The Development of an Analytical System for Student Support Services

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ABSTRACT: *The higher education is very essential for people because it concerns with an individual's quality of life improvement, future career possibilities, upper wages and so on. However, many students drop out of the university because of diverse problems. The student problems are divided into five main aspects: learning, financial, social, health and psychological aspect. Some students face with one problem; others face with more than one. To maintain the student retention rate and to increase the opportunity to graduate from the university, the student support services workflow information system (SSS WIS) is necessary for the university. The proposed SSS WIS can screen the student with problems for incubating. In this paper, the education analytics for the student support services is proposed. The experimental results show that the proposed method can raise student retention rates to 92.76 percent.*

1. Introduction

The student support services (SSS) is very important to maintain the student retention rate and increase the opportunity of degree completion [1-3]. APQC American Productivity and Quality Center (APQC) [4] proposed the Education Process Classification Framework (Education PCF) for the academy. All academies can define the comprehensive work processes without duplicated process. This framework focuses on the student support services by determining as the main procedure of the effective administration of the academy as shown in Figure 1.

Normally, the first process of the academy is defining the strategy and goal to persuade students applying to the academy; this is called the enrollment management [5]. Subsequently, the student enrollment marketing, the academy strategy to attract and engage prospective students, is conducted. The examples of student enrollment digital marketing are YouTube, Line, Facebook, Instagram, Twitter, etc. [6]. For recruiting students to meet the target number, it is necessary to integrate processes covering all university divisions such as registration and academic evaluation, financial and accounting, academic support, student affairs
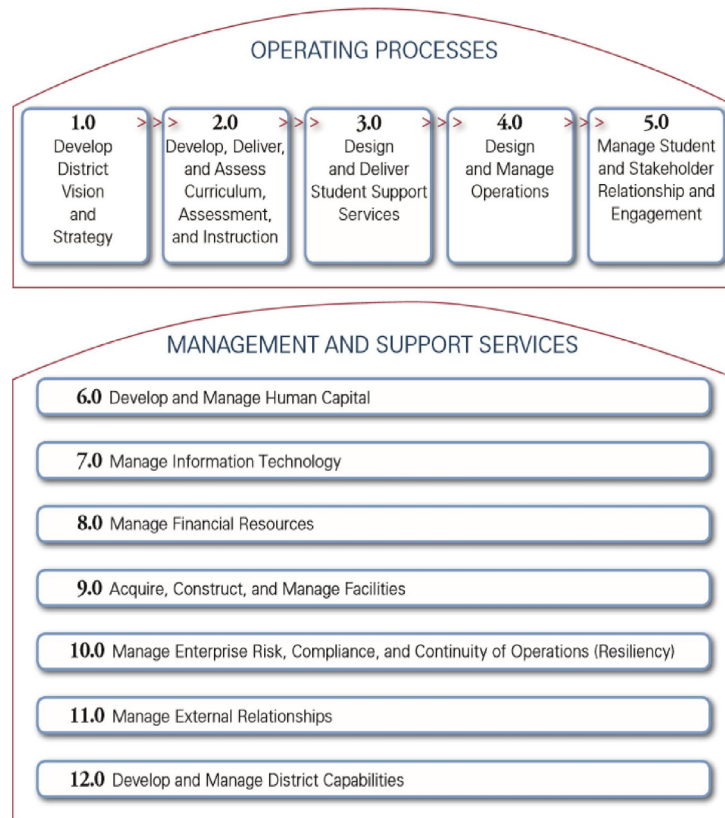
Figure 1. Education Process Classification Framework [4, p.1]

and so on. Most universities, however, those divisions have no good collaboration. Each division has their own information system which cannot integrate to the others. Supposing that the university has a good information system of student support services integrating all divisions, the university will get useful information to take care of students until they complete the degree. If not all information from many divisions is wasted.

The student support services workflow information system functions are student data gathering from various divisions and student data analytics. The advice and incubation can make a student troubleshooting. Thus, the gathered data are most likely used to individually analyze the student who needs help. In this paper, the educational analytics for the student support services system is proposed to classify the student who has such problems.

The other parts of this paper are organized as follows. The related works of education analytics are briefly reviewed in section two. The problem analytics and student screening into the incubation processes are explained in section three. The student support services workflow information system algorithms and educational analytics processes are illustrated in section four. The experimental results and conclusion are presented in section five and six, respectively.

2. Related Work

Educational analytics is the indicator which evaluates the performance of the academy and the stakeholders such as students, lecturers, officers, executives, and the university executive committees. Generally, the indicator is divided into two main aspects: academic and administration. Furthermore, the analytics in higher education is classified into seven types by Bameveld, Arnold & Campbell [7]. There are (1) analytics (2) business analytics (3) academic analytics (4) learning analytics – academia (5) learning analytics – industry (6) predictive analytics and (7) action analytics as shown in Figure 2.

In this paper, the educational analytics of the student support services is based on business analytics and academic analytics. Nowadays, the academy has been gathering data in various forms. The collected data are prepared or cleaned to execute to get
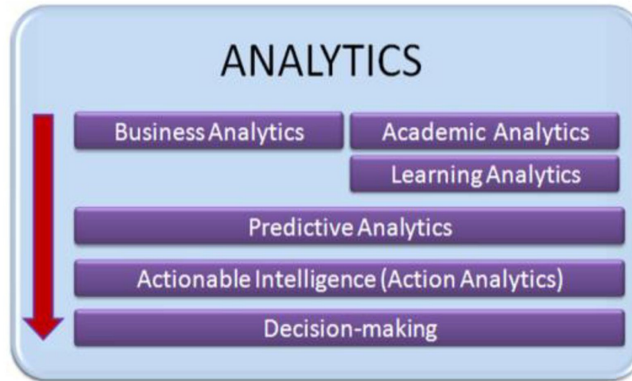
Figure 2. Conceptual Framework of Analytics in Business and Higher Education [7, p.5]

the indicator results which are used to improve the learning efficacy. Bichsel [8] found that the obstacle of using educational analytics is the lack of data scientists.

De Freitas et al. [9] studied the student retention by creating the problem probability indicators of some students who have problems. The student support services are defined by these indicators which are based on the conceptual Learning Analytic Model (LAM). In addition, Hu, LO & Shih [10] applied data mining techniques to identify the risky student and student study forecasting for troubleshooting which possibly occur to the students. Likewise, Yadav, Bharadwaj & Pal [11] predicted the student graduation by decision tree algorithm which is one of data mining techniques. This information is very useful information because of four benefits as follows. Firstly, the information can be used to analyze the student efficacy one by one. Secondly, it is able to classify the causes of student midway dropping out. Thirdly, it is used to identify the student who needs help. Finally, it can decrease the pedagogical mistake for teachers in the next semester. In this paper, the description for the problem analyzing and student screening into the incubation will be discussed in details in the next section.

3. Problem Analytics and Student Screening into the Incubation Process

The student support services (SSS) process is a set of procedures which collects student data for individually analyzing and screens the student who has a problem into the incubation process. The process of problem students filtering for troubleshooting consists of three main steps: student data collection, problem analytics and screening student for incubation, and incubation list classification. The details of these steps are illustrated as follows.

3.1. Student Data Collection
The first step is to collect the student data. The data are used to classify the factor of the non-graduating student. Each group of collected data are designed the indicator to filter the student for incubation. The incubated student will get the best advice which is extracted from the problem analytics. Therefore, the possible non-graduating student has the more opportunity may possibly be the graduating student. The data used are separated into five aspects:

1) Education record data: the record of grade point average (GPA) of grade 7 – 12 and undergraduate

2) Family financial data: overdue or delayed tuition fee payment and other fees

3) Social data: statistic of activities and social interaction record

4) Health data: medical checkup report, congenital disease or medical problems affects learning outcome

5) Psychological data: mental disorder or personality disorder.

3.2. Problem Analytics and Screening Student for Incubation
The problems analytics are considered under five domains of learning outcome and four reinforcing factors. The first one consists of ethics and moral, knowledge, cognitive skills, interpersonal skills and responsibility, and numerical analysis, communication and technology skills. The second one comprises financial, social, health and psychological. Both are used to identify student considered to be in the watch list.

Define t_i to be the index which i denotes as follows:

$i = l$: Learning

$i = f$: Financial

$i = s$: Social

$i = h$: Health

$i = m$: Psychological

Therefore, each indicator is defined as the following.

3.2.1. Learning Index
Usually, the student can complete the undergraduate degree if the grade point average (GPA) is greater than or equal to 2.00. There are many cases of students dropping out because of the GPA is not satisfied. The causes of lower GPA are poor class attendance, not understanding their courses, time management, etc. Thus, the educational index (t_l) of problem analytics is determined as,

$$t_l = GPA \geq 2.00$$

3.2.2. Financial Index
Despite academic excellence student, the other important factor that the student makes a decision an entrance to the university is the financial factor. There are a lot of academic excellence students do not have an opportunity to study in higher education because of financial difficulties. Moreover, some current students also drop out midway because of inability to pay tuition fees. In this paper, the financial index t_f is defined as,

t_f = The number of days for late payment of tuition fees

3.2.3. Social index
Normally, student has a friend both in the real world and the online world. However, some students do not launch the activities with friends in the university. In fact, the students who do not participate in the activities are divided into two groups. The first group does not like to join activities because they only want to study. The second group does not like to join activities because they may be an introvert or have a social problem. Accordingly, one way to evaluate the problem student should be evaluated by the participation in activities or clubs as the following.

• The record of activities or clubs participation.

• The record of participating the online activity or social media in the university.

This index applies to evaluate the student who has a social problem. The evaluator gives the rating scale. The scale is comprised of two types: social problem (SP) and no social problem (NSP). Thus,

$$t_s = Rating\ (SP,\ NSP)$$

3.2.4. Health Index
One factor of failure for degree completion is health. Therefore, the rating scale is employed to evaluate student health problems. The scale is also consisted of two levels as social index: health problem (HP) and no health problem (NHP). Thus,

$$t_n = Rating\ (HP,\ NHP)$$

3.2.5. Psychological Index
The psychological problem or mental health problem is diseases that affect how patients feel, think, act or anything relates to

surroundings. Many people know someone who has, thus, mental illness is very common. However, the symptoms of the psychological problem can range from mild to severe. In many cases, it makes a daily life of people hard to handle. Likewise, some students have a mental illness that affects the learning outcome. This mental illness may relate to the health problem, social problem and so on. To assess the student having a psychological problem or not, the rating scale is applied. The possible output has two values: a mental problem (MP) or no mental problem (NMP). That is,

$$t_m = Rating\ (MP,\ NMP)$$

The conditional process to screen student for incubation process can be written as,

$\quad$ if $t_t < 2.0$ then add d to the watch list

$\quad$ if $t_f \geq 30$ then add d to the watch list

$\quad$ if $t_s = sp$ then add d to the watch list

$\quad$ if $t_n = hp$ then add d to the watch list

$\quad$ if $t_m = mp$ then add d to the watch list

where

$WL\ (d_1, d_2, d_3,..., d_j, d_n)$ be the n students watch list which have to enter the incubation process.

pp_{ij} be the problem profile i where $1 \leq i \leq n, j = 1$ to 5 and $pp_{ij} = 1$ if the student i has the jth problem.

$\quad$ For students, it can be defined as
$\quad\quad$ $i = 1$ to n

For problem aspects, it can be defined as
$\quad\quad$ $j = 1$ to 5

For instance, if $pp_{ij} = 1$ then make an appointment between the advisor and the student for troubleshooting the problem of aspect j.

3.3. The Incubation list for Troubleshooting
The incubation list is the list of the way to solve the problem defined as follows.

l_{1j_1} = The list of Learning incubation

f_{2j_2} = The list of financial incubation

s_{3j_3} = The list of social incubation

h_{4j_4} = The list of health incubation

m_{5j_5} = The list of psychological incubation

Each incubated student must have the incubation list to solve their problem individually. However, one student may have many problems. Thus, it is necessary to add the incubation list more than one. There is much troubleshooting for each incubation list as the following.

3.3.1. Learning incubation Troubleshooting
l_{11} = Get a tutoring service by fellow student

l_{12} = Get a tutoring service by tutor club

$\vdots$

l_{1j_1}

3.3.2. Financial Incubation Troubleshooting

f_{21} = Get a scholarship

f_{22} = Get a part-time job at the library

$\vdots$

f_{2j_2}

3.3.3. Social Incubation Troubleshooting

s_{31} = Join a volunteer club

s_{32} = Join a musical club

$\vdots$

s_{3j_3}

3.3.4. Health Incubation Troubleshooting

h_{41} = Leave of absence for short time

h_{42} = Treat illness

$\vdots$

h_{4j_4}

3.3.5. Psychological Incubation Troubleshooting

m_{51} = Get the study stress treatment

m_{52} = Get psychotherapy treatment because of love problems.

$\vdots$

m_{5j_5}

After the problem student meets the advisor, the result of the problem and the troubleshooting are divided into three ways which display in table 1.

The result of problem considering	Troubleshooting
The problem can be solved	use the designated incubation method
The problem cannot be solved	move to another program, faculty or resignation
The problem has been postponed	postpone the incubation and get more data

Table 1. The result of problem considering and the troubleshooting

4. SSS Workflow Information System Algorithm and Educational Analytics Process

4.1. SSS Workflow Information System Algorithm

The student support services (SSS) is the process related to student data gathering, screening, problem classification, notification and making an appointment, incubation for the problem solving, monitoring and evaluation. The SSS workflow information system algorithm is illustrated in Figure 3.
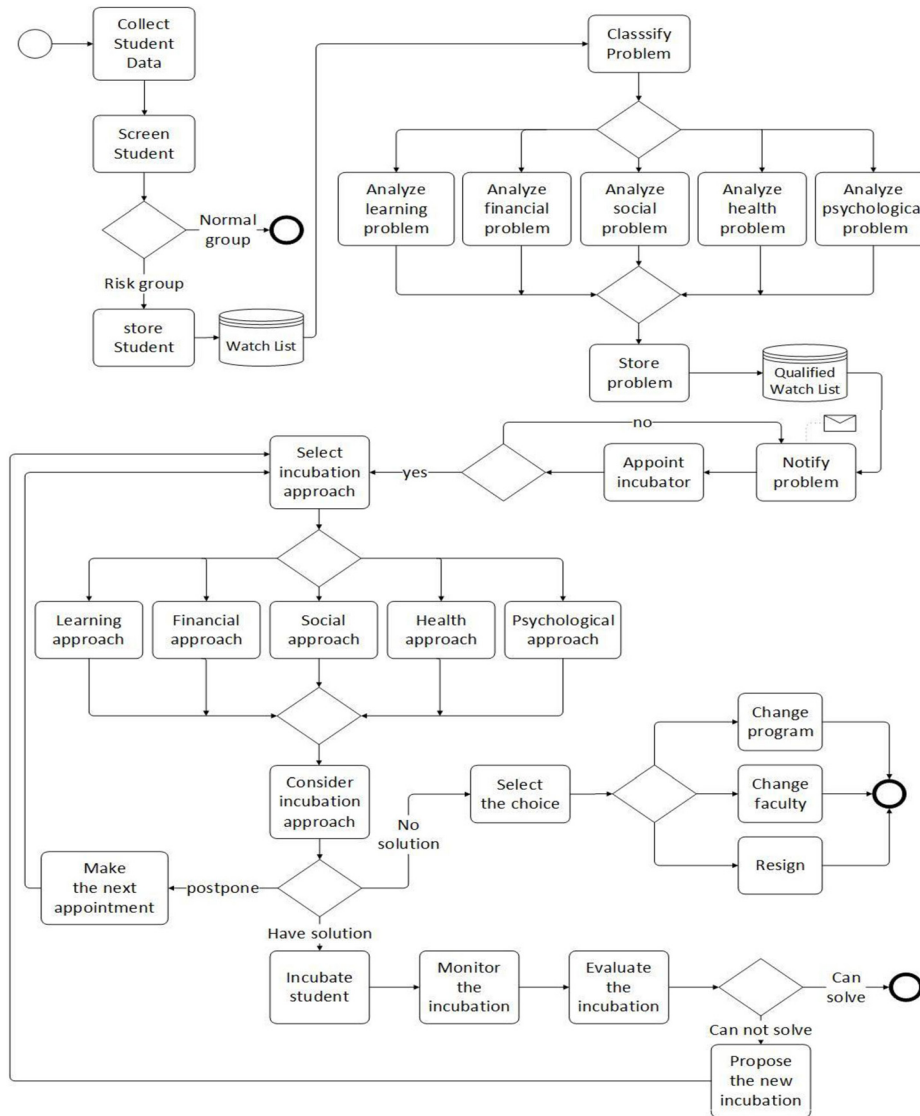
Figure 3. SSS Workflow Information System procedures

1) Collecting student data from

        - University business unit

        - Advisor and lecturers

        - Social media

2) Preliminary to student i analysis to construct watch list (WL)

$$\text{if } t_t < 2.0 \text{ then } pp\,(i, t_t) = 1$$

$$\text{if } t_f \geq = 30 \text{ then } pp\,(i, t_f) = 1$$

$$\text{if } t_s = sp \text{ then } pp\,(i, t_s) = 1$$

$$\text{if } t_n = hp \text{ then } pp\,(i, t_n) = 1$$

$$\text{if } t_m = mp \text{ then } pp\,(i, t_m) = 1$$

$$\text{if weight } (pp(i)) \geq 1 \text{ then put } i \text{ in } WL$$

3) Scan $pp(i,j)$ for students where weight $(i,*) \geq 2$ to recommended in candidate QWL

4) Schedule SSS committee meeting to consider WL and candidate QWL

5) Obtain the final QWL

6) Classify each student i's problem in one of the 5 areas

7) Send warning to the advisor

8) Send e-mail to student to setup meeting time

9) Track the appointment time of student and advisor, then send alert one day before the meeting. Send alert two hours before the meeting.

10) At the consultation meeting, a student in the will have the QWL following status

10.1 Incubate
A solution f_{ijk} will be considered to student i

10.2 Non-incubate
An alternate solution will be considered and approved in the Incubation Process next meeting

10.3 Delay moving solution
A new appointment will be step

11) Monitor and assessment
For student
        if problem persists then find additional measure and seriousness
        if problem has been solved then take the student from the IL, QWL and WL

4.2. Education Analytics for the Student Support Services

The student support service (SSS) using the monitoring and evaluation based on the workflow information system is necessary to get the index data which measures the successful operation. These indexes are called educational analytics. In this paper, the educational analytics is composed of four features as the following.

1) The number of problem students

$$\text{QWL} = \text{the number of students which has weight } pp_{ij} \geq 1$$

2) Incubation ration per QWL student

$$IR = \frac{\text{The number of IL student}}{\text{The number of QWL student}}$$

3) The proportion of the student who are in the incubation and leaves QWL

$$RR = \frac{\text{The number of student who leaves QWL}}{\text{The number of IL student}}$$

4) The proportion of the QWL student who keeps retention

$$GR = \frac{\text{The number of student who keeps retention}}{\text{The number of QWL student}}$$

To increase the effectiveness and performance of the student support service, three notification levels of the student support service operation are accordingly defined to Bloom [12] in table 2.

Score	Operation status	Notification level
$>= 80$	🟢	normal
$60-79$	🟡	watchful
<60	🔴	urgent troubleshooting

Table 2. The notification level for the student support service

5. Experimental Results

According to success indices of educational analytics for SSS workflow information system, after they are implemented to students in the Faculty of management science at Lampang Rajabhat University in the first semester of 2018 (August – December 2018), the experimental results display in Table 3.

Type of students with problems	The number of students with problems	Troubleshooting status			the number of student retention	%
		incubation completion	in process of incubation	resignation		
non-incubated student	41	-	-	34	7	17.07
incubated student	235	113	105	17	218	92.76
total of student with problems	276	113	105	51	225	81.52

Table 3. The experimental results of SSS workflow information system

1) The 1,192 students who are loaded to the problem analytics system, there are 276 problem students. That is 23.15 percent of all students who need help.

2) After the time for the appointment is set up and alerted by the system, there are 235 of 276 students with problems follow the appointment, the other 41 students are not. Thus, there is 85.14 percent of students with problem who need help and appreciate the incubation.

3) For the non-incubated student, there are 7 students or 17.07 percent of retention student.

4) For the incubated student, there are 113 of 235 incubated students that the system can solve their problems. The others of 105 incubated students are still in the incubated process and 17 incubated students are resignation. In other words, there is 48.09 percent of success incubation, 44.68 percent of in process of incubation and 7.22 percent of resignation. The percent of student retention is 92.76 percent. This indicates that the SSS information system can help the students and maintain them to continually study in the university.

5) At the end of the semester, there are 225 of 276 students with problems still study at the university and some of them complete degree. Thus, the student retention rate is 81.52 percent.

In addition, the output of the notification level of the student support service which is classified by indicators is shown in table 4.

List of Indicators	Score	Operation status	Notification level
IR	85.14	🟢	Normal
RR	48.09	🔴	Urgent troubleshooting
GR	92.76	🟢	Normal

Table 4. The notification level of the student support service classified by indicators

6. Conclusion

The SSS workflow information system is the new innovation to operate the student support services. It can collect the student data and analyze the problem of students individually. After analyzing data, the student is filtered for the incubation process. Moreover, the system not only can notify and make a scheduled time of an appointment between the student and the advisor but also the system can monitor and evaluate the student with problems. To evaluate the success of an incubated operation, the educational analytics for SSS is applied. The experimental results show that the system can increase the student retention rate for 92.76 percent. For our future work, the SSS workflow information system is developed by using deep learning to increase the system performance and expand the more condition for solving problems. Moreover, to increase the system elasticity and efficiency, the system is linked to all databases of the university.

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