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A Case Study of Applying Learning Analytics in General Mathematics Class

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Abstract

The researcher hope to extend the cafe management period and aims to draw more active participation through various methods and use more tools of communication with the students to receive continuous feedback not only during exam period but during the semester. As mentioned in the debate, the class will be supplemented to help not only the teacher but also the students, in line with the purpose of learning analytics, and the researcher confirmed that by analyzing the learners' learning activities and styles using Naver Cafe's analysis tools, the quality of the individual learning abilities can be enhanced. In the future, this research could be useful as a case study of using learning analytics and hopefully learning analysis tools will be used more widely in education and that this research can be extended into more fields.

Keywords: Big Data, General Mathematics, Learning Analytics, Mathematics Education

1. Introduction

This template, the development of 21st century information technology have reigned in a new era where a large amounts of data are being produced by emails, online video services, web-browsing, and social networking Lee, et al[5]. This large amount of data that can no longer be saved, did not manage, nor analyzed using previous methods is called big data Hong[4]. From the internet, a large amount of complex and various data can be acquired from traces of logs or searches but the data need to be managed and analyzed using analytics in order to ensure the quality and meaningfulness of the data in the different areas. Therefore, modern society is faced with finding a new method to access the large amount of data Lee et al[5]. In areas such as national defense, elections, marketing, sports, and transportation, cases are increasing in which quick decisions have created value Lee et al[5]. Even in educational settings, it has technologically become feasible to use the internet and the mobile environment of smartphones to save information as digital data and help each learner McAfee[7]. And recently much research on the educational use of analytics, namely learning analytics. The goal of learning analytics is to interpret various data on the students and predict the learning performance to increase the learning efficiency for each individual Beth[2]. Also, it interprets the curriculum, professor, and evaluation as well as the learner's learning ability, participation and learning process in real time. It should be pointed out that the large amount of data and the individual learner's disposition are being analyzed at the same time. The advance of learning analytics allows quantitative research qualitative research to be carried out at the same time. By analyzing social networks, one can avoid standardized data and read into the learner's thoughts and overcome the limitations of insights from limited analysis by Lee et al[5]. In education, big data are inadequately used in research limited to areas such as suicide prevention, signs

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of school violence; educational data are categorized and linked to characteristics of big data to construct conceptual models and make suggestions on their use Hong[4].

For this research, the researcher ran a Naver (a Korean portal site) cafe for two weeks and answered questions and offered guidelines for students of "D" university preparing basic mathematics course finals exam. Analytics tools provided by Naver cafe were used to analyze visits and posts of the students; ultimately, the researcher wanted to find out the possibility of using learning analytics for educational purposes. Couple problems can be pointed out with this research. First, the research was conducted during a very short period of time. Second, instead of pursuing the basic purpose of emphasizing cultivation of the enhancement of academic achievement or possibility of academic success, this research emphasized, from the teacher's perspective, more on the purpose of giving insight about the learners to the teacher and enhancing the quality of the class. But as mentioned before, this case study hopes to confirm educational meaning and direction of learning analytics.

2. Research Problems

The research addresses the next three problems.

- The relationship between the page hits and grades of each student.
- To determine the understanding of the students of difficult problems by analyzing the relationship between the problem and the hits on the pages.
- To analyze the learning patterns of the students by looking at the change in the number of cafe's members by date, and the path leading to the pages.

2.1 Learning Analytics

2.1.1 Definition and Characteristics of Learning Analytics

Analytics uses computer science, mathematics, and statistics to extract useful information from the large amount of data records. Learning analytics measure, collect, and analyze learner's data and environment to optimize the learner's learning ability and environmentt[1]. The data acquired from the learner provide useful information to the teacher and removes the risk of the learner giving up on a class in the learning process; thus, it supports learning success in Siemens[9]. The purpose of such data is to support the teacher and school in predicting and providing a customized education according to the student's learning ability in Bark[6]. Learning analytics allow the learner to adapt to learning content, mediate for at-risk students, and provide feedback Bark[6]. Educational big data optimizes learning by providing individual learning to the students by analyzing their learning habits based on the collected data in Siemens[9].

2.1.2 Case Studies of Learning Analytics

College	Program	Characteristics	Result
British Columbia University	VISTA LMS	The Instructor Tools menu within the VISTA system provide a web analysis program that shows a range of data on the students like previous assignments or discussions and the items such as quizzes or subject of discussion to the URL the student visited before arriving at the class homepage or pages visited after the class homepage. The teacher can set which of these data to receive.	From the results, the teachers can decide in real time the best study course or strategy, and identify potential at-risk student group to help them avoid a failing grade.

As can be seen from the different cases shown above, the colleges use a variety of learning analytics tools to help the students choose a suitable course or become successful in the course; it helps identify potential at-risk students and offers help before it is too late. This research uses a new tool, namely by operating a web-portal site Naver's cafe and observing and analyzing the variety of statistics, activities logs given as study analysis tools to see the effectiveness as educational tools. The research is similar to the British Columbia University's Vista system in that it uses the web to make analysis, but it differs from the system in that it doesn't use such programs as LMS.

2.2 Research Method

2.2.1 Research Subjects and Period

This study was conducted on 150 freshmen students for Busan D University by operating a exam preparation cafe for the purpose of finding the learning contents, structure and educational use through the cafes learning analysis. The cafe was operated as a university level basic mathematics final exam preparation cafe, from June 4, 2014 to June 18, 2014 for 15 days.

2.2.2 Research Tools

The research tools used were provided by the Naver cafe's analytics; by using statistics functions provided by the analytics, such as visitor status, page views, visiting dispersion by time and day, the time period between visits, time on spent on pages, the visitor's site usage behavior can be determined. Also the visitor's input such as search input status, search word, URL input, input summary by time period, search engine and search word used, site visited before coming into the cafe can be seen. The tools allow has a page view function, which shows the most popular pages by rank; it also shows the page visited prior to the cafe, the page type, and bounced pages rankings. The analytics tools provide other statistics about the visitor's operating environment such as the browser, operating system, display resolution, mobile operating system; it also shows a graph showing which operating system is run by most of the visitors.

2.2.3 Data Collection and Analysis

In order to implement the research, a cafe (http://cafe.naver.com/dongmyungmath) was set up on Naver named "D College Freshmen College Basic Mathematics Finals Exam Preparation Clinic" and anticipated problems and advanced problems on exponents, logs, Trigonometry 1, Trigonometry 2, Sequence of Numbers were divided and uploaded into ten menus. The students of three classes, numbering 150 students, were told fifteen days before the finals exam about the cafe and that they could ask about advanced problems with which they had difficulties; the students were encouraged to actively use the cafe for their exam preparation. The students could also use the cafe to turn in assignments, in order to visit the cafe more often.

The teacher made an effort to help the students prepare for their final exams by giving feedback, answering the questions of the students, and explaining the process of solving the problems as soon as possible. The teacher provided different problem solving methods that were suited to the individual on even the same problems so that students could observe and think about different approaches in problem-solving methods. Not only were the sign-up date of the learners, visiting dates, page views of the students were recorded but also their visiting paths, statistics on posts and individual activities were analyzed every day using the cafe's analytic tools. The cafe was regularly publicized and the daily and weekly rankings of posts and replies were posted in order to draw more participation and to raise the practical use effect. Various tips and anticipated exam areas were suggested in order to create an atmosphere where the students could use the cafe in order to prepare for their exam.

2.3 Research Results

After managing the cafe for fifteen days, learning analysis tools were used to analyze the relationship between cafe activities and grades, difficult problems in each chapter, and learning types; these three factors were analyzed in line with the research objectives and the following results were obtained.

2.3.1 Is there a Quantitative Relationship between the Cafe Activities and Grades?

In order to find out the relationship between the students who actively participated in the cafe and those who didn't during this period, of the 150 subjects of the study, the frequency of visits and number of questions posted of the top twenty and bottom twenty members were picked from 128 cafe members and their grades were compared as shown in Table 1.

According to the results, the top twenty active members showed an average score of 85.65, but the bottom twenty active members showed an average score of 60.25, showing a big difference in scores between them. The average grade ranks of the students also showed a large gap between the most active members of the cafe, who averaged 31st while the average rank of least active members was 87th. From this we can conclude that the members who actively participated in the cafe had higher scores.

Table 1. The top and bottom twenty active cafe members, their grades, and rankings in the class

Activity Rank	Visits & Questions	Score	Grade Rank		Activity Rank	Visits & Questions	Score	Grade Rank
1	38	78	50		109	7	58	92
2	38	77	54		110	6	56	97
3	36	98	1		111	6	62	85
4	35	88	30		112	6	73	60
5	26	98	1		113	6	50	109
6	26	92	19		114	6	53	103
7	25	93	14		115	5	88	30
8	22	98	1		116	5	57	94
9	22	82	42		117	5	52	105
10	20	95	10		118	5	62	85
11	20	70	65		119	5	81	45
12	19	88	30		120	4	57	94
13	18	95	10		121	4	60	88
14	17	71	62		122	4	71	62
15	17	66	77		123	4	56	97
16	16	71	62		124	4	58	92
17	16	68	72		125	3	56	97
18	16	96	8		126	3	53	103
19	15	98	1		127	3	54	102
20	15	91	23		128	2	50	109

2.3.2 Which Questions did the Students find most Difficult in each Chapter?

The coverage of final exams included chapters on exponents, logs, trigonometry and sequence. In order to find out which questions from each chapters confounded the students the most and to analyze the content difficulty, the learning analysis tool were used to investigate the rank and number of hits of the most popular pages and the most popular questions. The results are shown in Table 2.

From the results, one can conclude that the students had difficulties using graphs and the chapter on trigonometry. Looking at the dispersion of page access, the students were confounded with the same difficult problems regardless of the individual student's ability.

2.3.3 Research on Learning Pattern of Students using the Cafe's Learning Analysis Tools

Using the various learning analysis tools of the Naver Cafe, the changes in the number of members, posts, page views, paths leading to the site were analyzed to investigate the learning disposition and styles of the students.

Table 3 shows by date the number of new members and total members.

From the results, one can see that the learners signed up for the site around ten days before the exam date to prepare for the exams and they were much more likely to sign up on a weekday than the weekday, with most signing up on a Monday, Tuesday, or Wednesday. Of the 150 subjects, twenty-two didn't sign up, leading to the conclu-

Table 2. The content and number of hits of the top twenty pages with most hits during the management of the cafe

Rank	Chapter	Content	No. of hits	Difficulty
1	Sequence	Limit of Sequence of Numbers	277	High
2	Trigonometry	Trigonometry Graphs	269	High
3	Trigonometry	Trigonometry Graphs	240	Medium
4	Trigonometry	Composites of Trigonometry	229	High
5	Sequence	Limit of Sequence of Numbers	228	High
6	Trigonometry	Inequality in Trigonometry	213	Medium
7	Trigonometry	Trigonometry Graphs	198	High
8	Trigonometry	Trigonometry Graphs	180	High
9	Trigonometry	Inequality in Trigonometry	179	High
10	Log	Log Graphs	154	Medium
11	Sequence	Limit of Sequence of Numbers	136	High
12	Log	Log Graphs	134	Medium
13	Trigonometry	Trigonometry Graphs	133	Medium
14	Exponent	Exponential Graphs	111	High
15	Log	Log Graphs	103	High
16	Trigonometry	Composites of Trigonometry	103	Medium
17	Sequence	Sequence Formulas	101	Medium
18	Log	Application of Log Properties	93	Medium
19	Log	Log Graphs	89	Medium
20	Trigonometry	Composites of Trigonometry	89	Medium

Table 3. Changes in the number of total members and new members by date

Date	Total Members	Member Increase		Date	Total Members	Member Increase		Date	Total Members	Member Increase
6/4 W	2	2		6/9 M	65	16		6/14 Sa	115	2
6/5 Th	32	30		6/10 T	84	19		6/15 Su	119	4
6/6 F	39	7		6/11 W	103	19		6/16 M	123	4
6/7 Sa	42	3		6/12 Th	110	7		6/17 T	125	2
6/8 Su	49	7		6/13 F	113	3		6/18 W	128	3

Table 4. Cafe Posts and Page Views by dates

Date	Posts	Page Views		Date	Posts	Page Views		Date	Posts	Page Views
6/4 W	14	32		6/9 M	60	1249		6/14 Sa	90	1260
6/5 Th	55	746		6/10 T	54	1228		6/15 Su	67	1563
6/6 F	8	247		6/11 W	36	747		6/16 M	32	1173
6/7 Sa	4	100		6/12 Th	89	878		6/17 T	31	1331
6/8 Su	6	167		6/13 F	23	838		6/18 W	56	1049

sion that around 15% of the subjects were not interested in using the cafe to prepare for the exam. Table 4 shows page views and posts by dates.

From the results one can see that students asked the most questions for seven days from June 9, ten days before the exam until June 15, three days before the exam, and page views concentrated around five days before the exam. The learning form used by the students took was to ask a variety of questions during the beginning while towards the end many observed and learned from the questions and answers in the posts. Table 5 shows the paths taken by the members to sign-up for the cafe.

According to the results, the students used the Naver Cafe app or directly input the site address on mobile web pages much more than signing up for the cafe through Desktop Personal Computers.

Table 5. Paths taken to sign up for the cafe

Rank	Paths Taken	Views
1	Direct input(cellphone)	699
2	m.cafe.naver.com(cellphone)	262
3	www.naver.com(computer)	156
4	cafe.naver.com(computer)	80
5	sectioncafe.naver.com	77

2.3.4 Debate on the Research Results

The goal of learning analytics is to interpret various data on the students and predict the learning performance to increase the learning efficiency for each individual in Beth[2]. Learning analytics provide customized academic achievement, admission, and path. It also allows teachers to manage and analyze the learning and troubles of the students and use them for educational purposes in Kwon[11]. The purpose of learning analytics is to raise the achievement of all the students by providing feedback in the learning process to many students so that they can successfully complete the course. Learning analytics can help enhance course grades in the short term, and, in the long run, it can help the students choose suitable courses and prepare for employment by playing a large role in deciding and pursuing the right major. It can help raise the satisfaction and achievement level of the students of Korea relative to students of other countries. Actually, some research shows that using posts and forums often and writing more on them correlates with higher academic achievement and more active class participation by West[6].

The limitations of the research were that it was a pilot research and, as such, it was conducted on a limited scale of final exams in a short time period, so that the teacher could only figure out the level of interest and conduct analysis on the grades. It did not directly help at the educational utilization level because it didn't analyze the learning styles or learning process by analyzing the behavioral patterns of the students. Therefore, research

will be conducted during the next semester and applied to all the courses taken by the students. By showing the students graphs two times during the semester, once before mid-terms and the other before finals, that show them how they are doing in such areas as assignments, quizzes, and participation compared to other students, the researcher hopes to help them better prepare for their exams. It is regrettable that the research period was too short and not enough meaningful data related to learning were acquired to conduct qualitative analysis on social networking. The research will be thus be supplemented to use learning analytics, as required by its meaning, to help students in their courses and help the teacher better understand the state and level of the students.

3. Conclusion

During the research the learning analysis tools from the learning cafe were used to observe and research various statistics data and activities to find out the effectiveness of the learning analysis tools and their educational use. The following is a summary of the learning analysis results acquired from running a final exam preparation cafe aimed at college freshmen for a duration of fifteen days.

First, the cafe's learning analysis tools were used to find out individual access, posts, replies, views of the pages and their relationship to the students' grades, and a strong correlation was found between the relationship. The amount of activity in the cafe is correlate to the amount of learning, and the learning effectiveness is increased, reflected by the grades of the students; the increase of interest shown in the cafe can be said to reflect the interest in the exam. Therefore, the learning analysis tools can be used to warn students with low cafe activity of their class status beforehand to prevent low academic performance results.

Second, the popular page views and page hits, which are part of the cafe's learning analysis tools, help figure out which content in the chapters the learners have the most problems. The solutions and feedback are attained through individual questions, but statistics and question content can be analyzed to see which common problems are misunderstood and which problems were the most difficult ones; this analysis will be helpful for researching textbooks and textbook content development.

Third, the change in the number of members by date, number of posts, page views, and paths leading to the site can be analyzed to determine not only the interest level of the subject and grade analysis but the various learning styles. The various learning process behavior patterns can be analyzed from data acquired from the paths students take for learning, the days the students study the most, and the time the students actively start exam preparations; such data can be put to educational use.

The researcher hope to extend the cafe management period and aims to draw more active participation through various methods and use more tools of communication with the students to receive continuous feedback not only during exam period but during the semester. Conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

As mentioned in the debate, the class will be supplemented to help not only the teacher but also the students, in line with the purpose of learning analytics, and the researcher confirmed that by analyzing the learners' learning activities and styles using Naver Cafe's analysis tools, the quality of the individual learning abilities can be enhanced. In the future, this research could be useful as a case study of using learning analytics and hopefully learning analysis tools will be used more widely in education and that this research can be extended into more fields.

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