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Where are Dropouters ?

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Abstract

A method is devised and tested to predict which students will remain at a low level of comprehension based on information obtained from a mathexam at the beginning of a semester-long class at the university. It is achieved by assigning questions of a level of difficulty appropriate to the objectives of the class and to the level of the students

Keywords: Class comprehension, Math tests for Physics, Popularity curve

1 Introduction

Experience shows that some students have the potential to understand the class without dropping out with a little instruction. We define a dropouter as a student on the verge of falling who will drop out without appropriate instruction. Increased comprehension is assumed to mean that interest in the learning content is aroused. From this perspective, we find similarities in the universal behavior of the rise and fall of popularity of online content. We think that a similar mechanism can be applied to the level of interest in the class [1][2][3][4]. According to this analogy, we have found the functions presented in the following chapter. “Clicker” and “facial expression measurement" have been proposed as methods for measuring comprehension and concentration [5]. We have further developed and demonstrated a method of estimating students' final level of comprehension based on how well they solved the problems by drawing clear images in their minds. One of the authors (Konashi) has been teaching mechanics to first-year students of School of Engineering Science and School of Engineering at Osaka University. The goal is to match the image of natural phenomena with the mathematical equations that express them, that means to improve imagery ability. Computer Graphics (3DCG) and Augmented Reality (AR) videos have been used in classes to create visual impressions and improve understanding [6]. In the class, example problems were used to write down natural phenomena into equations of motion or, conversely, to imagine natural phenomena from the equations of motion. Mathematical problems have been used to estimate this correspondence ability (denoted as imagery ability). The results showed that students whose imagery ability and computational skills in math problems were at the lower level, were more likely to have a lower level of understanding of physics by the end of the semester. We concluded that if we keep these students in mind and apply countermeasures, we will be able to give lectures with zero dropouts. In section 2, the concept of analysis is introduced, and in sections 3 and 4, the teaching method and results of analysis are presented. 5 is a summary and future applications.

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2 Theoretical Outline

We know a temporal change, in which interest in a certain matter arises but wanes with time. It is well known that the part of the interest fades can be represented by an exponential decrease [1]. As described in the Introduction, to match Net Contents, the interest-increasing part is expressed as a polynomial and smoothly connects it with the decay part. The following (Equation 1) is derived.

$$Views = A \frac{f(x)}{exp\frac{x}{L} - 1} \quad (1)$$

$$A{:}\,Scale\ Parameter\ , \quad x{:}\,trials\ , \quad L{:}\,level\ parameter\}$$

$$f(x) = a_1x + a_2x^2 + a_3x^3 + a_4x^4 + .\,...\ :a_1, a_2, a_3, a_4.\,...\,weight\ parameters$$

The following (Figure 1) is an example of fitting: the number of daily views of Niconico[2] and YouTube[3] can be reproduced by choosing the suitable parameters. A is a parameter for adjusting the size to fit the maximum value to equation 1 and is named the scale parameter. x is a parameter expressing time or frequency. L is a parameter to classify the level of proficiency. a1 ... etc. are parameters for expressing the trend and are intended to be used for data analysis by assuming x as a continuous function. In Figure 1, the simplest example is drawn with A=1, a_3=1, and a_i=0 , $i \neq 3$.

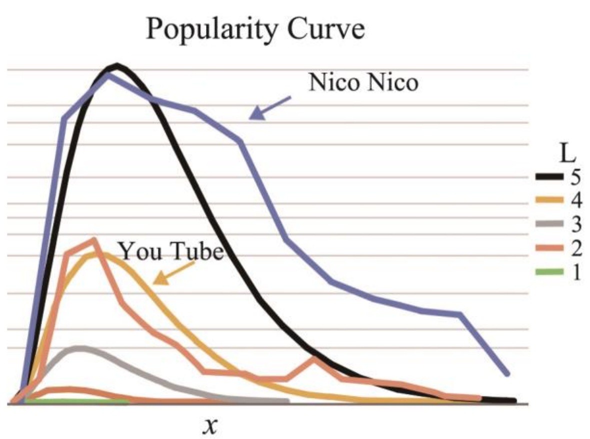

Figure 1: Number of views on the Net

We have applied this (Equation 1) to reduce the decline in students' interest in class and to increase the attendance rate in class [4]. In this paper, we tried to judge at an early stage which level of this curve the student belongs to.

3 Methods of Teaching and Data Observables

We constructed the following class system and collected class data.

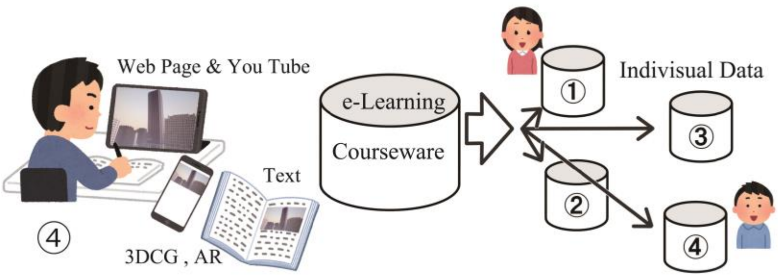

Figure 2: Image of courseware & Students in the course

3.1 Course System

All course materials are stored in an administrative database (Figure 2). These are managed by the courseware. The feature of our system is that 3DCG and AR created by ourselves are incorporated in the pdf with QR codes or AR markers.

3.2 Lectures

As noted in the Introduction, in each lesson, I have picked up a familiar phenomenon and applied the concept of mechanics to write down the equation of motion. I have repeated the process of transforming and solving the equation while explaining the meaning of each term of the equation. 3DCG and AR are made correspondingly to the phenomenon to help students image creation. We think that improving the imagery ability would deepen the understanding[6].

3.3 Observables

We have examined by using the following question whether students who had high imagery ability at the start of the curve (at the beginning of the class) are students with high peaks. A unique feature of this paper is that, as noted above, we aim to improve the imagery ability on physics. We searched for appropriate check problems and we have found that the best way to measure this is to use a mathematical problem. This is because in each class we emphasize the improvement of imagery ability on physics, and students quickly become accustomed to this, so it is necessary to check from a different perspective. The following policy is used to create a math problem Q1 for this purpose. 1) Calculations are not easy, but students can be solved by computational skills alone.2) They can imagine the meaning of a part of the formula as a figure. Mathematical expressions have meaning as a whole. We have done with similar questions Q2, Q3, and Q4, and are omitted for reasons of space. It has assumed that there were no differences in academic performance between years in the relevant department.
Q1 Find the value of following equation. Measure the time required for the answer. (source : https : //manabitimes.jp/math/1727)

$$\sum_{j=0}^{7} {}_9C_j \times_{10} C_{7-j}$$

4 Analysis

The Q1 was conducted in the first class. Improvements in imagery ability were then measured at 3-week intervals by mathematical questions. As mentioned in 3.3, students seemed to have become accustomed to the idea and no significant differences have been found. Since the first and second semesters were in different faculties, the comparison of grades were be divided into the first and second semesters and conducted in 2020 and 2021 in the same faculty. Table 1 compares the performance on Q1 for the top 10 and the bottom 10 in total physics exam score.

4.1 School of Engineering Science

The percentage of correct answers to Q1 for students who had good total scores was higher than for students who had poor total scores, with a 92% confidence level. Conversely, students who were able to solve Q1 had a 93% confidence level that their total scores were better than those who were not able to solve Q1.

Table 1: Compare grades with students from 2021 and 2020

20201st. Half	Q1	Q1	Q2	Q3	20211st. Half	Q1	Q1	Q2	Q3	Q4
(89Students)	(3)	Answer Time (sec)	(2)	(2)	(90Students)	(3)	Answer Time (sec)	(2)	(2)	(4)
Lower average	0.50	6.50E+02	1.00	0.95		0.80	5.70E+02	1.10	1.00	1.60
Lower unbiased dispersion	0.28	4.32E+04	0.00	0.25		0.18	3.40E+05	0.10	0.22	0.27
Upper average	0.80	8.21E+02	1.15	0.85		1.00	5.58E+02	1.10	1.00	2.00
Apper unbiased dispersion	0.18	1.98E+05	0.11	0.23		0.00	6.10E+04	0.16	0.00	0.00
Z Value	1.41	-1.10	1.41	-0.46		1.50	0.06	0.00	0.00	2.45
Reliability	92%	14%	92%	32%		93%	52%	50%	50%	99%

In the School of Engineering, we have the same results as for the above. Our tentative results are now more certain. Omitted due to limitation of pages. From this, we believe that questions such as Q1, which simultaneously test computational and imagery ability, will be a touchstone for growth in performance in this subject.

5 Conclusion

By creating confirmation questions tailored to the students 'level and using this paper 's method of estimating final comprehension, we can measure students' responses early in the course and know students' insufficiency at an early stage. [7] Combining face-to-face lectures with this system allows students' lack of understanding to be addressed on the spot. This year, we are trying various assistance methods in the Online class for students who may be likely to be dropouters found by the method of this paper. Finally, we can build "No Student Left Behind " teaching system.

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