The Study of the Factors and Development of Educational Model

The Relationship between the Learner Context and the Curriculum Context in Higher Education

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Wongpanya Nuankaew
Rajabhat Maha Sarakham University, Thailand.

Pratya Nuankaew (✉)
University of Phayao, Phayao,Thailand.
pratya.nu@up.ac.th

Abstract—The objectives of this research were 1) to study the factors of the relationship between the learner context and the curriculum in higher education, 2) to construct of the model relationship between the learner context and the curriculum in higher education, and 3) to test the quality and accuracy after having the model and prototype application of the relationship between the learner context and the curriculum in higher education. Seven instruments were used in this research, including mean, standard deviation, percentages, decision tree, text mining, cross validation, and confusion matrix. The research findings are as follows; 1) The factors that are important to the learner's continuing studying consist of two factors: education system, and interest in studying. 2) The results of the model performance showed that the model has a high level of accuracy (76.50%). 3) The result of the prototype test application by the user is also acceptable, with 68.98 percent accuracy from 1,109 testers. In the future, the researcher has the expectation to develop more accurate predictions.

Keywords—Data Mining in Education, Educational Recommendation System, Learning Analytics Model, Student Model

1 Introduction

Over the past several decades, the process of educational development has emerged and there are many outages. Many successful educational institutions need to go through challenging steps from the education system, education model, and rapidly changing technology. The concept of having institutions such as life communities and lifelong learning communities through education and awareness of the important role of education is the main goal of development to achieve the Sustainable Development Goals (SDGs) [1]. According the World Education Forum 2015 [2] which was hold in Incheon, the Republic of Korea, May 19-22, 2015, the education future vision was

fully captured by the proposal to ensure an inclusive and equitable quality for all educational institutions to promote lifelong learning opportunities for learners [2].

In Thailand's educational system, it has already been developing towards education standards since more than twenty years ago. There is the provision of the National Education Act B.E. 2542 [1] and the Basic Education Curriculum B.E. 2544 [3], which made entire of educational institutions to be aware of the expediency for the reform of Thai education. Consequently, there is a National Education Standards proposed by the Education Council, which is composed of five significant bases including academic information, scrutiny by scholars, the participation of all stakeholders, public relations, and public polls [1].

During 2001-2009, it was the first time in Thailand that the National Education Standard was set [3]. There was the prescription of desirable characteristics, quality, and requisites of whole educational institutions. The standard was established to serve as benchmarks for the purposes of promoting, monitoring, auditing, evaluating, and conducting educational quality assurance [4]. It also defined the significant ideas of education to include the provision of lifelong learning and transforming Thai society into knowledge society [5].

Since 2009, Thai Qualifications Framework for Higher Education (TQF:HEd) has announced and enforced. This reformation has affected all levels of education and reconstructed a new dimension of Thai higher education [6]. There was an increase of curriculums focusing on the skills of critical thinking, problem-solving, and Thai value developing including ethical and moral development, knowledge, cognitive skills, interpersonal skills and responsibility, numerical analysis, and communication and information technology skills [5]. The development of Thailand's education standards is shown in Figure 1.

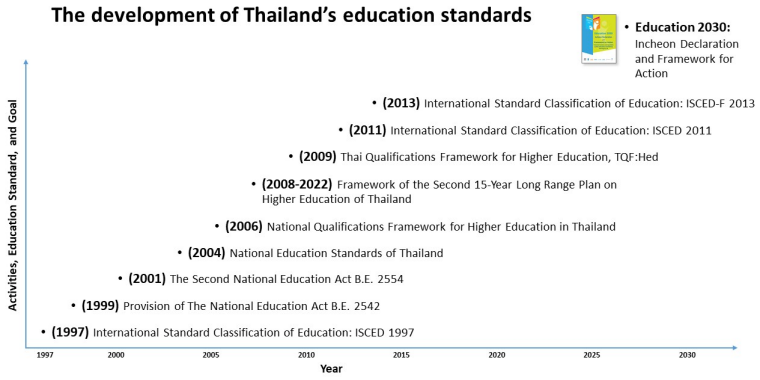

Fig. 1. The development of Thailand's education standards

Figure 1 shows that Thailand's education is addressed in the co-vision of Incheon Declaration: Education 2030 [2]. All standards are committed for promoting quality and lifelong learning opportunities for all levels of education. As the preparation of

educational institution side for ensuring the quality along with the external enforcement from Thai government, there are the contributions and challenges for other factors further than the quality of institution which can affect the learner's decisions for choosing to enroll in particular university.

Moreover, the increase of the Y axis reflects the importance and consistency of the development of the educational quality with the target of the Education 2030. It performs ensuring the equitable quality education and promoting lifelong learning opportunities. Therefore, the research aims to study the relationship between institutions and the context of learners as shown in Figure 2.

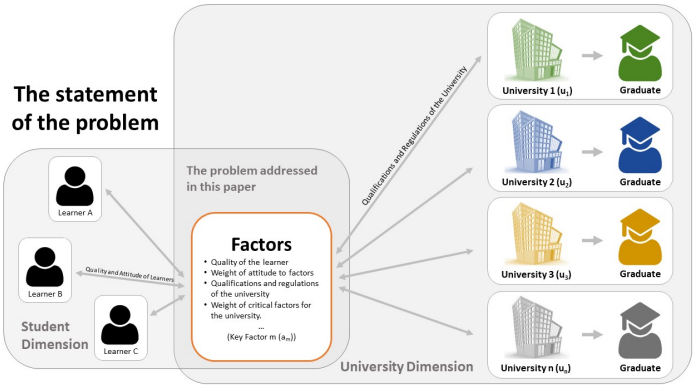

Fig. 2. The statement of the problem

According to Figure 2, the statement of the problem consists of the learner dimension and the educational institution dimension. The first dimension are students who have the expectations for the suitable university and graduate to achieve their goals in the future [7-8]. Conversely, the second dimension is the university, which is supposed to provide the correct and unique information for students [9-11]. This research does not only aim to make the recommendations (institution or program) that suitable for the students, but also provide the stuffs for the institution which support the appropriated information for the learner context.

1.1 Research purpose

The research purpose is aimed to represent a model recommendation by optimizing the relationship between learner context and the curriculum context. Matching learners that are suitable for the appropriate curriculum context can be determined after identifying the appropriate factors from both the institution and the learner, which is shown in the research methodology.

1.2 Research approach

Research approach has been defined and explained in the research methodology. There are three main steps. The first step is to study the factors of the relationship between the learner context and the curriculum in higher education. The second step is to construct the relationship between the learner context and the curriculum in higher education. Finally, the last step is to test quality and accuracy after having the educational model. All research procedures show an overview in Figure 4.

2 Literature Reviews

2.1 Situation and limitations of Thailand education

From the importance and problems of education in Thailand, it can summarize the impacts of the institute in a variety way such as the qualification framework of education, regulations, policy, and guidelines for education reform in Thailand [12].

Therefore, this section summarizes these impacts in four dimensions, including educational programs, educational indicators, stakeholder attitudes, and learning outcomes as shown in Figure 3.

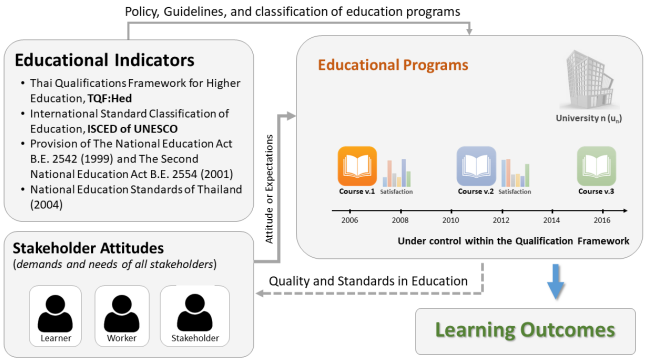

Fig. 3. Situation and limitations of Thailand education

Educational programs: Generally, the academic programs can be changed anytime. It is necessary to build an institution confidence. One of the problems of education in Thailand is that, despite the adjustment of educational programs, most universities and instructors still adhere to the traditional conceptual framework which is not consistent with changes in the educational context of the modern world.

An example of an obvious problem is the enforcement of the legal framework, regulations, and requirements of the institution as a measure of quality of education. It is still used as a criterion for quality checking of learners. Typically, those terms are called the Quality Assurance (QA) to guarantee the quality educational program [13].

With research that discusses the responsibility of the institution, it must be used to improve the quality of students rather than the above criteria [14].

Educational indicators: While educational indicators need to focus on standards as the main issue, the setting of educational quality standards is essential. In higher education, Thailand has determined the quality education framework called Thai Qualification Framework for Higher Education (TQF: HEd) [4]. The purpose of TQF: HEd is to define and control the framework for standardizing teaching and learning activities in order to meet the standards of education in Thailand. It consists of seven elements including TQF 1 National Qualifications Framework for Higher Education in Thailand, TQF 2 Programme Specification, TQF 3 Course Specification, TQF 4 Field Experience Specification, TQF 5 Course Report, TQF 6 Field Experience Report, and TQF 7 Programme Report. While, the kind of learning expected of students are defined inti five domains including Domain 1 Ethical and Moral Development, Domain 2 Knowledge, Domain 3 Cognitive Skills, Domain 4 Interpersonal Skills and Responsibility, and Domain 5 Analytical and Communication Skills.

From the enforcement and operation of the TQF, it was found that there are many aspects of issues for consideration in implementing the framework of institutions such as recognition of prior learning, problems of diversity and awareness of higher standards, verification of standards, condition of learning, and so on [5]. However, even though there are many requirements or regulations, those involved need to adjust to meet the criteria, which the relationship of the discussion in the research is shown in Figure 3. Moreover, the educational indicators are under control of International Standard Classification of Education; ISCED of UNESCO, Provision of The National Education Act B.E. 2542 (1999), The Second National Education Act B.E. 2554 (2001), The Third National Education Act B.E. 2553 (2002), The Four National Education Act B.E. 2562 (2019), and National Education Standards of Thailand (2004). Which all indicators make the education system more coercive measures.

Stakeholder attitudes: The stakeholder attitudes are defined as the demands of all stakeholders such as student, teacher, employee, employer, and parents [15]. It is an important variable that is consistent and relevant to choosing a place to study. While the personal data used in this research are conducted with the purpose, the achievement is analyzing the attitude of students for representing the program through students' interests, family income, social capital, community, personal decisions, instructional purpose, and etc.

Part of this research is based on attitudes towards educational institutions by considering participation in education management, university students' perception, the reputation of educational institutions and others.

Learning outcomes: Learning outcomes are statements that describe significant and essential learning that learners have achieved and can be reliably demonstrated at the end of a program [16]. It means that the learning outcomes are to identify what the learner will know and be able to do after graduation. In the same way, learning outcomes should reflect on the conceptual knowledge, essential knowledge, and generic skills. It also focuses on the results of the learning experiences along the way and towards the destination. Overall, it should be delegated in a potential and competency

manner after completing the program [17]. It can summarize relevant factors in the overall context of the educational program as shown in Table 1.

Table 1. Summary of curriculum context

Characteristics	Features	
Curriculum context	The popularity of the University Curriculum	Education standard Quality assurance

2.2 Learner context dimension

To get the requirements of learner context, it supposed to focus on the feedback, which is the key feature of the process [18-19, 24-26]. Most students take the feedback and learning environments as a tool to select the institutions and define the purpose of their learning. Effective feedback is considered as an important tool to improve the learning and requirements, which are recognized and understood by students and teachers.

Examples of the significant research related to learners' attitudes towards the development of educational quality include Papadakis's research team [24], Kalogiannakis and Papadakis's research [25], and Papadakis's research [26]. They present students' perspectives on teaching techniques that can collaborate in applying and improving modern technology as a very important stakeholder in the 21st century.

As the results, feedback must be timely, relevant, and suitable for the context. Which, the difference in feedback occurs from a different perspective. However, the nature of learner context will be linked to their personal attitude. It is called the learner context, which includes institution policies, students' achievements, students' improvement and students' workload as shown in Table 2.

Table 2. Summary of learner context [18-19, 24-26]

Characteristics and Features		
Student's Interests	***Student's Characteristics***	***Student's Environment***
Interest in studying Career path The identity of the University Obtained knowledge Education system	Ability Skills Knowledge Learning style	Social capital and Economic Trust in institutions Personal decision Family income Community Purpose of study

Accordingly, a matching method between the learner context and the curriculum context in higher education is required to study the variables which are essential for both sides. In this research, the belief is that it is possible to match the right students with the most appropriate educational institution.

3 Research Methodology

The research methodology consisted of three main steps. The first step is to study the factors of the relationship between the learner context and the curriculum in higher education. The second step is to construct the relationship between the learner context and the curriculum in higher education. Finally, the final step is to test the quality and accuracy of the application after having factors and educational model.

Where, the seven instruments were used in this research, including mean, standard deviation, percentages, decision tree, text mining, cross validation, and confusion matrix. All research procedures show an overview in Figure 4.

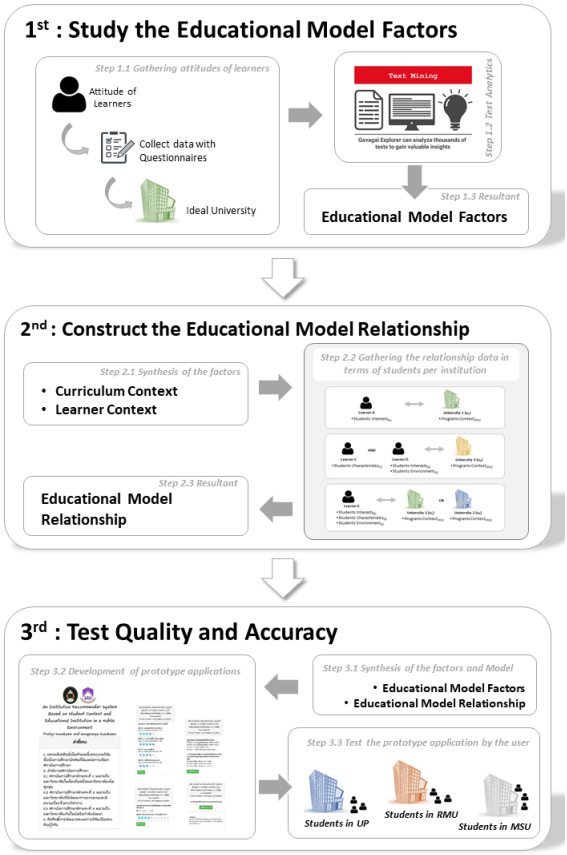

Fig. 4. Overview of all research procedures

3.1 Study the educational model factors

This section aims to study the educational model factors of the relationship between the context of learners and tertiary curriculums. It consists of three sub steps:

The first step is the process of gathering attitudes of learners with questionnaires from a variety of ideal universities. The second step is the process of drafting the factors of the relationship between the context of the learner and the curriculum by analyzing the data from the questionnaire by analyzing the text mining.

Finally, the final step is the certification process of the factors of the relationship between the learner's context and the curriculum, as detailed in each step as follows.

Gathering attitudes of learners: This section deals with the collection and compilation of data from surveys that use questionnaires designed to gather opinions about institutional selection. The dataset is comprised of data gathered from 256 students at 2 universities, including 92 students of the School of Information and Communication Technology, University of Phayao and 164 students of the Faculty of Information Technology, Mahasarakham Rajabhat University. Processes and procedures for sample selection are described in part of sub-research [18].

The questionnaire used as a questionnaire in Thai language, which shows examples of queries on the website https://goo.gl/UGm5oZ.

Text analytics: After collecting opinions, this step is to filter the data to determine the prototype of the factor. This process uses scientific processes to develop. The researcher chose to use the CRISP-DM methodology and the text mining analysis tool to analyze the factors for creating prototypes. The CRISP-DM procedure consists of six steps: business understanding, data understanding, data preparation, modeling, evaluation, and deployment. The main purpose of using CRISP-DM is to manage the data that has been gathered for maximum efficiency.

After that, the data was analyzed with a text mining tool. The result is the prototype factors and the prototype is used to prove the importance of the study at this stage by showing the details of the examination in the next step.

Resultants of educational model factors: This step is the last step of the first section, with the purpose of examining and considering the factors that are found to be used to decide the interest in further study of students. The process consists of analyzing results from the text mining developed with the decision tree model. Reasons for choosing the decision tree process because it is a simple procedure for modeling and can use the resulting node to select factors. After that, use the model testing process called confusion matrix [20, 23] and cross validation methods [20, 23] with the aim to select the most effective model.

The composition of confusion matrix consists of three tools, including accuracy, precision, and recall as shown in Table 3 and Equation (1). In addition, the effective model selection process, the researcher has added tools to manage the data to test the effective model by choosing the cross validation methods [20, 23] to test which is an effective tool.

The process begins by dividing the collected data into two parts: the first part is called training data set for developing models, and the second part is called testing data set for testing the models. Diagram showing the use of such tools as shown in Figure 5.

$$Accuracy = \frac{TP+TN}{TP+FP+FN+TN} \quad (1)$$

Table 3. Confusion Matrix

Predicted / Actual	True Condition		Precision
	Positive	***Negative***	
Predicted Positive	True Positive (TP)	False Positive (FP)	Precision $_{(Positive)} = \frac{TP}{TP + FP}$
Predicted Negative	False Negative (FN)	True Negative (TN)	Precision $_{(Negative)} = \frac{TP}{TP + FP}$
Recall	Recall $_{(Positive)} = \frac{TP}{TP + FN}$	Recall $_{(Negative)} = \frac{TN}{FP + TN}$	

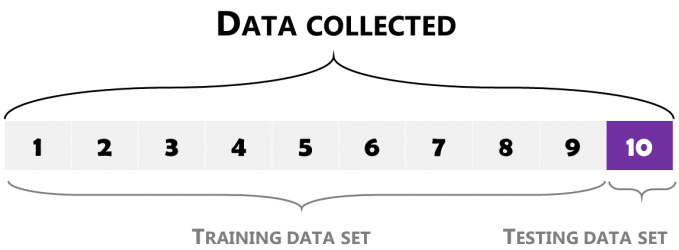

Fig. 5. Cross validation methods

3.2 Construct the educational model relationship

This section is aimed to construct the model of the relationship between the learner context and the curriculum. There are divided into three sub-steps:

Step 1 is the synthesis of factors in Section 1 to study the relationship of learner factors with the ideal university. Step 2 is to collect the relationship data in terms of students per institution. Step 3 is to develop a model of educational relations between students and the curriculum by considering to separate the ideal university.

Synthesis of the factors: Synthesis of factors is intended to be used in the study of the relationship patterns arising from different ideal universities. It has a clear difference from the previous section. By collecting data earlier, is to study the factors from the interest in further study of students from the ideal university. In addition, the nature of the question is to explore open questions for respondents to express their opinions without limitations. On the other hand, the collection in this section is compiled from the closed-ended questionnaire based on the context of the learner and the role of the relevant curriculum by summarizing various factors in Table 1 and Table 2.

Gathering the relationship data in terms of students per institution: Based on the beliefs of the researchers found from relevant research, it was found that the context of the learner and the context of the educational institution can occur in many patterns. For example, the context of a learner that is suitable for only one institution's context. The context of many learners is suitable for the context of a single educational institution. The context of many learners is suitable for the context of an institution only in one place. The resulting patterns are shown in Figure 6.

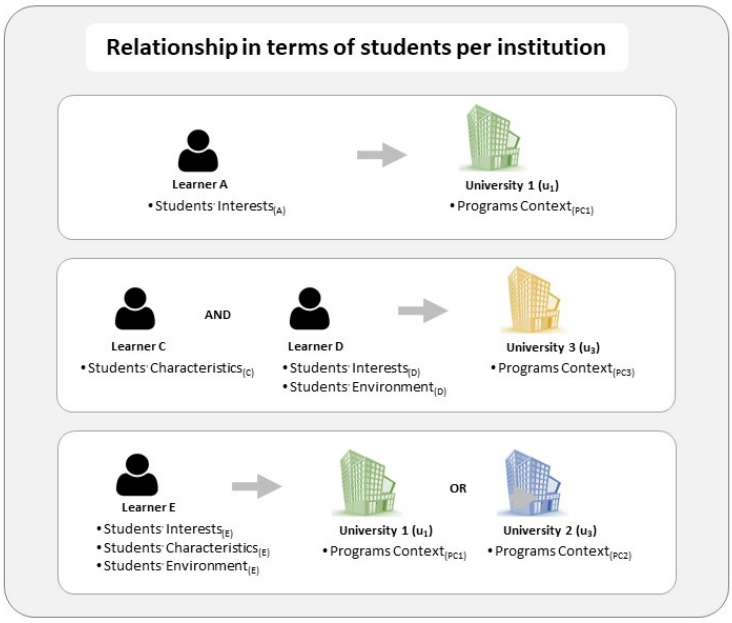

Fig. 6. The relationship in terms of learners per institution

Based on research findings, the researcher therefore classifies the data collection group in the ideal university. Data collection is a distinct source of information. It is randomly re-collected the data through the new survey of 885 students from three universities: Rajabhat Mahasarakham University, Mahasarakham University, and the University of Phayao as shown in Table 6. Finally, the raw data are provided by the students, which are stored at https://goo.gl/UGm5oZ.

After that, the data was analyzed and developed into the relationship of the educational model according to the students' attitudes. In the prototype creating, it is aims to determine the performance and effectiveness of the data analysis and data relationship. The process offers a way to determine the performance that consists of three measurements, which are accuracy, precision, and recall [23]. The details of the process are the same as in the previous step, which shows the calculation in Figure 5.

Resultant of educational model relationship: After having a prototype, it is necessary to implement and validate the prototype. The purpose of this process is to find the prototype performance from the model. The process in this test uses the same tool as the factors performance testing procedure. It consists of cross-validation methods, confusion matrix, accuracy, precision and recall as shown in Figure 5, Table 3 and Equation (1).

The result of the prototype performance is presented in the results and discussion section.

3.3 Test quality and accuracy

This section aims to study the user's satisfaction towards the application named "An Institution Recommender System Based on Student Context and Educational Institution in a Mobile Environment". Such applications were developed from the prototype model and the underlying factors studied in Section 1 and Section 2.

The content of this section is divided into three parts: the process of developing a prototype application, and the process of testing the prototype application by the user.

Synthesis of the factors and model: The synthesis of this factors and the prototype model is to apply the results that have been analyzed from Section 1 and Section 2 to define and design the application development process. The designed steps consist of four main steps: explaining the purpose and qualifications of the application, predicting interest in university education, appropriate university predictions based on attitudes and results summary pages. The result of the prototype application is presented in the next steps.

Developing a prototype application: The development of the prototype application, the researcher uses the principles of program development to be comprehensive and complete application. The system development life cycle: SDLC is the process to develop prototype. It consists of 5 steps as follows: requirement analysis, design, implementation, testing, and evolution.

Test the prototype application by the user: The researcher designed and tested the prototype application with users by dividing the test into three universities: Rajabhat Mahasarakham University, Mahasarakham University, and the University of Phayao.

The testing process consists of three steps:

- Inquiring under the cooperation of students
- Allowing students to test using the program
- Checking the results. In examining the results, the researcher considered the student's affiliation and the results that the prototype application recommended. The results of the prototype application will be shown in the report section.

4 Research Results and Discussion

In this section, it has presented the results of the activities, which consists of three main components. The first part is the study report of factors that predict the decision to study further. The second part is the study report and the development of the prototype model to suggest the appropriate educational institution. The last part is the quality and accuracy test report of the prototype application.

4.1 Report of educational model factors

The data obtained in this section is compiled from the opinion questionnaire, it consists of two data sources: University of Phayao, and Rajabhat Mahasarakham

University as shown in Table 4. The unstructured raw data provided by students is stored at https://goo.gl/vQvR3m and presented examples in Figure 7.

Table 4. Summary of Opinion Questionnaire

Institution	Respondents			
	Gender	***Education Year***		***Total***
UP: University of Phayao	39 Male 53 Female	1st year 4th year	= 59 students = 33 students	92 students
RMU: Rajabhat Mahasarakham University	48 Male 116 Female	1st year 2nd year 3rd year 4th year	= 48 students = 44 students = 41 students = 31 students	164 students
Total	87 Male 169 Female	1st year 2nd year 3rd year 4th year	= 107 students = 44 students = 41 students = 64 students	256 students

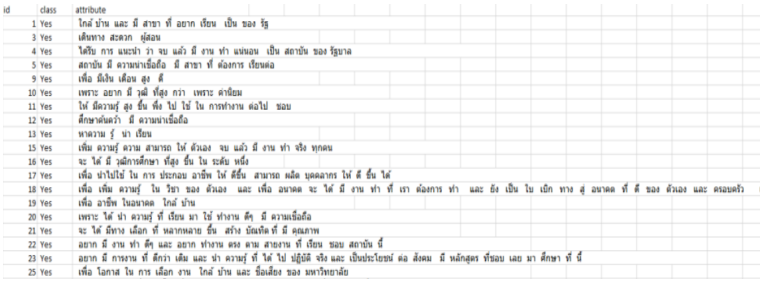

Fig. 7. The sample data from opinion questionnaires

After compiling the data, the researcher conducted various data collection including data extraction, data sorting, and grouping of factors based on the opinion in the questionnaire by summarizing factors from the questionnaire as shown in Table 5.

Table 5. Summary of Critical Factors

Critical Factors	Number of Records
Interest in studying	80 Records (31.25%)
Career path	64 Records (25.00%)
The identity of the University	54 Records (21.09%)
Obtained knowledge	33 Records (12.89%)
Education system	21 Records (8.20%)
Total	252 Records (98.44%)

Table 5 shows the grouping of factors which show the importance of factors from respondents. Then the use of data to calculate the relationship of factors to predict the interest of the learners as shown in Figure 8. The factors derived from the model consist of two factors: education system, and interest in studying.

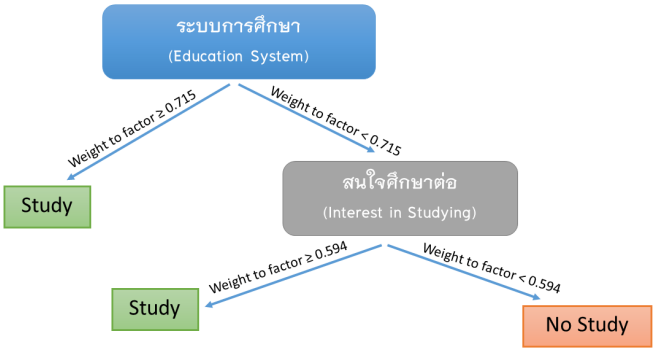

Fig. 8. The predictive model for decisions on continue study

4.2 Report of construct the educational model relationship

The data in this section is clearly separated from the above section and additional data is collected by gathering from 3 educational institutions: University of Phayao, Rajabhat Mahasarakham University, and Mahasarakham University as presented in Table 6. The raw data are stored at https://goo.gl/UGm5oZ.

Table 6. Summary of Questionnaire

Institution	**Respondents**			
	Gender	***Education Year***		***Total***
UP: University of Phayao	114 Male 72 Female	1st year 2nd year 3rd year 4th year	= 64 students = 49 students = 40 students = 33 students	186 students
RMU: Rajabhat Mahasarakham University	176 Male 258 Female	1st year 2nd year 3rd year 4th year	= 123 students = 108 students = 106 students = 97 students	434 students
MSU: Mahasarakham University	105 Male 160 Female	1st year 2nd year 3rd year 4th year	= 109 students = 81 students = 58 students = 17 students	265 students
Total	395 Male 490 Female	1st year 2nd year 3rd year 4th year	= 279 students = 238 students = 195 students = 173 students	885 students

Table 6 shows the data of the respondents who applied to analyze statistics as shown in Table 7. The satisfaction value is measured through five Likert scales survey questionnaire and the satisfaction value. It is interpreted with five rating scales, which is shown in this section.

Table 7. Satisfaction value toward learner context and the curriculum context

Statement	Value				
	RMU	***MSU***	***UP***	***Average***	***S.D.***
Statement 1. Students' Interests					
Interest in studying	3.99	3.34	3.73	3.74	0.804
Career path	3.88	3.39	3.63	3.68	0.831
The identity of the University	3.97	4.08	3.55	3.92	0.758
Obtained knowledge	3.90	3.62	3.80	3.79	0.684
Education system	3.78	3.52	3.69	3.66	0.791
Average:	3.94	3.61	3.67	3.78	0.776
Statement 2. Students' Characteristics					
Ability	4.00	3.21	3.70	3.70	0.821
Skills	3.77	3.21	3.67	3.58	0.705
Knowledge	3.85	3.41	3.69	3.68	0.628
Learning style	3.40	2.86	3.59	3.28	0.710
Average:	3.75	3.17	3.66	3.56	0.739
Statement 3. Students' Environment					
Social capital and Economic	3.73	3.12	3.68	3.54	0.783
Trust in institutions	3.98	4.26	3.88	4.04	0.699
Personal decision	3.03	2.58	3.69	3.04	0.816
Family income	3.43	2.82	3.86	3.34	0.865
Community	3.13	2.70	3.35	3.05	0.783
Purpose of study	3.40	2.70	3.59	3.23	0.908
Average:	3.45	3.03	3.67	3.37	0.882
Statement 4. Curriculums' Context					
The popularity of the University	4.52	3.87	3.62	4.14	0.830
Curriculum	4.27	4.25	3.85	4.17	0.724
Education standard	4.02	4.06	3.87	4.00	0.641
Quality assurance	3.81	3.51	3.83	3.72	0.651
Average:	4.15	3.92	3.79	4.01	0.737
Total Average:	3.78	3.39	3.70	3.65	0.834

Table 7 shows the results of the satisfaction value toward learner context and the curriculum context in higher education from the students' viewpoint. It can be represented the students do agree that the students' interests are reasonable to be a critical factor in the "agree" level as the average value is equal to 3.78. The students do agree that the students' characteristics are suitable to be a critical factor in the "agree" level as the average value is equal to 3.56. The students do agree that the students' environment is appropriate to be a critical factor in the "agree" level as the average value is equal to 3.37. The students do agree that the curriculum context is right to be a critical factor in the "agree" level as the average value is equal to 4.01. Finally, the students do agree that the overall statement is reasonable in the "agree" level as the average value is equal to 3.65.

After preliminary statistical analysis, the researcher developed the prototype model and tested with confusion matrix with accuracy, precision, and recall measurement to find the model's performance. In the testing process, it is divided into two parts, consisting of 10-fold cross validation method, and leave-one-out cross validation method, as shown the results in Table 8 and Table 9, respectively.

Table 8. Model's performance from 10-fold cross validation method

Predicted \ Actual		True Condition			Class Precision
		True RMU	***True MSU***	***True Up***	
Accuracy: 76.50 %	Predicted RMU	328	19	29	87.23%
	Predicted MSU	81	227	35	66.18%
	Predicted UP	25	19	122	73.49%
	Class Recall	75.58%	85.66%	65.59%	

Table 8 displays the results of testing performance with 10-fold cross validation method. It can be seen from the table that the accuracy displayed high performance as the accuracy value is equal to 76.50%. Meanwhile, the average of the precision and recall results in the part of the predictions are the higher levels.

Table 9. Model's performance from leave-one-out cross validation method

Predicted \ Actual		True Condition			Class Precision
		True RMU	***True MSU***	***True Up***	
Accuracy: 74.35 %	Predicted RMU	331	21	25	87.80%
	Predicted MSU	75	224	39	66.27%
	Predicted UP	28	20	122	71.76%
	Class Recall	76.27%	84.53%	63.38%	

The testing performance for leave-one-out cross validation method is shown in Table 9. The testing was highly accurate as the accuracy value is equal to 74.35%, which is close to previous performance. As the testing performance with 10-fold and leave-one-out cross validation methods, it provides the similar results as the accuracy and the average of precision and recall in higher level. Therefore, it can be concluded that this model is the most appropriate and reasonable to be implemented for this research. The prototype model is used to make the relationship between the learner context and the curriculum context in higher education as shown in Figure 9.

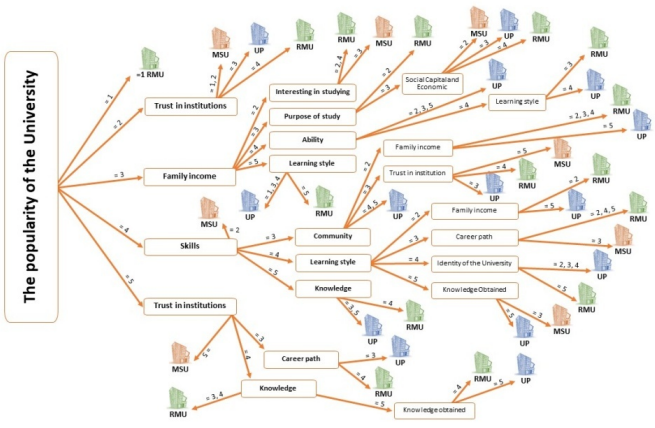

Fig. 9. Prototype model

4.3 Report of test quality and accuracy

Based on the prototype model, this step is to develop a prototype application to test and evaluate user satisfaction. The interface of the prototype application consists of seven screens, including explanations of application, predictive function for decisions on continuing study, level of acceptance towards factors, and recommendation the appropriate educational institution. Such procedures and functions are shown in Figure 10 to Figure 16.

Fig. 10. The Prototype Application

Fig. 11. The Prototype Application

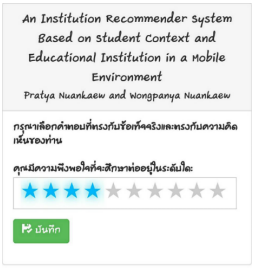

Fig. 12. The Prototype Application

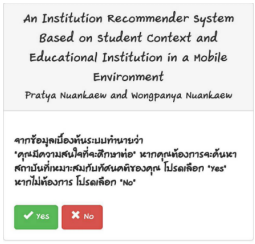

Fig. 13. The Prototype Application

Fig. 14. The Prototype Application

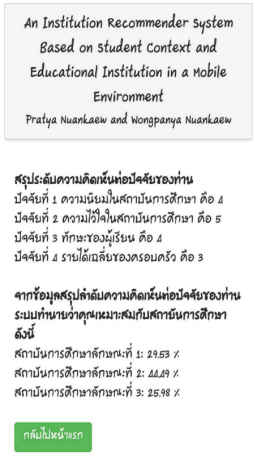

Fig. 15. The Prototype Application

Fig. 16. The Prototype Application

After developing the prototype program, the researcher adopted the prototype program to test with 1,109 students in three educational institutions: 286 students from University of Phayao, 478 students from Rajabhat Mahasarakham University, and 345 students from Mahasarakham University.

The results from the tests of the three students found that the prototype application had the correct predictive ability at 765 sets of the 1,109 data, representing to 68.98 percent.

5 Discussion

In this section, the researchers aim to discuss only in a scientific perspective. There are three issues: The first issue is the data collection perspective as summarized in Table 4, Table 5, Table 6 and Table 7. The second issue is the perspective of using machine learning tools in data analysis as analyzed in Figure 8, Figure 9, Table 8 and Table 9. The last issue is to extend and apply research results.

5.1 Discussion of data collection

From the research methodology, it consists of three main steps, in which all three steps use a sample that separates the data from each other. Therefore, this discussion is therefore a separate discussion.

The first group is an example from the part of the educational model factor as shown in Table 4. It can be seen that the data source is limited, which is not an overview of all universities in Thailand. Thus, the researcher has expanded the scope of the sample group to collect the second section as shown in Table 6. However, both parts have different goals for data collection. The first part is to explore the needs of further education and the second part is to study the relationship between students and curriculum in the higher education institution. While the final data collection is intended to test the application. Therefore, it can be concluded that the data collection is appropriate and meets the research objectives.

Moreover, the results show that the factors in this research were consistent with the relationships and attitudes of respondents. These are 19 significant factors, which are divided into two types including 15 factors of learner context and 4 factors of program context. The data and opinions expressed satisfaction with the significant factor in the agree level, which is the average of all variables equal to 3.65. The variables which are important to the decision of the information obtained from the questionnaire such as a curriculum with an average is equal to 4.17, the popularity of the university is equal to 4.14, trust in institutions is equal to 4.04, and education standard is equal to 4.00.

5.2 Discussion of using machine learning tools

In analyzing the prototype model with machine learning, the researchers used a variety of tools. It consists of using text mining, prototype model development, association rules creation, and model performance testing. It is therefore concluded that the factors and models that have been developed are effective and appropriate.

The first issue is the analysis of factors that are important to further study decisions. It consists of the educational system factor and the study of interest factors which are presented in Figure 8. The second issue is the analysis to develop predictive models and recommend suitable educational institutions for learners. The results have been tested for performance in Table 8 and Table 9. Then it was selected to develop as a model of decision making model, as shown in Figure 9.

From Table 8 and Table 9, it shows that the prototype model has a very high accuracy level. Therefore, it can be concluded that this model is suitable to present students in the university introduction. Based on such analysis and selection principles, it has been used by developing the prototype application as shown in Figure 10- Figure 16.

5.3 Discussion on the extension and applied research results

After developing the prototype program, the researcher adopted the prototype program to test with 1,109 students in three educational institutions: 286 students from University of Phayao, 478 students from Rajabhat Mahasarakham University, and 345 students from Mahasarakham University. As a result of this test, the researcher found that the prototype application was able to accurately predict 68.98 percent which is considered high level.

From the test results, it was found that the accuracy level was satisfactory. It also has errors that do not match the test data. When considering the data sources from Table 4 and Table 6, it was found that the samples were not distributed at all levels of the year. Therefore, researchers believe that information that is not covered every year may result in an effective prediction model. In future research, the researcher will try to collect information to be more comprehensive.

6 Conclusion

This research has three main objectives:

- To study the factors of the relationship between the learner context and the curriculum in higher education
- To construct of the relationship between the learner context and the curriculum in higher education
- To test the quality and accuracy after having the model of the relationship between the learner context and the curriculum in higher education.

The research methodology consisted of three main steps. The first step is to study the factors of the educational model. The second step is to construct the relationship of the educational model. The final step is to test the quality and accuracy of the application after having factors and educational model. There are seven instruments used in this research, including frequency, mean, standard deviation, percentages, decision tree, text mining, cross validation, and confusion matrix.

From the research process, it was found that the factors that are significant to further study decisions include education system, and interest in studying as shown in Figure 8. While the prototypes represent important relationships between the context of the learner and the course as shown in the high accuracy level in Table 8 (76.50%). Finally, the results of the prototype application testing were satisfactory (68.98%).

As analyzed in the discussion section, which consists of three issues. The researcher believes that the results of this research can be used to improve the development of

suitable educational institutions for future students. Which in the future, the researcher has the expectation of developing more accurate predictions to give advice to the students' institutions that are more interesting.

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8 References

[1] O. of the N. E. Commission, "National education act of BE 2542 (1999)," *Bangkok: Seven Printing Group*, 1999.

[2] I. Declaration, "Education 2030: Towards inclusive and equitable quality education and lifelong learning for all," in *World Education Forum*, 2015, pp. 19–22.

[3] D. of the C. I. D. Commission, M. of Education. (2001). "Basic Education Curriculum B.E. 2544 (A.D. 2001)," *The Express Transportation Organization of Thailand, Bangkok.*

[4] O. of the H. E. Commission, "National Qualifications Framework for Higher Education in Thailand Implementation Handbook," *Retrieved March*, vol. 2, p. 2014, 2006.

[5] O. of the H. E. Commission, "Thai Qualifications Framework for Higher Education," *TQF: HEd BE*, vol. 2552, 2013.

[6] P. Maneerat, K. Malaivongs, and J. Khlaisang, "The comparison of Thai qualification framework for higher education and capability maturity model integration for service," *Procedia-Social and Behavioral Sciences*, vol. 182, pp. 225–231, 2015. https://doi.org/10.1016/j.sbspro.2015.04.759

[7] A. P. Cabral and I. Huet, "Research in higher education: The role of teaching and student learning," *Procedia-Social and Behavioral Sciences*, vol. 29, pp. 91–97, 2011. https://doi.org/10.1016/j.sbspro.2011.11.211

[8] M. Adenipekun, A. Ibiyemi, Y. M. Adnan, and M. N. Daud, "Comparative analysis of sustainable facilities planning and users' satisfaction in Nigerian universities-a standardised residuals approach," *International Journal of Higher Education and Sustainability*, vol. 1, no. 1, pp. 40–65, 2015. https://doi.org/10.1504/ijhes.2015.073447

[9] H. Dieleman and M. Juarez-Najera, "Introducing a transdisciplinary curriculum to foster student citizenship: A challenge beyond curricula reform," *International Journal of Higher Education and Sustainability*, vol. 1, no. 1, pp. 3–18, 2015. https://doi.org/10.1504/ijhes.2015.073463

[10] P. Nuankaew, W. Nuankaew, K. Phanniphong, and S. Bussaman, "Mobile Applications for the Prediction of Learning Outcomes for Learning Strategies and Learning Achievement in Lifelong Learning," in *International Conference on Interactive Collaborative Learning*, 2017, pp. 400–412. https://doi.org/10.1109/tale.2017.8252332

[11] W. Nuankaew, P. Nuankaew, S. Bussaman, and P. Tanasirathum, "Hidden academic relationship between academic achievement and higher education institutions," in *2017 International Conference on Digital Arts, Media and Technology (ICDAMT)*, 2017, pp. 308–313. https://doi.org/10.1109/icdamt.2017.7904982

[12] D. Boccanfuso, A. Larouche, and M. Trandafir, "Quality of higher education and the labor market in developing countries: Evidence from an education reform in Senegal," *World development*, vol. 74, pp. 412–424, 2015. https://doi.org/10.1016/j.worlddev.2015.05.007
[13] I. Huet *et al.*, "Linking a research dimension to an internal quality assurance system to enhance teaching and learning in Higher Education," *Procedia-Social and Behavioral Sciences*, vol. 29, pp. 947–956, 2011. https://doi.org/10.1016/j.sbspro.2011.11.327
[14] K. Schildkamp and W. Kuiper, "Data-informed curriculum reform: Which data, what purposes, and promoting and hindering factors," *Teaching and teacher education*, vol. 26, no. 3, pp. 482–496, 2010. https://doi.org/10.1016/j.tate.2009.06.007
[15] D. Ho, M. Lee, and Y. Teng, "Exploring the relationship between school-level teacher qualifications and teachers' perceptions of school-based professional learning community practices," *Teaching and Teacher Education*, vol. 54, pp. 32–43, 2016. https://doi.org/10.1016/j.tate.2015.11.005
[16] L. Nuchwana, "How to link teaching and research to enhance students' learning outcomes: Thai University Experience," *Procedia-Social and Behavioral Sciences*, vol. 69, pp. 213–219, 2012. https://doi.org/10.1016/j.sbspro.2012.11.401
[17] L. K. Gudeva, V. Dimova, N. Daskalovska, and F. Trajkova, "Designing descriptors of learning outcomes for Higher Education qualification," *Procedia-Social and Behavioral Sciences*, vol. 46, pp. 1306–1311, 2012. https://doi.org/10.1016/j.sbspro.2012.05.292
[18] P. Nuankaew, W. Nuankaew, and T. Thamma, "The Recommended System for the Relationship between Educational Programs and Stu-dents' Interests," in *2016 International Conference on Digital Arts, Media and Technology (ICDAMT)*, 2016, pp. 2-3A.4:34. https://doi.org/10.1109/icdamt.2017.7904982
[19] D. Pereira, M. A. Flores, A. M. V. Simão, and A. Barros, "Effectiveness and relevance of feedback in Higher Education: A study of undergraduate students," *Studies in Educational Evaluation*, vol. 49, pp. 7–14, 2016. https://doi.org/10.1016/j.stueduc.2016.03.004
[20] W. S. Nuankaew, P. Nuankaew, D. Teeraputon, K. Phanniphong, and S. Bussaman, "Perception and Attitude Toward Self-Regulated Learning of Thailand's Students in Educational Data Mining Perspective," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 14, no. 09, pp. 34–49, May 2019. https://doi.org/10.3991/ijet.v14i09.10048
[21] K. W. Lee *et al.*, "Investigating the ICT needs of 'Digital Natives' in the learning of English in a public university in East Malaysia," *Procedia-Social and Behavioral Sciences*, vol. 118, pp. 242–250, 2014. https://doi.org/10.1016/j.sbspro.2014.02.033
[22] M. Ozkan and B. Solmaz, "Mobile addiction of generation z and its effects on their social lifes:(An application among university students in the 18-23 age group)," *Procedia-Social and Behavioral Sciences*, vol. 205, pp. 92–98, 2015. https://doi.org/10.1016/j.sbspro.2015.09.027
[23] D. M. Powers, "Evaluation: from precision, recall and F-measure to ROC, informedness, markedness and correlation," 2011.
[24] S. Papadakis, M. Kalogiannakis, E. Sifaki, and N. Vidakis, "Evaluating Moodle use via Smart Mobile Phones. A case study in a Greek University.," *EAI Endorsed Trans. Creative Technologies*, vol. 5, no. 16, p. e1, 2018. https://doi.org/10.4108/eai.10-4-2018.156382
[25] M. Kalogiannakis and S. Papadakis, "Evaluating pre-service kindergarten teachers' intention to adopt and use tablets into teaching practice for natural sciences," *International Journal of Mobile Learning and Organisation*, vol. 13, no. 1, pp. 113–127, 2019. https://doi.org/10.1504/ijmlo.2019.10016617

[26] S. Papadakis, "Evaluating pre-service teachers' acceptance of mobile devices with regards to their age and gender: a case study in Greece.," *IJMLO*, vol. 12, no. 4, pp. 336–352, 2018. https://doi.org/10.1504/ijmlo.2018.10013372

9 Authors

Wongpanya Nuankaew received a B.Sc. degree in Computer Science in 2004, and M.Sc. degree in Information Technology in 2007 from Naresuan University. She is currently a lecturer at the Faculty of Information Technology, Rajabhat Maha Sarakham University, Maha Sarakham, Thailand. Her research interests are in digital education, innovation and knowledge management, data science, and big data and information technology management. wongpanya.nu@rmu.ac.th

Pratya Nuankaew received a B.Ed. Degree in Educational Technology in 2001, M.Sc. degree in Information Technology in 2008 from Naresuan University, and a Ph.D. degree in Computer Engineering in 2018 from Mae Fah Luang University. He is currently a lecturer at the School of Information and Communication Technology, University of Phayao, Phayao, Thailand. His research interests are in learning analytics, digital education, and educational data mining.

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