.00	95.83	69.31	100.00	83.33
91.94	54.00	10.69	70.00	95.83	60.28	100.00	66.67
91.67	72.00	10.02	100.00	86.11	85.84	100.00	100.00
87.50	39.00	4.37	100.00	27.78	61.25	93.33	100.00
91.39	51.00	11.94	100.00	81.94	87.22	100.00	100.00
78.61	26.00	9.95	0.00	27.78	47.78	83.33	33.33
98.33	57.00	7.88	100.00	95.83	93.33	100.00	100.00
71.11	52.00	4.15	80.00	66.67	77.08	100.00	66.67
85.00	40.00	7.38	90.00	65.28	62.50	96.67	50.00
93.33	25.00	2.07	100.00	33.33	41.25	26.67	0.00
75.28	47.00	6.49	100.00	59.72	87.08	100.00	66.67
0.00	3.00	0.13	0.00	0.00	0.00	0.00	0.00
0.00	3.00	2.16	0.00	5.56	0.00	0.00	0.00

Table 2. Normalized online activities and final grades

FINAL GRADE	Total Numbers of Post	Total Stay Time in CMS	Pre-course Quiz	Quizzes before Mid-term	Quizzes after Mid-term	Assignments before Mid-term	Assignments after Mid-term
1.00	0.65	0.26	1.00	0.64	0.89	1.00	0.83
0.90	0.58	0.25	0.00	0.70	0.69	0.83	0.50
0.94	0.62	0.25	0.80	0.94	0.96	1.00	0.83
0.83	0.35	0.21	1.00	0.71	0.35	1.00	0.50
1.00	0.68	0.33	1.00	0.90	0.99	1.00	1.00
0.76	0.65	0.24	0.90	1.00	0.96	1.00	1.00
0.69	0.36	0.35	0.90	0.91	0.60	1.00	0.83
0.94	0.67	0.24	0.90	0.72	0.88	1.00	1.00
0.93	0.59	0.25	0.90	0.75	0.68	1.00	0.83
0.93	0.74	0.46	0.60	0.90	0.71	1.00	1.00
0.80	0.59	1.00	1.00	0.48	0.50	1.00	0.33
0.79	0.68	0.46	0.90	0.84	0.61	0.77	0.67
0.95	0.57	0.31	0.00	0.91	0.58	0.67	0.83
0.88	0.61	0.24	0.80	0.68	0.74	0.93	1.00
0.63	0.54	0.39	0.00	0.87	0.71	0.83	0.67
0.89	0.70	0.32	0.90	0.65	0.39	0.83	0.50
0.39	0.14	0.01	0.00	0.00	0.00	0.50	0.00
1.00	0.71	0.26	1.00	1.00	0.64	0.92	0.67
0.99	0.67	0.13	1.00	0.67	0.57	0.77	0.67
0.96	0.72	0.27	0.90	0.94	0.73	1.00	0.83
0.98	0.77	0.32	1.00	0.90	0.80	1.00	1.00
0.82	0.51	0.31	1.00	1.00	0.66	1.00	0.50
0.98	0.74	0.77	1.00	0.86	0.99	1.00	0.83
0.85	0.80	0.24	1.00	0.90	0.97	1.00	1.00
1.00	0.75	0.34	0.90	0.61	0.91	1.00	0.67
1.00	0.68	0.40	0.90	0.80	0.99	1.00	0.83
1.00	0.70	0.44	1.00	0.91	0.86	0.93	0.83
0.66	0.96	0.18	1.00	0.65	0.84	0.93	0.67
0.70	0.32	0.39	0.00	0.96	0.44	0.67	0.53
0.90	0.70	0.17	1.00	0.78	0.63	0.83	0.67
0.63	0.49	0.10	0.80	0.29	0.50	0.43	0.00
1.00	0.64	0.33	0.90	0.78	0.84	1.00	0.83
0.68	0.32	0.17	0.00	0.29	0.27	0.00	0.00
0.92	0.75	0.28	1.00	0.90	0.74	1.00	0.93
0.58	0.13	0.08	1.00	0.29	0.45	0.33	0.00
0.99	0.45	0.34	0.90	0.65	0.80	0.93	0.87
0.74	0.30	0.21	0.00	0.46	0.55	1.00	0.67
0.96	0.39	0.12	1.00	0.29	0.33	0.33	0.00
0.54	0.35	0.08	0.00	0.29	0.50	0.67	0.33
0.89	0.64	0.26	1.00	1.00	0.74	1.00	0.83
0.92	0.74	0.33	0.70	1.00	0.65	1.00	0.67
0.92	1.00	0.31	1.00	0.90	0.92	1.00	1.00
0.88	0.52	0.13	1.00	0.29	0.66	0.93	1.00
0.91	0.70	0.37	1.00	0.86	0.93	1.00	1.00
0.79	0.33	0.30	0.00	0.29	0.51	0.83	0.33
0.98	0.78	0.24	1.00	1.00	1.00	1.00	1.00
0.71	0.71	0.12	0.80	0.70	0.83	1.00	0.67
0.85	0.54	0.22	0.90	0.68	0.67	0.97	0.50
0.93	0.32	0.06	1.00	0.35	0.44	0.27	0.00
0.75	0.64	0.20	1.00	0.62	0.93	1.00	0.67
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.06	0.00	0.06	0.00	0.00	0.00

Table 3. Ranks of all activities based on values of Gamma

Gamma	Activities	Group
1.000	Assignments before Mid-term	Significantly Correlated
0.913	Quizzes after Mid-term	
0.882	Quizzes before Mid-term	
0.755	Total Numbers of Post	Well Correlated
0.725	Assignments after Mid-term	
0.688	Pre-course Quiz	Slightly Correlated
0.000	Total Stay Time in CMS	Weakly Correlated