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Analysis of Courses Affecting Academic Achievement in Higher Education with Association Rules Technique

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Abstract: Improving the quality of education is to develop humanity at its best. Therefore, this research aims at 3 goals. The 1st goal is to study the course structure that affects students' academic achievement, the 2nd goal is to study the relationships of each course that affect students' academic achievement, and the 3rd goal is to assess the patterns of each course's relationship on student achievement. Data collected for research were student data from the B.B.A. (Business Computer) at the University of Phayao from 2001 to 2020, totaling 2,017 students. The research tools are mining association rules with the Apriori algorithm, Support value, Confidence value, LaPlace value, Gain value, PS value, Lift value, and Conviction value. The research results found that it is imperative to accelerate problem-solving of learners' knowledge, skills, and abilities related to Mathematics and English knowledge in improving future curricula with the primary goal of further improving learner quality. The key findings of this research reveal that Thai students still need support and solutions in Mathematics and English for sustainable learning.

Keywords: academic achievement, learning styles, student, academic performance.

运用关联规则技术分析影响高等教育学业成绩的课程

摘要：提高教育质量是为了最大限度地发展人类。因此，本研究旨在实现 3 个目标。第一个目标是研究影响学生学业成绩的课程结构，第二个目标是研究影响学生学业成绩的每门课程的关系，第三个目标是评估每门课程对学生成绩的关系模式.为研究收集的数据是帕尧大学商业计算机从 2001 到 2020 年的学生数据，共有 2,017 名学生。研究工具是使用先验的算法挖掘关联规则、支持值、置信度值、拉普拉斯值、增益值、销售价格值、提升值和信念值。研究结果发现，以进一步提高学习者素质为首要目标，加快解决学习者与数学和英语知识相关的知识、技能和能力问题是未来课程改进的当务之急。这项研究的主要发现表明，泰国学生仍然需要数学和英语方面的支持和解决方案才能实现可持续学习。

关键词：学业成绩，学习方法，学生，学习成绩。

1. Introduction

Artificial Intelligence (AI) technology is now very important in technological development and innovation [1]. Creating competitiveness to make Thailand a developed country with stable and sustainable economic growth and giving Thailand higher competitiveness through national strategic issues are relevant for artificial intelligence technology to support the twenty-year national strategy of Thailand [2, 3]. Developing a modern technological infrastructure is an approach to fostering an ecosystem of collaborative research and innovation from the private sector, universities and agencies, or universities worldwide. Moreover, creating and transferring basic and advanced

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technologies for acquiring the benefit of their use is Thailand's national vision and goal. It is also for real users' needs in private and public areas. In addition, this issue aims to support and accelerate operations in data science, artificial intelligence, and robotics to increase competitiveness so that everyone can access and take advantage of the information security governance tool. It contains cyber information covering ethics and non-violations of privacy.

Moreover, artificial intelligence is important for strategic human resource development and empowerment issues. In developing Thai society to have an environment conducive to and supporting human development throughout life, the need for reforming the learning process is responsive to 21st-century changes by focusing on the learners' learning skills. They are always keen to learn, design new learning systems, change teacher roles, enhance education management systems, lay the foundation for learning systems using digital platforms, and create educational systems for excellence [4, 5]. As mentioned, all parties involved, both public and private, should promote the learning of all people in the country through digital technology, digital platforms, and technology infrastructure. However, nowadays, various educational institutions' teaching and learning processes lack technological change. There is still a low proportion of investment in modern technology to be used in the organization. As a result, educational institutions continue to rely on traditional processes, with a high focus on teachers being at the center of the lesson with learning organized within the classroom.

What is missing is a research study and an in-depth focus on education, for example, finding a learning style that is appropriate and aligned with the learner's qualifications, especially a lesson design that is consistent with learning achievement [6]. In addition, in-depth studies to study the relationship between the structure of the courses in the program of study are also necessary and desirable [7].

Therefore, the research purposes are three important goals: The first is to study the course structure that affects students' academic achievement. The second goal is to study the relationships of each course that affect students' academic achievement. Finally, the final goal is to assess each course's relationship patterns with student achievement. Data collection is a collection of 2,017 students from the B.B.A. (Business Computer) at the University of Phayao from 2001-to 2020, with 254,456 students' transactions. As mentioned above, the researchers believe that this research will greatly affect the development of the quality of Thai education. The research team has carefully selected and designed the research. It consists of descriptions of materials, research methodologies, reports of findings, discussion of findings, and conclusions. Overall, the research team strongly believes that it will further develop the quality of Thai education.

2. Materials and Methods

The research materials and approach have conducted research according to the process of the CRISP-DM model [8–10].

2.1. Business Understanding

Business understanding is the process of analyzing to understand the problem and determine the research direction [9, 10]. Working over research questions and problems, the researchers aimed at the 3 goals. The 1st goal is to study the course structure that affects students' academic achievement, the 2nd goal is to study the relationships between each course that affect students' academic achievement, and the 3rd goal is to assess the patterns of each course's relationship on student achievement.

2.2. Data Understanding

Understanding the data is the study of the data components to select the appropriate data for research [9, 10]. The data collection is the students' data from the Department of Business Computer at the School of Information and Communication Technology, the University of Phayao, in the past twenty years (2001-2020). The data received is 254,456 transactions of student information from a business computer program. Preliminary data showed that the proportion and trend of enrollment in the business computer program were significantly reduced. Meanwhile, the dropout trend increases every year compared to the number of students admitted each academic year, as shown in Table 1.

Table 1 Data gathering (Data updated: April 13, 2021)

Categories	**Academic year**					**Total**
	2001-2003	**2004-2007**	**2008-2011**	**2012-2016**	**2017-2019**	
Graduation (scheduled)	286 (14.18%)	356 (17.65%)	276 (13.68%)	127 (6.30%)	0	1,045 (51.81%)
Graduation (delayed)	29 (1.44%)	36 (1.78%)	60 (2.97%)	108 (5.35%)	0	233 (11.55%)
Dropout	82 (4.07%)	196 (9.72%)	196 (9.72%)	167 (8.28%)	16 (0.79%)	657 (32.57%)
Current students	0	0	0	0	82 (4.07%)	82 (4.07%)

Continuation of Table 1						
Admission	397 (19.68%)	588 (29.15%)	532 (26.38%)	402 (19.93%)	98 (4.86%)	2,017 (100%)

From these data, the hypothesis and research questions is the course structure related to the dropout? Can the structural relationship of the curriculum influence the dropout? What kind of relationship does a student have to graduate or drop out?

2.3. Data Preparation

After understanding the data and the problem, the next step is to prepare the data to be accurate and suitable for developing the model as required [9, 10].

The data gathered were 2,017 students from the B.B.A. (Business Computer) at the University of Phayao, Thailand. The data collection is separated into 5 categories according to the objectives and scope of the research. It consists of former 397 students who enrolled in the 2001-2003 academic year, 588 students who enrolled in the 2004-2007 academic year, 532 students who enrolled in the 2008-2011 academic year, 402 students who enrolled in the 2012-2016 academic year, and 98 students who enrolled in the 2017-2019 academic year.

The curriculum is updated according to government policy every 3-5 years.

Table 1 detailed the B.B.A. (Business Computer) during the past twenty years (the 2001-2020 academic year). According to the curriculum revises, it is separated into 5 categories of data gathering (3-5 years at a time). For the details in Table 1, it was found that the proportion of graduation to dropout ratio has a higher tendency to drop out. For example, in the 2001-2003 academic year, the dropout ratio was 82 students, representing 20.65% of the population and approximately 4.07% of the total population. While in the 2012-2016 academic year, the dropout ratio was 167 students, representing 41.54% of the population and approximately 8.28% of the total population. It has a proportional increase to 203.66% of the number of students who drop out (167:82). It seems to be an obvious problem in the future, as demonstrated in Fig. 1 and 2.

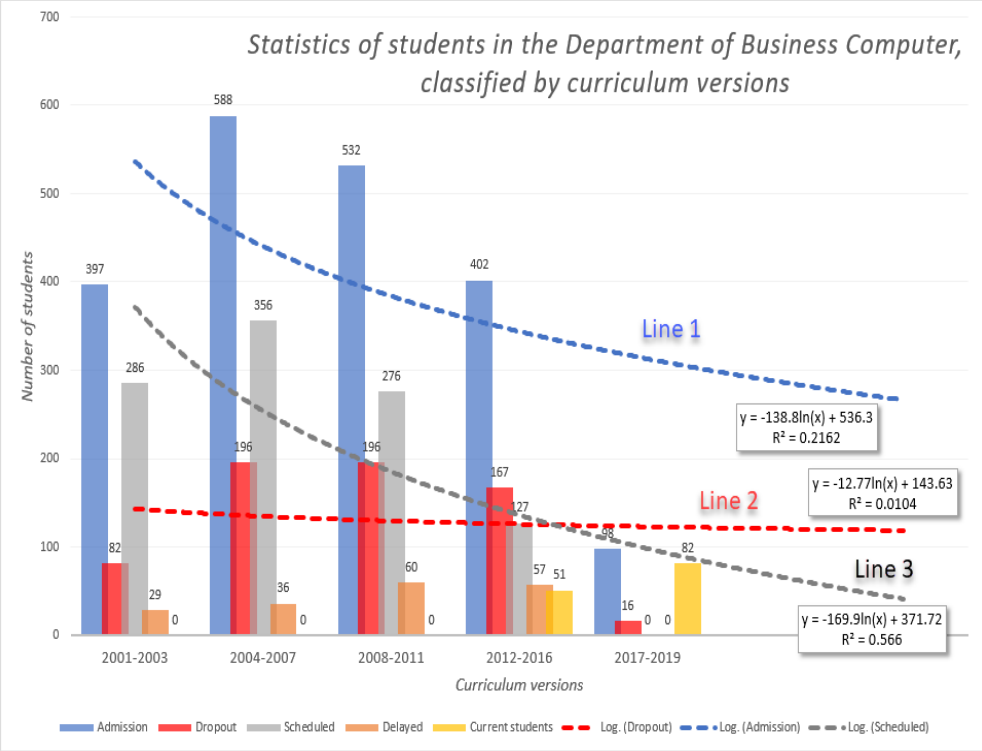

Fig. 1 Students in the B.B.A. (Business Computer)

Fig. 1 clearly shows that the overall trend of students in almost every category tends to decrease, as shown in the blue dash line (line 1). While the trend of graduation according to the curriculum structure (graduated as scheduled) appears to be sharply declining, as shown in the gray dash line (line 3). In addition, it intersects line 2 to show the proportion of student dropout trends in the 2015 academic year. Further details classified by academic year are shown in Fig. 2.

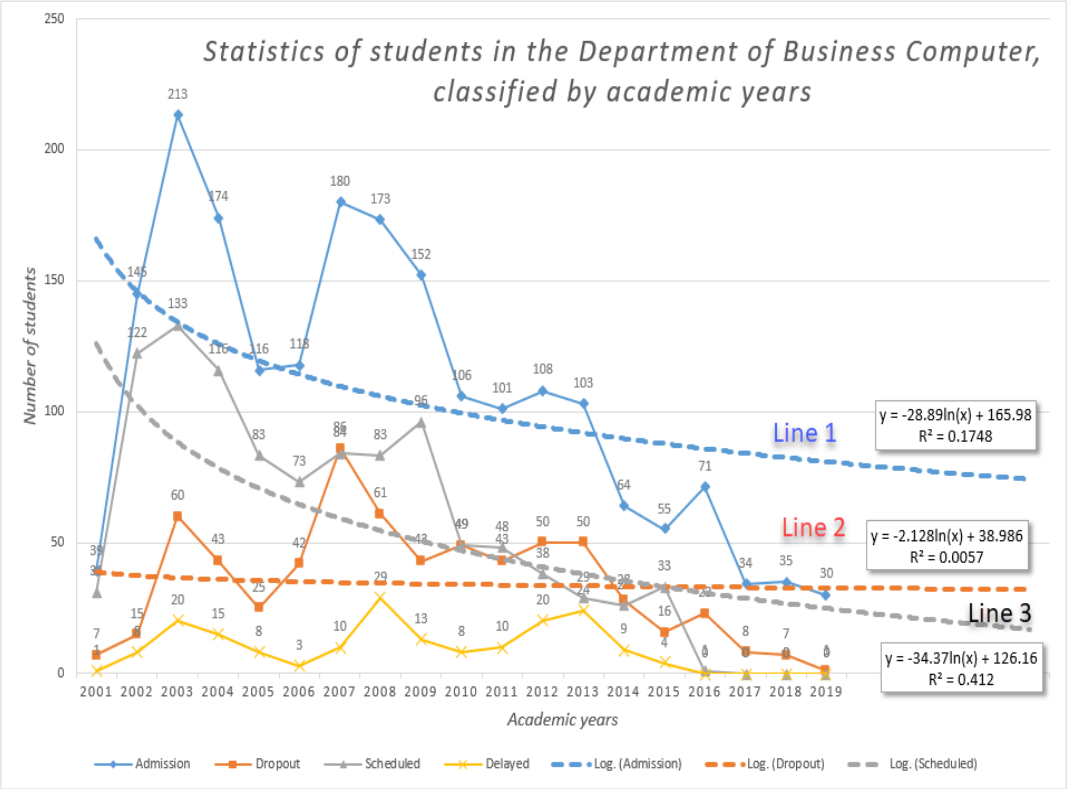

Fig. 2 Students in the B.B.A. (Business Computer)

Fig. 2 shows data compiled by academic year. Obviously, between 2001 and 2007, there was a tendency to increase enrollment in business computer disciplines. However, after 2008, enrollment in the Department of Business Computer has decreased. The worrying part is that dropout rates and input rates have reduced distance. Moreover, the details and years of student dropout are presented in Table 2.

Table 2 Data collection classified by academic year (Data updated: April 13, 2021)

Academic	Admission	Dropout	Graduation		Current students
			Scheduled	Delayed	
2001	39 (1.93%)	7 (0.35%)	31 (1.54%)	1 (0.05%)	0
2002	145 (7.19%)	15 (0.74%)	122 (6.05%)	8 (0.40%)	0
2003	213 (10.56%)	60 (2.97%)	133 (6.59%)	20 (0.99%)	0
2004	174 (8.63%)	43 (2.13%)	116 (5.75%)	15 (0.74%)	0
2005	116 (5.75%)	25 (1.24%)	83 (4.12%)	8 (0.40%)	0
2006	118 (5.85%)	42 (2.08%)	73 (3.62%)	3 (0.15%)	0
2007	180 (8.92%)	86 (4.26%)	84 (4.16%)	10 (0.50%)	0
2008	173 (8.58%)	61 (3.02%)	83 (4.12%)	29 (1.44%)	0
2009	152 (7.54%)	43 (2.13%)	96 (4.76%)	13 (0.64%)	0
2010	106 (5.26%)	49 (2.43%)	49 (2.43%)	8 (0.40%)	0
2011	101 (5.01%)	43 (2.13%)	48 (2.38%)	10 (0.50%)	0
2012	108 (5.35%)	50 (2.48%)	38 (1.88%)	20 (0.99%)	0
2013	103 (5.11%)	50 (2.48%)	29 (1.44%)	24 (1.19%)	0
2014	64 (3.17%)	28 (1.39%)	26 (1.29%)	9 (0.45%)	2 (0.10%)
2015	55 (2.73%)	16 (0.79%)	33 (1.64%)	4 (0.20%)	2 (0.10%)
2016	71 (3.52%)	23 (1.14%)	1 (0.05%)	0	47 (2.33%)
2017	34 (1.69%)	8 (0.40%)	0	0	26 (1.29%)
2018	35 (1.74%)	7 (0.35%)	0	0	28 (1.39%)
2019	30 (1.49%)	1 (0.05%)	0	0	28 (1.39%)
Total	2017 (100%)	657 (32.57%)	1,045 (51.81%)	182 (9.02%)	133 (6.59%)

Table 1 and Table 2 clearly show the number of students who drop out, as many as 657, representing 32.57 percent of the total students. While the number of students graduating on schedule, with only 1,045 students, represents 51.81 percent of all students.

From the data gathered, this research is conducted in 5 sub-steps: selecting data, cleaning data, constructing data, integrating data, and formalizing data.

2.3.1. Selecting Data

The data selection aims to have comprehensive data. However, table 1 and Table 2 showed that the data during the 2017-2019 academic year does not contain

all the components due to the completion of the curriculum structure.

For example, no students have graduated. Therefore, research will not be used in the development of models. The research will specify the scope of use only for the 2001-2016 academic year. At the same time, the 2017-2019 academic year data will be used to apply and test the model to determine its suitability and analyze the developed model.

2.3.2. Cleaning Data

Data cleaning aims to manage irrelevant data and make the selected data match the research objectives. The researcher's data was 7,296 students from the School of Information and Communication Technology School at the University of Phayao. This student data consists of student information from eleven programs during the twenty years, from the 2001-2020 academic year, as detailed in Fig. 3.

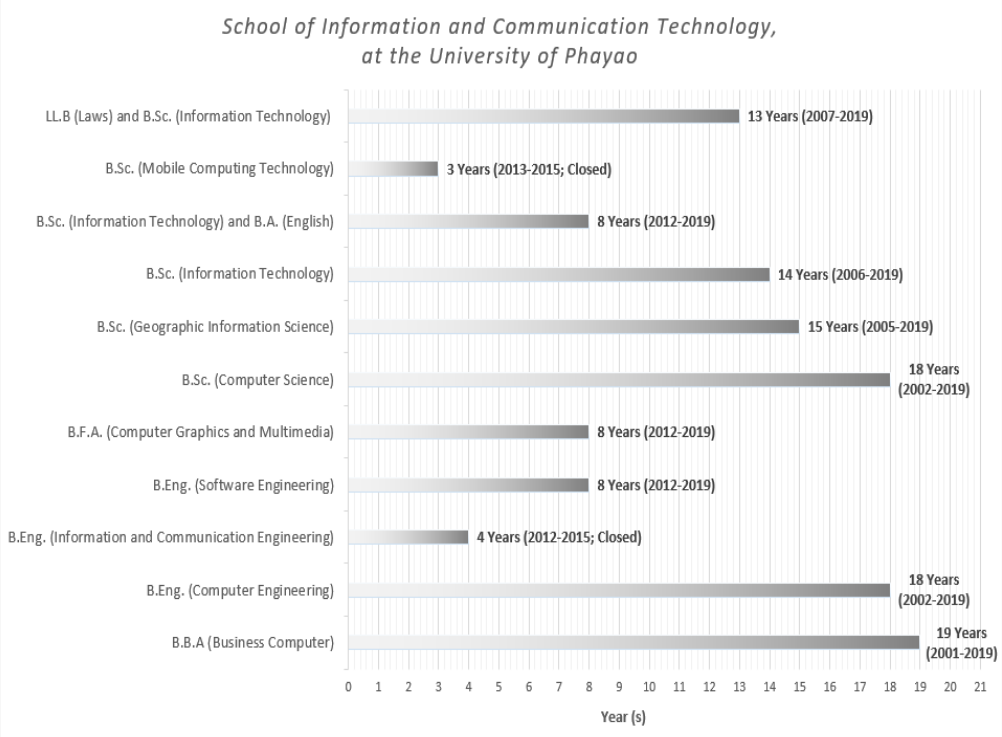

Fig. 3 Duration of the educational programs

As shown in Fig. 3, there are two closed educational programs. In addition, there are eight curriculums unrelated to business computer programs. Therefore, to clean up the data and select the correct data within the scope and complete details, it is also necessary to transform the data into ready-to-use formats, which requires 3 additional steps: constructing data, integrating data, and formalizing data.

2.3.3. Constructing Data

Constructing data uses data that occurs each time, also known as a transaction record, to create data structures in basic data preparation. The transaction record of data collected is composed of 9 attributes: course id (c_id), student id (s_id), academic year (a_year), semester id (smt_id), course code (c_code), course name (c_name), course type (c_type), course credit (c_credit), and course grade (c_grade) as shown in the example of the data structure compiled in Table 3 to Table 5.

Table 3 Constructing data (Data updated: April 13, 2021)

c_id	s_id	a_year	smt_id	c_code	c_name	c_type	c_credit	c_grade
CID01	SID01	2001	1	CD001	Name01	GE	3	B+
CID01	SID01	2001	1	CD002	Name02	GE	3	B
CID01	SID01	2001	1	CD003	Name03	M	3	A
CID01	SID01	2001	2	CD004	Name04	GE	1	C
CID01	SID01	2001	2	CD005	Name05	M	3	B+
CID01	SID01	2001	2	CD006	Name06	M	3	A
CID01	SID01	2001	2	CD007	Name07	GE	3	A
CID01	SID01	2001	2	CD008	Name08	GE	3	B
CID01	SID02	2001	1	CD001	Name01	GE	3	D
CID01	SID02	2001	1	CD002	Name02	GE	3	C+
CID01	SID02	2001	2	CD004	Name04	GE	1	B
CID01	SID02	2001	2	CD005	Name05	M	3	B

Continuation of Table 3

CID01	SID02	2001	2	CD006	Name06	M	3	A
CID01	SID02	2001	2	CD007	Name07	GE	3	A
CID01	SID03	2001	1	CD002	Name02	GE	3	D+
CID01	SID03	2001	1	CD003	Name03	M	3	C+
CID01	SID03	2001	2	CD004	Name04	GE	1	B
CID01	SID03	2001	2	CD005	Name05	M	3	A
CID01	SID03	2001	2	CD006	Name06	M	3	A
CID01	SID03	2001	2	CD007	Name07	GE	3	A
CID01	SID03	2001	2	CD008	Name08	GE	3	B
…	…	…	…	…	…	…	…	…
CID0x	SID0y	Year	Semester	Code	Name	Type	Credit	Grade

Table 4 Integrating data (Data updated: April 13, 2021)

Student details
Student ID: 44xxxxx1
First and Last names: ABCDEF WXYZ
Educational program: Bachelor of Business Computer Program
Affiliation: School of Information and Communication Technology

Semester	**Student status**	**Education status**	**Registration data**		**Cumulative registration data**	
			Credits	**Avg.**	**Total credit**	**Total average**
1 (2001)	Studying	Normal	19	3.10	19	3.10
Course code	**Course name**	**Section**	**Credit**	**Grade**		
001111[1]	English I	171	3 (3-0)	B+		
001126[1]	Thinking, Reasoning, and Ethics	171	3 (3-0)	B		
001127[1]	Man and Environment	171	3 (3-0)	A		
001136[1]	Global Issues	171	3 (3-0)	C		
001151[1]	Quality of Life Improvement	171	3 (2-2)	B+		
001152[1]	Body Conditioning	0	1 (0-2)	B+		
252182[1]	Calculus I	171	3 (3-0)	C+		
Semester	**Student status**	**Education status**	**Registration data**		**Cumulative registration data**	
			Credits	**Avg.**	**Total credit**	**Total average**
2 (2001)	Studying	Normal	18	3.41	37	3.25
Course code	**Course name**	**Section**	**Credit**	**Grade**		
001103[1]	Thai Language Skills	171	3 (3-0)	A		
001112[1]	English II	171	3 (3-0)	B		
001125[1]	Information Technology	171	3 (3-0)	A		
001135[1]	Thai Studies	171	3 (3-0)	B		
001141[1]	Introduction to Computer	171	3 (2-2)	B		
001245[1]	Science in Everyday Life	171	3 (3-0)	B+		
Semester	**Student status**	**Education status**	**Registration data**		**Cumulative registration data**	
			Credits	**Avg.**	**Total credit**	**Total average**
1 (2002)	Studying	Normal	21	2.35	58	2.93
Course code	**Course name**	**Section**	**Credit**	**Grade**		
205221[1]	Grammar and Writing	171	3 (3-0)	B		
213100[1]	Introduction to Business	171	3 (3-0)	C+		

Continuation of Table 4

214110[1]	Introduction to Economics	171	3 (3-0)	B
217102[1]	General Psychology	171	3 (3-0)	B
222101[1]	Principles of Accounting I	171	3 (2-2)	D
231201[1]	Business Statistics	171	3 (2-2)	C

Table 5 Formalizing data (Data updated: April 13, 2021)

s_id	**Academic Results (Grade)**							**GPA**
	CD001	**CD002**	**CD003**	**CD004**	**CD005**	**…**	**Code**	
SID01	B+	B	A	C	B+	...	C+	2.93
SID02	D	C+	B	B	B	...	B	2.70
SID03	B	D+	C+	B	A	...	A	3.17
SID04	C	C	B+	B	A	...	A	2.60
SID05	C	C+	C	C+	A	...	B+	2.07
SID06	C	D	F	C+	A	...	B+	2.02
SID07	D	C	D+	C	A	...	B	2.62
SID08	D	D	D	C	A	...	A	3.03
SID09	D+	D+	D	C	B	...	B+	1.34
SID10	C+	D	W	B+	A	...	C+	2.12
SID11	C	C	C	C+	B	...	B+	2.73
SID12	C	D	C	C	A	...	B+	3.30
SID13	C	A	C	C	A	...	B+	3.02
SID14	C	D+	C+	C+	A	...	A	1.48
SID15	D	D	D	C	A	...	A	2.46
…	…	…	…	…	…	...	…	…
Student ID	Grade	Grade	Grade	Grade	Grade	Grade	Grade	GPA

All data collected consists of 254,456 transactions posted on the website: https://bit.ly/34JfNub. However, according to research ethics, all information on this website has erased all students_id (s_id) data.

2.3.4. Integrating Data

Integrating data is the process of managing data collected in relation to individual data. It is organized to show according to the structure of the educational program, as it was shown in Tables 3 and 4.

2.3.5. Formalizing Data

Formalizing data is converting data into a form that can be calculated to create a prototype model. Examples of data management in this section are shown in Table 5. The data collection and preparation make the researchers know that the data are different in detail. An important example is the number of credits and courses students must register for. Each version has different amounts of credits and courses. Therefore, it is necessary to analyze each version separately.

2.4. Modeling

After understanding the problem and preparing the data for model development, the next part is the model development process.

This research chooses to find the relationship between the occurrence of the data model known as "Apriori" as the type of Mining Association Rules [11–13]. Data mining association rules have two key components: finding large datasets and correlating them [12, 13]. The fundamental process is to analyze patterns of transactions that occur regularly. As a result, it is desirable to discover important relationships between various items.

Certain items in a transaction will reflect other items in the same transaction. This research is a simulation and imitation of the above ideas. Taking 254,456 transactions obtained from the University of Phayao to analyze data through data preparation included selecting data, cleaning data, constructing data, integrating data, and formalizing data to create a relationship model. It will consider courses that appear paired and strongly influence one another.

2.5. Evaluation

The tool for determining efficiency is monitoring and evaluation [8, 9]. Choosing the right tool for model development needs to be considered. Thus, the research evaluation consists of the Support value, Confidence value, LaPlace value, Gain value, p-s value, Lift value, and Conviction value.

2.6. Deployment

The deployment part is the application of the findings. Applications can take place on many levels. It can happen at both the conceptual and the operational levels [8]. For example, relationship analysis uses support and confidence values as the core for determining relationships by considering the relationships and influence of the course categories that appear simultaneously and result in students graduating

or dropping out.

3. Research Findings

In the research results, the researchers have divided the research report into 3 parts to be consistent with the objectives set.

3.1. Course Structure Affects Achievement

As discussed in Table 1, the Business Computer Education program consists of five versions. However, with the last version, students are still in the process. This research is therefore presented in four versions. It summarizes the course structure compared to the number and proportion of students who graduated, as shown in Table 6.

Table 6 Course structure affects academic achievement (Data updated: April 13, 2021)

	Academic year			
	2001-2003	**2004-2007**	**2008-2011**	**2012-2016**
Number of credits	141	136	136	129
Number of courses	47	46	46	43
Number of general education courses	12	12	11	11
Number of specific courses	35	34	35	32
The number of courses with students who failed the criteria	27	51	58	70
The average number of students who failed per course	11.85	19.61	20.59	14.76
Graduated students as scheduled	286 (72.04%)	356 (60.54%)	276 (51.88%)	127 (31.59%)
Graduated students as delayed	29 (7.30%)	36 (6.12%)	60 (11.28%)	108 (26.87%)
Dropped out students	82 (20.65%)	196 (33.33%)	196 (36.84%)	167 (41.54%)
Admission	397 (100%)	588 (100%)	532 (100%)	402 (100%)

Note: All curriculums require students to take three free elective courses (9 credits included in specific courses)

Table 6 shows the findings from the past curriculums. It shows that in the past the students were studying hard. That is evident from the number of credits and courses reduced in each curriculum version. On the contrary, things were severely astounding that there were more than three times more students failing incidents in fifteen years; this is displayed in the number of courses with students who failed the criteria. For example, from 2001 to 2003, there were only 27 courses that students did not pass the criteria. While in 2012 to 2016, there were 70 courses in which students did not pass the criteria.

Therefore, to find the courses that influenced the students' academic achievement, the researchers looked for the relationship of the courses that influenced the students' disqualification in each course, as presented in the next section.

3.2. Course Affects Students' Achievement

The study of the course relationship in this research was to study the possibility that students would not pass the course criteria simultaneously, known as "the Frequent Item Sets". The research tool in this section is the Apriori technique. The value used for consideration is support value. The results of each course version analysis are presented in Tables 7 to 10.

Table 7 Frequent item sets by the curriculum 2001-2003

Size	**Support Value**	**Item 1**	**Item 2**
1	0.644	Business Mathematics	
1	0.344	English II	
1	0.160	Thai Studies	
1	0.110	Thai Language Skills	
1	0.080	English I	
1	0.067	Principles of Accounting I	
2	0.184	Business Mathematics	English II
2	0.092	Business Mathematics	Thai Studies
2	0.055	Business Mathematics	English I
2	0.104	English II	Thai Studies
2	0.061	English II	Thai Language Skills
2	0.061	Thai Studies	Thai Language Skills

Table 7 presents the findings from the 2001-2003 academic year. Table 7 shows that Business

Mathematics has a 64.40% chance that students in this course will not pass the criteria. It was considered a high level indicating that most of the students in the program had learning difficulties in mathematics. In addition, it was found that students with English language problems had a 34.40% chance of not achieving success in English II.

Table 8 Frequent item sets by the curriculum 2004-2007

Size	Support Value	Item 1	Item 2
1	0.415	English I	
1	0.170	Data Structure and Algorithm	
1	0.167	Principles of Accounting I	
1	0.142	Business Statistics	
1	0.123	Business Mathematics	
1	0.120	English II	
1	0.113	Software Packages in Business	
1	0.111	Conspectus of the Lower Northern Region	
1	0.101	Computer Programming	
1	0.097	Grammar and Writing	
1	0.085	Principles of Accounting II	
1	0.085	Human Behavior	
2	0.059	English I	Data Structure and Algorithm
2	0.078	English I	Business Mathematics
2	0.052	English I	English II
2	0.080	English I	Software Packages in Business
2	0.071	English I	Conspectus of the Lower Northern Region
2	0.071	English I	Human Behavior
2	0.071	Data Structure and Algorithm	Business Statistics

Table 8 presents the findings from the 2004-2007 academic year. Table 8 shows that the English I have a 41.50% chance that students in this course will not pass the criteria. It was considered a high level indicating that most of the students in the program had learning difficulties in the English language.

Table 9 Frequent item sets by the curriculum 2008-2011

Size	Support Value	Item 1	Item 2
1	0.286	Business Mathematics	
1	0.274	English III	
1	0.260	Introduction to Computer Practice	
1	0.225	English I	
1	0.168	Data Structure and Algorithm	
1	0.151	Computer Programming	
1	0.130	Thai Language Skills	
1	0.116	Business Statistics	
1	0.113	Principles of Accounting I	
1	0.095	Principles of Accounting II	

Size	Support Value	Item 1	Item 2
1	0.090	Basic Writing	
1	0.080	Introduction to Business	
1	0.076	Business System Analysis and Design	
1	0.073	Object-Oriented Programming Language	
1	0.064	Taxation	
2	0.104	Business Mathematics	Introduction to Computer Practice
2	0.080	Business Mathematics	English I
2	0.097	English III	Introduction to Computer Practice
2	0.111	English III	English I
2	0.066	English III	Data Structure and Algorithm
2	0.073	English III	Thai Language Skills
2	0.061	English III	Business Statistics
2	0.095	Introduction to Computer Practice	English I
2	0.064	Introduction to Computer Practice	Introduction to Business
2	0.061	English I	Thai Language Skills
2	0.059	Data Structure and Algorithm	Business Statistics

Table 9 presents the findings from the 2008-2011 academic year. Table 9 shows that Business Mathematics has a 28.60% chance that students in this course will not pass the criteria. It was considered a high level indicating that most of the students in the program had learning difficulties in mathematics. In addition, it was found that students with English language problems had a 27.40% chance of not achieving success in English III.

Table 10 Frequent item sets by the curriculum 2012-2016

Size	Support Value	Item 1	Item 2
1	0.413	English I	
1	0.331	Business Mathematics	
1	0.196	Fundamental Information Technology	
1	0.176	English III	
1	0.152	Business Finance	
1	0.126	Thai Language Skills	
1	0.120	Introduction to Programming	
1	0.111	Principles of Management	
1	0.109	Introduction to Economics	
1	0.106	Principles of Marketing	
1	0.079	Basic Writing	
2	0.194	English I	Business Mathematics
2	0.144	English I	Fundamental Information Technology
2	0.091	English I	English III
2	0.082	English I	Thai Language Skills
2	0.067	English I	Introduction to Programming

Continuation of Table 10

2	0.106	Business Mathematics	Fundamental Information Technology
2	0.070	Business Mathematics	English III
2	0.065	Business Mathematics	Thai Language Skills
2	0.059	Business Mathematics	Introduction to Programming
2	0.062	Business Mathematics	Principles of Management
2	0.076	Business Mathematics	Introduction to Economics
2	0.065	Business Mathematics	Principles of Marketing
2	0.062	Thai Language Skills	Introduction to Programming
2	0.065	Thai Language Skills	Principles of Management
2	0.065	Thai Language Skills	Principles of Marketing
2	0.056	Thai Language Skills	Fundamental Information Technology
2	0.062	Introduction to Economics	Fundamental Information Technology
2	0.070	Principles of Management	Principles of Marketing

Table 10 presents the findings from the 2011-2016 academic year. Table 10 shows that English I has a 41.30% chance that students in this course will not pass the criteria. In addition, it was found that students with mathematics problems had a 33.10% chance of not achieving success in Business Mathematics.

3.3. Assessment of Curriculum Correlation Model on Students' Academic Achievement

The correlation model of this research was assessed using seven tools: Support value (Spt), Confidence value (Cfd), LaPlace value (LPl), Gain value, p-s value, Lift value, and Conviction value (Cvt).

4. Research Discussion

Discussing the results of this research is a summary of the research findings from the stated objectives.

4.1. Course Structure Affects Achievement

A study of the course structure found that the Business Computer program reduced coursework and credits with every curriculum revision, as detailed in Table 6. However, the number of students failing to complete all programs is likely to increase since it was 20.65% in the 2001-2003 academic year and 41.54% in the 2012-2016 academic year. In addition, most students tended to be slower when trying to graduate on time, as shown by 72.04% of graduates in the 2001-2003 academic year and 31.59% of graduates in the 2012-2016 academic year. Moreover, the number of courses in students fail to achieve academic performance has greatly increased. Table 6 shows the courses students did not pass according to the criteria. In the 2001-2003 academic year, there were 27 courses students did not pass about the criteria. While in the 2012-2016 academic year, there were 70 courses in which students failed to meet the criteria. It increased by 259.26%. Even though the University of Phayao offers students to choose from more free elective courses, students still cannot meet the criteria for each course.

Table 6, therefore, concludes that the credit and course reductions may not affect academic achievement. However, the impact on learning achievement can be influenced by the abilities and potential of each learner. Therefore, further analysis considers the nature of the course in which the learner failed to meet the criteria as it coincided. It is summarized in the next section.

4.2. Course Affects Students' Achievement

"Course relationship affects students' academic achievement" is the study of patterns in the occurrence of a course in which the student fails the course criteria. The results of each curriculum version analysis are presented in Tables 7 to 10. It can be summarized that the curriculum in the 2001-2003 academic year by the Business Mathematics course impacted the student's lack of academic achievement. There was a 64.40% chance that the student would not pass the course criteria.

In addition, the English II courses have important implications for learners' academic achievement. For example, there was a 34.40% chance that the student would not pass the course criteria. One course was significant to the learner for the 2004-2007 academic year. It is an English I course where learners had a 41.50% chance of not meeting the course criteria. For the 2008-2011 academic year, four courses were significant to the learners. It has a Business Mathematics course with a 28.60% chance of failing the course, an English III course with a 27.40% chance

of failing the course, an Introduction to Computer Practice course with a 26.00% chance of failing the course, and an English I course with a 22.50% chance of failing the course. Finally, the 2012-2016 academic year had two courses that were significant to the learners. It has an English I course with a 41.30% chance of failing the course and a Business Mathematics course with a 33.10% chance of failing it.

In essence, this research revealed that students in the Business Computer program in all curriculum versions had problems with their knowledge of mathematics and English as the main problem. In addition, the researchers found that both courses influenced learning disabilities in the other courses. That is discussed in the next section.

4.3. Assessment of Curriculum Correlation Model on Students' Academic Achievement

As was discovered above, most of the students in the Business Computer program had problems in mathematics and English courses. The researchers, therefore, summarized the effects and influences arising from both courses. It was found that Business Mathematics and English II courses influenced each other. It also affects three other courses in the 2001-2003 academic year curriculums: English I, Thai Language Skills, and Thai Studies. The curriculum in the 2004-2007 academic year had courses related to Mathematics and English that had a significant effect on failure to complete eight other courses: Business Mathematics, Business Statistics, Conspectus of the Lower Northern Region, Data Structure and Algorithm, English I, English II, Human Behavior, and Software Packages in Business. The curriculum in the 2008-2011 academic year had courses related to Mathematics and English that had a significant effect on failure to complete six other courses: Business Mathematics, Data Structure, and Algorithm, English III, English I, Introduction to Computer Practice, and Thai Language Skills. The curriculum in the 2012-2016 academic year had courses related to Mathematics and English that had a significant effect on failure to complete eight other courses: Business Mathematics, English III, English I, Fundamental Information Technology, Introduction to Economics, Principles of Management, Principles of Marketing, and Thai Language Skills.

4.4. Comparing Results with Recent Studies

Research on the application of artificial intelligence technology to improve the quality of education is ongoing and has attracted wide attention [14]. The study of learning achievement on learning behaviors has created innovations in designing learning styles that are suitable for learners [15]. Based on these findings, it is imperative to accelerate the problem-solving of learners' knowledge, skills, and abilities related to Mathematics and English to improve future curricula to improve learner quality further. It is consistent with the current study.

5. Conclusion

This research has 3 goals. The 1st goal is to study the course structure that affects students' academic achievement, the 2nd goal is to study the relationships of each course that affect students' academic achievement, and the 3rd goal is to assess the patterns of each course's relationship on student achievement. The data collection is the students' data from the B.B.A. (Business Computer) at the University of Phayao from 2001 to 2020, totaling 2,017 students. It consists of former 397 students who enrolled in the 2001-2003 academic year, 588 students who enrolled in the 2004-2007 academic year, 532 students who enrolled in the 2008-2011 academic year, 402 students who enrolled in the 2012-2016 academic year, and 98 students who enrolled in the 2017-2019 academic year as detailed in Table 1. The research methodology follows the process of the CRISP-DM model. It consists of six steps: business understanding, data understanding, data preparation, modeling, evaluation, and deployment, as explained in the materials and methods section. The research tools and research test are mining association rules with the Apriori algorithm, Support value, Confidence value, LaPlace value, Gain value, PS value, Lift value, and Conviction value.

In conclusion, it was found that the number of courses and the number of credits for the revised courses tended to decrease. It counters the trend of scheduled graduations. It was found that there was an increased tendency among students to graduate later than scheduled. In addition, it was found that learners were more likely to fail in completing their studies, as summarized in Table 6. In the analysis of courses, there is a potential to affect students, as shown in Table 7 to Table 10. It was found that subjects related to Mathematics and English affected failing achievement criteria in other courses. In addition, from Table 11 to Table 14, it was concluded that these two courses had a great influence on other courses. It was found that during the 2001-2003 academic year, there were five affected courses; during the 2004-2007 academic year, there were eight affected courses; during the 2008-2011 academic year, there were six affected courses, and during the 2012-2016 academic year, there were eight affected courses as discussed in the discussion section.

From discovering the essence mentioned above, the researcher is determined to present the research findings to plan for sustainable student development in learning.

5.1. Recommendations

Regarding suggestions for future researchers and practitioners, the researchers have a strong expectation that the senior management in the organization in

which the researcher has used the data for this research will use the research results to improve, develop, and formulate strategies for sustainable student solutions. In addition, the research was funded by the University of Phayao, so the researcher expects that the university will continue to support and expand the research into practice.

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