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Application of Learning Analytics in University Mathematics Education

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Abstract

Objectives: The method of learning analytics was applied to Mathematics in a college course. **Methods/Statistical Analysis**: For one semester, Naver Cafe had been managed in a manner of question and answer and data were collected. **Findings**: The data were analyzed in terms of the correlation between the number of utilization and grade and pattern of study and we figured out which chapter is difficult for students. The results tell us that higher the number the students access to Café, higher the score they gained. **Improvements/Applications**: This method is able to apply for other subjects and further, various learning-methods should be developed in the future.

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

1. Introduction

The 21st century's information and communication technology has brought us into a new era where the amount of data generated by emails, online video services, web-browsing and Social Networking Services (SNS) is exponentially expanding[1]. This large amount of data is called big data, which requires new technologies for storage, management and analysis[2-4]. Modern society is facing challenges demanding alternative approaches to access of incredibly large data[5]. Keeping pace with the era of big data, value creation by prompt decision-making are increasingly witnessed in various areas, including national defense, elections, marketing, sports, and education.

The recent advent of new technologies and efforts to take advantage of them are drawing much attention to learning analytics, which represents the educational use of analytics[6]. The goal of learning analytics is to develop customized educational strategies for improving learning efficiency of each individual student by collecting and analyzing student data[7].

In this study, we ran a Naver Cafe for the students enrolled in a basic mathematics course offered by Pusan University as a general education course and provided online mentoring and responded to the students' questions regarding class materials. In particular, we investigated the potential usage of learning analytics as an educational tool by analyzing visiting log and contents in the students' posts using the tools provided by Naver.

2. Learning Analytics

2.1 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 environment. 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[8]. 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[9].

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2.2 Research Problems

This study addresses the following three issues: First, it addresses the relationship between the number of logins and grades for each individual student. Second, it touches on the understanding of challenging problems that most students consider difficult by analyzing the page hits. Third, it discusses the learning styles of individual students by monitoring and analyzing the number of Cafe members, site hits per day, and paths leading to the Cafe.

2.3 Case Studies of Learning Analytics

Advisor, which was designed by Arizona state university, recommends major and related courses fitted to a student and has contributed to the increased graduate rate from 77 to 84%.

In addition, Austin Peay University employed the Degree Compass program to suggest the most suitable 10 courses for students; indeed, 57% of the courses the students took overlapped with the courses suggested by the program.

Furthermore, Purdue University conducts the signals test at the beginning of the semester to categorize students in high, medium, and low risk groups, and it is represented as a traffic light signal, which uses the results to inform the students of the risk of failures in the courses.

At last, British Columbia University provides suggestions regarding the efficient curricular and learning strategies customized for each student by analyzing assignments, discussions, and paths leading to class web page using the VISTA LMS program.

In this study, the educational effectiveness of learning performance analysis was investigated by running an online Cafe (provided by a portal Naver) as a new research tool and analyzing the statistical data of the online Cafe activities. The approach is comparable with the VISTA program, but no program such as the LMS was employed in this study.

3. Research Method

3.1 Research Subjects and Period

The research was conducted on 650 college freshmen of Pusan University and the Cafe was run from September 9 to December 12, 2015 for the students preparing the final exam.

3.2 Research Tools

The analytics provided by the Naver Cafe allowed us to statistically analyze the data on visitor status, page view, and daily and hourly visitor distributions, which together identified the usage pattern of the members. The analytics also provided the detailed information on search input status for statistical analysis, search words, and URL inputs

3.3 Data Collection and Analysis

A Naver Cafe, named as "Finals Exam Preparation Clinic for the T College Freshmen Basic Mathematics course", was set up and the average-level problems expected to be on the final exam and advanced problems from the 10 chapters covering equations, inequality, exponents, logs, and trigonometry I and II. A total of 650 students in 13 classes were notified about the online Cafe in which any challenging problems could be discussed and they were encouraged to actively use the Cafe for their exam preparation.

The teachers attempted to offer practical helps to the students for their finals by responding to the students' questions as soon as possible with relevant answers.

4. Research Results

4.1 Research Results

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. 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[10].

The data collected through managing the Cafe for a semester was analyzed according to the research goals. First, regarding the relationship between Cafe participation and grades, the top and bottom 20 members were selected based on the number of visits and questioning posts of 634 out of 650 individual members and the related figures are summarized in Table 1.

The average scores of the top and bottom 20 members were 82.43 and 43.62, respectively, and a noticeable difference was found in average grade rank (52nd vs. 433rd).

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

Activity Rank	Visits & Questions	Score	Grade Rank		Activity Rank	Visits & Questions	Score	Grade Rank
1	170	79	50		615	5	54	504
2	165	78	54		616	5	53	543
3	162	99	1		617	5	60	313
4	158	89	30		618	5	70	104
5	154	99	1		619	5	43	612
6	152	93	19		620	5	50	600
7	150	95	14		621	5	85	30
8	149	99	1		622	5	54	504
9	140	84	42		623	4	50	600
10	140	96	10		624	4	60	313
11	138	74	65		625	4	80	45
12	134	89	30		626	4	55	474
13	132	97	10		627	4	56	430
14	129	77	62		628	4	70	104
15	127	69	77		629	3	54	504
16	123	76	62		630	3	53	543
17	121	69	72		631	3	52	580
18	120	98	8		632	2	53	543
19	118	99	1		633	2	52	580
20	114	96	23		634	1	50	600

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	2832	High
2	Trigonometry	Trigonometry Graphs	2564	High
3	Trigonometry	Trigonometry Graphs	2422	Medium
4	Trigonometry	Composites of Trigonometry	2294	High
5	Sequence	Limit of Sequence of Numbers	2153	High
6	Trigonometry	Inequality in Trigonometry	2109	Medium
7	Trigonometry	Trigonometry Graphs	1987	High
8	Trigonometry	Trigonometry Graphs	1806	High
9	Trigonometry	Inequality in Trigonometry	1795	High
10	Log	Log Graphs	1544	Medium
11	Sequence	Limit of Sequence of Numbers	1364	High
12	Log	Log Graphs	1345	Medium

13	Trigonometry	Trigonometry Graphs	1337	Medium
14	Exponent	Exponential Graphs	1117	High
15	Log	Log Graphs	1038	High
16	Trigonometry	Composites of Trigonometry	1034	Medium
17	Sequence	Sequence Formulas	1013	Medium
18	Log	Application of Log Properties	936	Medium
19	Log	Log Graphs	895	Medium
20	Trigonometry	Composites of Trigonometry	898	Medium

These results suggested that the amount and efficiency of learning is proportional to the Cafe activities, eventually affecting the grade, and therefore low activity could be used to warn students to reduce the failure rate. Second, the number of hits on the popular pages and questions were analyzed to identify the questions and chapters, covering exponents, logs, trigonometry, progression, etc., that the students consider more challenging than others. The results are summarized in Table 2.

The results indicated that the students found, overall, that the subjects involving the use of graphs were difficult and the chapter covering trigonometry was the most challenging. Different from the traditional practice in which problem-solving and feedback was offered based on individual request, the analytics based on statistical figures and the contents of the students' questions provided an overall perspective on the subjects and chapters that most of the students found challenging. The approach and results from this study could be used to improve education contents and develop educational materials.

Third, the learning styles of the students were examined by analyzing the number of the Cafe members throughout the semester, postings, page views, paths leading to the site, etc. Table 3 shows the number of new members by date and changes in the number of total members.

The results demonstrated that the number of students signed up for the Cafe peaked seven days before the final and the sing-up rate was highest at the beginning of a week and lowest during the weekends. The number of students did not join the Cafe was 16 accounting for 2%. The number of postings and page views are summarized in Table 4.

According to the results, most of the questions were posted for seven days, ten to three days before the final and the largest number of visitors was recorded five days before the final. At the beginning of the semester, a wide range of new questions were posted and later the students tend to review the questions raised by other members and answers.

Table 5 shows the paths taken by the students to sign up for the Cafe.

In the path analysis, the accesses through direct input of the internet address of the Cafe on mobile devices and the Naver app were dominant compared to the access through desktop computers.

The results and insights on the path leading to the Cafe, the day(s) that the students invested more time on learning, and the interval between the date showed a sharp increase of Cafe activities and the date of the final exam enabled the identification of learning styles and therefore will have practical value for education.

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

Date	Tot Mem	MemInc	Date	TotMem	MemInc	Date	TotMem	MemInc
9/9	34	34	9/14	201	58	9/19	413	18
9/10	57	23	9/15	215	14	9/20	463	50
9/11	97	74	9/16	323	108	9/21	500	37
9/12	131	34	9/17	362	39	9/22	523	23
9/13	143	12	9/18	395	33	9/23	634	111

Table 4. Cafe posts and page views and dates

Date	Posts	Page Views		Date	Posts	PageViews		Date	Posts	PageViews
9/9	14	32		9/14	60	1249		9/19	90	1260
9/10	55	746		9/15	54	1228		9/20	67	1563
9/11	8	247		9/16	36	747		9/21	32	1173
9/12	4	100		9/17	89	878		9/22	31	1331
9/13	6	167		9/18	23	838		9/23	56	1049

The research was conducted on 650 college freshmen of Pusan University and the Cafe was run from September 9 to December 12, 2015 for the students preparing the final exam.

Table 5. Paths taken to sign up for the cafe

Rank	Paths Taken	Views
1	Direct input(cellphone)	1435
2	m.cafe.naver.com(cellphone)	362
3	www.naver.com(computer)	256
4	cafe.naver.com(computer)	143
5	sectioncafe.naver.com	45

5. Conclusions

In this study, the educational effectiveness of learning analytics based on various statistical data reflecting online Cafe activities was evaluated as a tool for learning performance analysis. In summary, a strong correlation between the involvement in the Cafe activity and the grade was found and the problems and subjects that most of the students consider challenging could be identified by analyzing the hits of the popular web pages. In addition, the learning style of individual students could be determined based on the changes of the number of members over time, postings, page views, and paths leading to the Cafe.

Hoping our study offers a resourceful case study of the application of learning analytics and performance analysis tools could be utilized more widely in education and other fields as well, I will end my presentation. Thanks for your attention and I will be glad to answer any questions.

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