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Research Article

Study on the Curriculum Development Method Based on the Amount of Knowledge Acquisition

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Abstract

The scientific design of the curriculum is a very important issue guaranteeing the quality of university education. The basic aim of drawing up a curriculum is how to organize the subjects so as to fit for the goal of training a talent and what is centered in drawing up a curriculum. It could be expressed as the evaluation index of a curriculum and how to set this index is also important. We focused on the amount of knowledge that can be considered the key to the talent evaluation index of university education and studied the curriculum evaluation model with a maximum knowledge acquisition. Then, we proposed the curriculum drawing methods by topological alignment algorithms. We established the evaluation method for constructing the subjects so that it could correspond to the talent training target of the relevant university course and made the knowledge acquisition model imitating the neural cell learning model in the artificial neural network. Based on this, we proposed this method. The method proposed in this paper should be more primitive that the ones by the modern algorithm but it has a number of advantages for the purpose of getting the maximum acquisition amounts.

Keywords

Curriculum, Development, Amount of Knowledge Acquisition, Topological Alignment, Algorithm

1. Introduction

Today, the aim of university education can be said to bring up students to be the talents who can work efficiently in the various conditions socially and professionally with high creative ability. Today there is an increased demand for talents, which requires that the university education should keep up with the developing situation [1].

Therefore, it is very important to draw up the educational curriculum flexibly so that it can be adapted to required items which are changing constantly.

For the flexible drawing up of curriculum, we have to put this work on informational basis, so many researches are being done for guaranteeing the scientific and flexible drawing up of curriculum [1, 2].

So we make the model by mathematical methods and apply the software technology [3, 4] and use the Artificial Intelligence (AI) technology widely, too.

The several types of curriculum models and the optimization methods are being introduced [1-3].

In this paper, we propose the one plan to design the curriculum scientifically and reasonably based on the requirement of drawing up a curriculum and the preceding research.

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2. Establishing of Curriculum Evaluation Model

The curriculum generally can be said to be the teaching plan or the course schedule for all knowledge which students will come across.

Practically, curriculum consists of things to learn, that is, many plans describing the subjects or course schedules. Hence, this might be a discipline, a subject, links of subjects or the whole teaching plans.

The evaluation of curriculum is the process of evaluating the one curriculum in several viewpoints and analysing its merits and demerits [4-7].

The purpose of curriculum evaluation is to find out and draw up the reasonable one which can give the maximum necessary knowledge.

To evaluate whether the curriculum is reasonable or not, we have to make the certain model.

In this paper, we chose the whole quantities of acquisition that the students get in the regular course and composed the optimal algorithm of curriculum so that the acquisition can be the maximum.

In order to do that, first of all, we proposed the method to compose the subjects so that it can agree with the target of training talents of relevant course.

2.1. Adaptation Evaluation of the Subject

G is "fitness" that refers to the index which determines to what extent the relevant discipline fits to the purpose of talents training in the curriculum.

To raise the effectiveness of education on condition that students' levels and cognitive ability are different, we have to draw out the curriculum according to their characters.

Every curriculum has their own inherent purposes and all the subjects that are included in the curriculum should correspond to its purpose [8-11].

Every subject differs from one another according to how suitable it is to the purpose of curriculum.

The value for estimating the degree of suitability on the purpose refers to $G \in [0,1]$. That is, if the subject *A* is completely suitable to the purpose, *G*=1 but if not, *G*=0.

General elementary subjects include the subjects such as "Calculus", "Physics", "Applied mathematics", "Linear algebra" and so on.

And the subjects to master the various, deep and comprehensive specialities in the fields of information system includes "Industrial robot technology", "Numeric system design", "Control device and system of a microcomputer", "Theory and experiment of a microcomputer" and so on.

The effect of all the subjects such as "Calculus", "Theory and experiment of a microcomputer", etc., on attaining the training target is different with each other.

If there is *n* number of experts who take part in determining the value *G* of the certain subject, the formula that determines *G* is as follows.

$$G = \sum_{i=1}^{n} w_i G_i \tag{1}$$

where, w_i is the weight coefficient of the ith expert ($w_i \in [0,1], \sum_{i=1}^{n} w_i = 1$).

G_i is the value of *G* determined by the ith expert.

Table 1 shows the values of *G* for some subjects included in the course of Information science and technology.

Table 1. *Values of G for some subjects included in the course of Information science and Technology.*

No	Subject name	*G*	No	Subject name	*G*
1	Calculus	0.82	6	Database	0.74
2	Physics	0.7	7	Industrial robot technology	0.85
3	Linear algebra	0.8	8	Numerical system design	0.87
4	Applied maths	0.84	9	Control device and system of a microcomputer	0.89
5	Programming method	0.87	10	Theory and experiment of a microcomputer	0.89

Table 2 shows the determining process of Value of *G* for «Database» subject.

Table 2. *Determining process of Value of G for "Database" subject.*

No	Expert	Weigh (G_i)	G_i	w_iG_i	$G = \sum_{i=1}^{n} w_iG_i$
1	Expert 1	0.15	0.8	0.12	0.745

No	Expert	Weigh (G_i)	G_i	w_iG_i	$G = \sum_{i=1}^{n} w_iG_i$
2	Expert 2	0.25	0.6	0.15	
3	Expert 3	0.2	0.9	0.18	
4	Expert 4	0.25	0.7	0.175	
5	Expert 5	0.15	0.8	0.12	

2.2. Curriculum Evaluation by Acquisition

2.2.1. Curriculum Evaluation Model by Acquisition

The following picture shows the part of the subject link diagram.

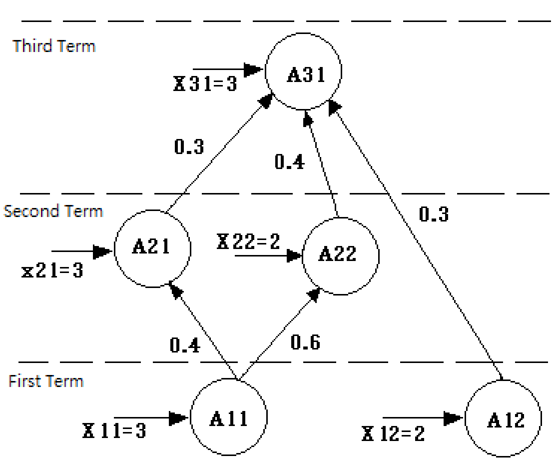

Figure 1. *The part of the subject link diagram.*

The acquisition amount can be said to be the learning amount that students get when they finish their study of the relevant subject.

In this paper, we determine the acquisition model by imitating the study model of neuron in the artificial neural network.

Generally, the study model of neuron in the artificial neural network is as follows.

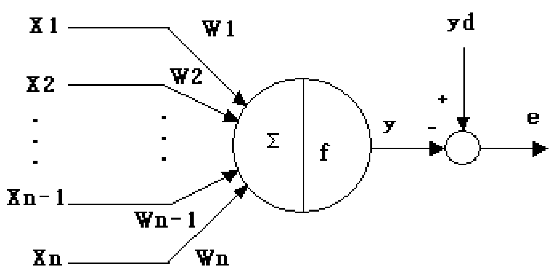

Figure 2. *The study model of neuron.*

where, $X = [X_1, X_2, \dots, X_n]^T$ is the input signal, $W = [W_1, W_2, \dots, W_n]^T$ is the join weight and Y_d is the supervised signal.

The acquisition of any subject among the linking ones in the curriculum can be determined as follows similarly to the study model of neurons.

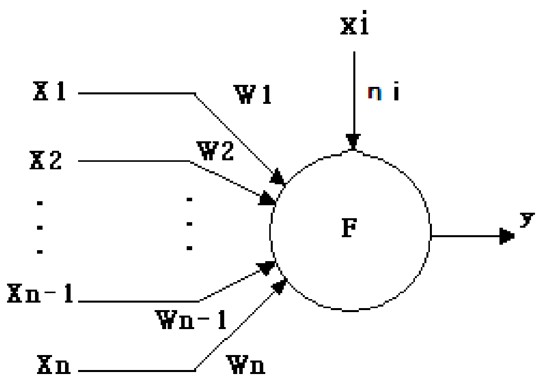

Figure 3. *Acquisition amount model of any one subject.*

where, $X = [X_1, X_2, \dots, X_n]^T$ is the credit of link subjects that are already learned, $W = [W_1, W_2, \dots, W_n]^T$ is a combined weight, η_i is the initiating ability, y is output signal, that is, the acquisition amounts when the subject is finished.

We assume that the learning person masters the knowledge of all subjects perfectly and the acquisition amount is additive.

The acquisition of any one subject can be expressed mathematically as follows.

$$y = a_{i-1}W_{i-1}X_{i-1} + \eta_i X_i \tag{2}$$

where, a_{i-1} is the preservation ratio of the contents that has been already learned and it is as follows.

$$a = 0.9874e^{-0.038t} \tag{3}$$

t is the necessary time from finishing one subject to starting the new subject that is linked with the one and the unit is a day.

W_{i-1} is the weight efficient of the subject that has been already learned.

η_i is the study efficiency of the new subject. This is related to the preparing degree of a student and the initiating ability of a teacher and it can be evaluated by the level and ability of a teacher in case that a student is prepared.

If one studies the new subject not learning the subject of previous step, $a_{i-1}W_{i-1}X_{i-1}$ item will be 0 and the study efficiency η_i will be also 0 or very small.

In other words, we can express if one doesn't study the subject of previous step, he can't study the new subject and if he does, the acquisition amount is very small.

Nowadays, the credit teaching management system is carried out in many universities all over the world.

In these universities, they fix the acquisition credits that are necessary for promotion and graduation and if one gains them, he can promote and graduate. [12-18].

The acquisition credit is the total credit numbers that are gained adding the ones of the subjects in the curriculum. This can be said to be the total knowledge (ability) acquisition amounts of the student who finishes the curriculum.

Adding the credit numbers is based on the complete additivity of the achieved knowledge or theory.

Practically, they have the certain additivity, not one because some of them may be forgotten.

The above equation can be said to be the one for acquisition credit adding the one of the relevant subjects after considering the forgetfulness and the study efficiency (the ability of initiating knowledge) to the acquisition (credit) of the students.

2.2.2. The Formalization of the Drawing up Curriculum Problems

Generally, there are many subjects in drawing up one curriculum and the hours and terms of execution are different.

Hence, it causes the problem that which curriculum can be the most scientific and reasonable one when the certain subjects can be put into the certain term in any order.

This is also the combination optimization problem, so it can be solved by considering all the cases but it requires a lot of time and we can't get necessary answer within the given time [19].

In this paper, we study the method to get the optimization answer by topologic alignment algorithm which is widely used in searching. In order to do this, we formalized the problem of drawing up a curriculum. The limit condition of this one is the order of a subject and the exceeding of hours.

This means the subject which should be prior to the present learning subject, and algorithm will be affected on how the relationship between the subjects to prioritize is given.

It is very important to fix the course time reasonably. Hence we have to type the number of course time correctly.

In this way, we can come to the conclusion of composing the subject linking diagram so that it can satisfy these two limit conditions and make the acquisition amounts to the maximum.

3. The Method of Drawing up the Curriculum by Topologic Alignment Algorithm

The remaining vertexes have all their parents except the vertex 1(major subject).

If you deal with essential subjects for learning the certain subject in the same or the coming term, since T is 0 at all nodes i, y_i is expressed as

$$y_i = x[i] + \sum_{j=1}^{n} y_{a_{ij}} e[i] a_{ij} \tag{4}$$

Here, $a_{ij}(j = \overline{1,n})$ is the vertex number of children that are connected to the node i.

Let's design algorithm in the way of filling subjects reversely from the last term to the first one.

Here, the problem to be solved is choosing the order of subjects to be filled in the terms.

We choose this order in the following way.

1) Assuming every T is always 0, we calculate the acquisition amounts of acquisition of all subjects.

The calculating method of this is as follows.

a) We establish the topological alignment into the given linking diagram model of essential subjects.

b) We calculate the acquisition amounts y_i in order of starting the subject which has the smallest topology. (In the equation [2], we can calculate y_i easily due to $y_{a_{ij}}(j = \overline{1,n})$ has smaller topology than i^{th} subject.

2) We choose the biggest node as the linking side multiplied by the acquisition amount among the children nodes of the first one (graduation paper) and fill this subject in terms.

3) When we cancel the chosen node in the model and connect the children nodes of that one with the parent node (first subject), we determine the weight of the side as follows. That is, we determine the weight of three sides as each side's weight multiplied by the side's weight which was connected to the cancelled node and the parent node of that one.

4) Step 2), 3) go on until all subjects are arranged in all terms.

The following principles will be observed until the whole acquisition amounts can be the maximum. Also, the preceding subject of the relevant one can have small acquisition amounts due to forgetfulness coefficient if one skips one term.

The whole curriculum making algorithm keeping these ones is as follows.

4. Results

We have an experiment with the course of Computer science in Kim Chaek University of Technology.

Table 3. *Result of experiment.*

No	Course Name	Original amount of knowledge aquisition	Proposed amount of knowledge aquitisition
1	1st Course	30.3	35.6
2	2nd Course	31.4	36.4
3	3rd Course	32.4	36.1
4	4th Course	29.8	35.2
5	5th Course	36.7	37.1
6	6th Course	31.1	34.3
7	7th Course	30.5	34.2
8	8th Course	32.4	34.1

In the Equation (1), δ means the learning efficiency of the new subject. This is related to how well the students are ready and teaching ability of a teacher and if a student is ready, it can be evaluated by a teacher's level and ability. For this problem, the learning efficiency is considered to be 1.

X is the credit of the relevant subject. On the assumption of lessons of total 16 h a week, the credit of the relevant subject has been determined as 1 credit a week on practical action and as 1 credit per 16 h about lessons.

From the experiment results, if the special knowledge course ability of a teacher is given and the credit of the subject is set up, it can be said that T (the time that takes to start learning a new subject after one subject) is the coefficient which affects the acquisition amounts. [20].

If one skips even one semester, namely if T is 180, a is small enough to be negligible as it is 0.0010506….

In other words, if we allocate subjects reasonably so as for T to be 0, we can get the larger amount of acquisition.

Finally, in the experiment, we have proposed that the compulsory subjects must be learned in the term of dealing with the subject or in the preceding term and then we obtained the experiment results.

5. Conclusion

In this paper, we formulated the acquisition amounts that the students should learn in the regular course as the evaluation model and proposed the algorithm to make the amounts be the maximum.

What is the most important is that though the curriculum evaluation model might be changed, we can flexibly change the optimized algorithm, and also if we use it as in the origin, we can raise the acquisition amounts by upgrading the algorithm constantly on condition that the inputs and the outputs are fixed.

We haven't found out the end value of G which was set up in the paper yet.

In the future, we will constantly improve the algorithm to raise the acquisition amount value furthermore.

Abbreviations

AI	Artificial Intelligence

Conflicts of Interest

The authors declare no conflicts of interest.

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