Build an education resources allocation planning model of school with integrating Information Technology

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Abstract – **The most important core competences of school education resources allocation is the teaching activities of integrating information technology into instruction. This paper explores integrating information technology into instruction how to build an education resources allocation planning model using De Novo programming for case study. We expect building an efficient planning model of integrating information technology into instruction for school education resources allocation, and using De Novo programming for achieving aspired/desired level base on education resources allocation of school. How we can be in the set budget for accomplishing the resources allocation with minimum cost. In empirical case we find if the resource limitation is loosen, and De Novo programming and resources allocation project management are implemented, the optimal resource allocation of integrating information technology into instruction will be achieved and the cost of school management can be reduced.**

Keywords - **De Novo programming, resource allocation, project management.**

1. INTRODUCTION

With the development of information technology (IT) and network applications, the most exciting changes in school education are methods of integrating IT into instruction. In now, the way students learning tend towards the pluralism. They can not be satisfied with the traditional teaching way and need more creative teaching methods. Especially in era when network science and technology is developed, students can obtain information easily and be stimulated by various kinds of knowledge. Furthermore, teachers have opportunities to change and adapt curriculum in different ways or to improve the quality of classroom activities by choosing the appropriate technology [35]. Different knowledge can reach education objective to make through the convenience of IT. Because of the convenience, the type of learning is changing and the teaching method is promoting. Information technology will always offer opportunities for teaching to be carried out in different ways [30].

The most important key in school education is integrating IT into instruction. In Taiwan, basic compulsory education consists of six years of elementary education and three years of junior high school education, but the curricula of the two educational levels have been connected and integrated into a new 1-9 curriculum. The Ministry of Education takes 'integrating IT into instruction' as a key point in education. The degree of integrating IT into instruction is the main standard for evaluating the education performance. All elementary and junior high schools put much emphasis on 'integrating IT into instruction'. The activity of integrating IT into instruction plays an important role in elementary and junior high school education.

The resources allocation of a school is vary important, especially in latest years. A school faces the situation is that limited resources, fewer students and more activities in now. How to allocate the efficient resources to proper places is the key point to school education. The performance of school resources allocation is related to the success of school education. The best of optimal resource allocation can through an efficient planning model aids to achieve the aspired level [7]. It is an important issue on how to plan a model of resource allocation in the activity of integrating IT into instruction. With De Novo programming it can build a project resources allocation model for integrating IT into instruction. This study utilizes empirical practicing got more efficient resources allocation through De Novo planning model. The result expressed the new planning systems can let school reduce waste resources and promoting education performance under minimize cost.

The remainder of this paper is organized as follows: Section 2 discusses the plan and the allocation model of resources. Section 3 discusses integrating IT into instruction. Section 4 illustrates an empirical case to demonstrate the proposed model of resources allocation for integrating IT into instruction. Section 5 presents conclusions and remarks.

2. Conceptual of resource allocation project

Integrating IT into instruction is a hot issue topic in school education, and how to allocate IT resources properly is more and more important. This section explores resources allocation project relate theory literature review that these theory basic for supporting this paper study.

2.1 Resources allocation project

Resources, broadly defined, have often been used in the literature in a generic sense to include capabilities [3]. Holcomb presented 'resources' to represent tangible or intangible assets owned or controlled by firms and 'capabilities' to represent organizational routines that allow firms to effectively integrate and use resources to implement their strategies [13]. Two key features appear

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to be germane, namely, that resources must enable the creation of value and must also resist the duplicative efforts of competitors [3]. The performance of certain firms was related to their possession of key resources [6].

Resource-based perspectives of integration is based on the original work of Penrose [27] and uses Barney's more recent translation of the resource-based view (RBV) of the firm, emphasizes the importance of resources in guiding firm activity and the management of a firm's portfolio of capabilities as central to competitive advantage [13]. According to the RBV, resources are either tangible or intangible and both heterogeneous and imperfectly mobile among firms [3]. The RBV has been the subject of extensive attention in the strategy literature in the past decade and it has become a popular explanation of performance heterogeneity at the firm level [18]. In the RBV, firms seek complementary resources to create synergies and acquire sustainable competitive advantage [22]. In order to acquire competitive advantage and the ability to respond quickly to a dynamic environment, firms should consider how to construct and extend limited resources to develop a capability for sustainable competitive advantage [11].

Resource allocation can be used as a practical tool to speed up certain projects [32]. Project planning and scheduling has become an important management tool for today's complex business and manufacturing systems [29]. Resources allocation project can also help school to improve its performance. We expect building an efficient project planning model for the best resources allocation and high performance of teaching activities.

2.2 The strategic planning of resources allocation

Integrating IT into instruction becomes one of most important activities in teaching, and it is also a core activity of school education. Moore and Benbasat suggested that there should be an efficient planning model for helping companies enhancing performance with limited resources [24]. Firms may be regarded as bundles of strategic resources, capabilities, and competencies that provide a distinct source of competitive heterogeneity [3]. Every school tries to attract student's attention on teaching activities to enhance teaching performance by integrating IT into instruction. There should be an efficient planning to increase the usage of school resources to enhance the performance of teaching and learning. Although computers are powerful tools for improving the effectiveness of instruction, inappropriate usage and preference of any technology and improper technology planning usually cause loss of time, energy and fiscal resources [35]. How to do the best strategic planning of resource allocation for integrating IT into instruction that aid enhances school education performance.

'Competitive strategy' has become an important management idea. In the past, scholars have found that competitive strategy is very useful in planning and increasing efficiency across organizations. Moreover, Comparative advantages in resources and resource deployment can serve to enhance the value provided [17]. An exceptional school attracts more students to attend than other school because of its competitive strategy. The performance of integrating IT into instruction was recognized an important issue of school core competence. To achieve high performance, top managers must provide a strong sense of strategic direction [12]. Strategic planning is a tool that assists the management in defining a company's future direction and developing a plan for its future development.

2.3 Base on De Novo programming for resources allocation

Integrating IT into instruction is an important trend for school education. The environment of school education is multiple and limitation resource in the real world. How to do building an efficient resources allocation model becomes an important issue. It is needs an efficient planning model can help school of integrating IT into instruction to achieve optimal level on resource allocation.

We expect to utilize De Novo programming building an efficient planning model of integrating IT into instruction. De Novo programming was proposed by Zeleny to redesign or reshape given systems to achieve an aspiration/desired level [38]. The original idea was that productive resources should not be engaged individually and separately because resources are not independent.

When we usually confront a situation that is almost impossible to get optimize all criteria in the real world. We should be to do alternative of all the criteria, this property is so called *trade-offs*. It is a *trade-offs* concept for limitation resource of firm operations level. The scholar Zeleny suggested *trade-offs* are properties of inadequately designed system and thus can be eliminated through designing better, preferably optimal system [37]. So, De Novo programming can deal with a multiple criteria optimization problem. We except to build a planning model based on De Novo programming for integrating IT into instruction.

3. Background of the empirical case

Integrating IT into instruction contribution was acknowledged in school education domain. A high performance integrating IT into instruction was need of a set complete planning model for its base. This section of study introduces a school of integrating IT into instruction and analysis the problem of teaching activities.

3.1 Introduction of a case study

The case of this study is a school established in the center area of Taiwan in 1946. And the school consists of grade levels of 1 to 6. By the year 2008, there are 33 teaching staff, 6 administrative staff and 541 students at

the school. The Bureau of Education has already held the IT capability examinations since 2002. All 32 teachers have passed the basic IT capability examination and 8 of all teachers have passed the advanced IT capability examination. 1 budding teacher graduated from Teacher's university did not attend the IT capability examination.

In hardware resources sectors: There are 35 students at most in each of 19 classrooms. The school has one computer classroom (with 38 computers and a projection system). And there are one personal computer, one TV-video sets, one DVD player and one CD player in each of 19 classrooms. School has 39 computers for students (1:13 ratio at student level) and 21 computers for teachers. In addition, there are 2 notebook computers, a projection system at school. The school provides an internet working environment for teachers. Teachers can make use of the network resources materials for their teachings. At the same time, teachers can print and get all their extra teaching materials from internet resources out for their classroom activities. The school provides ink jet printers, laser printers and enough related consumables for teacher's teaching activities.

In software resources sectors: The school uses "School Free Soft 3.0" (SFS3) software that contains of various utilities for students and staff. Among the utilities provided through the web are; information desk, registration, grades and attendance for students, registration office, personnel office, accounting and stock for administrative staff and finally question bank. Besides keeping periodic data about students, the system also allows to analyze and follow various data from administrative processes. The school also provides teaching materials, learning resources of IT and teaching application software for teachers. And Teachers can utilize those materials, resources and software at courses any time.

In human resources sectors: For improving the effectiveness and efficiency of teaching and learning activities in the school, the Ministry of Education provides the staff training funds every year. Several integrating IT into instruction courses for teachers have been previously established. There still have a series of staff training courses for teachers in this school. The IT application course has been established in order to enhance the teaching ability of integrating IT into instruction. The safety of network course helps teacher to get information from network properly and safely.

3.2 Conceptual of integrating IT into instruction

Taiwan proposed a "blueprint of technology education for secondary and elementary schools" in 2001 to enhance its national competitiveness as well as scientific and technical strength [23]. Therefore, integrating IT into instruction is the mainly activity in school education. The technology is used in four ways as: a knowledge source, a data organizer, an information presenter, and a facilitator [10, 28].Most teachers, especially those who attempt to provide students with a stimulating teaching and learning environment, have been attracted by the powerful capacity of IT in collecting teaching material that is scattered over different information sectors around the world. The main idea behind their desire to use this technology is not only to teach their students how to access their teaching materials, but also to train their students how to effectively explore the information for they needed [40]. Moreover, IT usage in school instrument might lead to "increased student writing, enhanced cooperative learning, enhanced integration of curriculum, greater application of learning style strategies, increased applications of cross-age tutoring, increased teacher communication, enhanced community relations and enhanced global learners" [34].

Technology has become an integral part of the educational setting since its debut in the early 1980s. Its use in the classroom has been met with mixed results. Teachers and researchers in the education field have been given the responsibility of integrating technology into their curriculum [41]. Teachers have opportunities to change and adapt curriculum in different ways or to improve the quality of teaching activities by choosing the appropriate technology. However, "technology use is not only about the hardware, Internet connections and so on. What is important is how the technology is integrated with the instructional program" [5].

Beetham emphasizes that, in characterizing those resources that are effective in changing practice [4]. It is appropriate to consider not only factors that impact on their use for teaching, but also factors that enable teachers to gain a sense of ownership of the resources and embed them in their own practice.

3.3 questions of integrating IT into instruction

In this empirical case, we find that school only put much more resources into teaching activities, not allocate resources properly. The question of integrating IT is how to allocate the three resources (hardware resources, software resources and human resources) properly. The more properly resources allocated, the higher school performance promoted. School is requested to provide on time delivery of appropriate resources for teaching activities of integrating IT. So how to build an optimal model of resources allocation for integrating IT into instruction is a key issue in school education.

4. Building a education resources allocation planning model for integrating IT into instruction

This section introduces the structure of De Novo programming model, includes the conceptual of De Novo programming, the model of resources allocation and the analysis of resources allocation project.

4.1 Conceptual of De Novo programming

De Novo programming can design an optimal system and deal with a multiple criteria optimization problem, when we usually confront a situation that is almost impossible to optimize all criteria in a given system. Zeleny suggested that *trade-offs* are properties of inadequately designed system and thus can be eliminated through designing better, preferably optimal system [37, 38]. Zeleny proposed the concept of *optimal portfolio of resources* which is design of system resources in the sense of integration, i.e. the levels of individual resources are not determined separately, so that there are no *trade-offs* in a new designed system. To do so, Zeleny developed a De Novo programming for designing optimal system by reshaping the feasible set. De Novo programming can achieve an aspiration/desired level for resources allocation and avoid *trade-offs* restriction.

4.2 De Novo programming for achieving the aspired level

A multicriteria problem can be described as follows [36]:

$$\begin{aligned} &Max \quad \boldsymbol{Cx} \\ &s.t. \quad \boldsymbol{Ax} \le \boldsymbol{b} \\ &\quad \boldsymbol{x} \ge 0 \end{aligned} \tag{1}$$

where $\boldsymbol{C} = \boldsymbol{C}_{q\times n}$ and $\boldsymbol{A} = \boldsymbol{A}_{m\times n}$ are matrices, $\boldsymbol{b} = (b_1,...,b_m)^T \in R^m$, and $\boldsymbol{x} = (x_1,...,x_j,...,x_n)^T \in R^n$

Let the κ -th row of C be denoted by $C^k = (c_1^k,...,c_j^k,...c_n^k) \in R^n$, so that $C^k x$ is the κ -th criteria or objective function (κ =1,…,q).

The ideal point of Eq. 1 is $f^* = (f_1^*,...,f_q^*)^T$, where $f_k^* = \sup\{C^k \boldsymbol{x} \,|\, \boldsymbol{x} \in \boldsymbol{X}\}$ for κ =1,…,q.

If there exist $x^* = (x_1^*,...,x_n^*)^T \in R^n$, such that $Cx^* = (C^1x^*,...,C^qx^*)^T = (f_1^*,...,f_q^*)^T$, then the x^* called the ideal solution.

When the purpose is to design an optimal system rather than optimize a give system, it is interest to consider following problem:

$$\begin{aligned} &Max \quad \boldsymbol{Cx} \\ &s.t. \quad \boldsymbol{Vx} \le \boldsymbol{B} \\ &\quad \boldsymbol{x} \ge 0 \end{aligned} \tag{2}$$

where $\boldsymbol{V} = \boldsymbol{pA} = (V_1,...,V_n) \in R^n$, $\boldsymbol{p} = (p_1,...,p_m) \in R^m$ and $\boldsymbol{B} \in R$ present the vector of unit prices of resources and total available budget respectively. We can call this kind of problem as multi-criteria optima system design (MOSD) problem.

The synthetic solution for MOSD problem:

If we consider each objective function separately, then Eq.1 can be written as follows:

$$\begin{aligned} &Max \quad \boldsymbol{C}^k\boldsymbol{x}; \quad \text{for } k = 1,...,q \\ &s.t. \quad \boldsymbol{Vx} \le \boldsymbol{B} \\ &\quad x \ge 0 \end{aligned} \tag{3}$$

If problem is a continuous "knapsack" problem, and the solution is

$$x_j^k = \begin{cases} 0, & j \ne j_k \\ \boldsymbol{B}/V_{j_k}, & j = j_k \end{cases} \tag{4}$$

Where $j_k \in \left\{ j \in (1,...,n) \,\middle|\, \max_j \left(c_j^k / V_j\right) \right\}$

If the number of criteria is less then that of variables, we can individually solve the problem and obtain synthetic solutions as follows:

$$x_{j_1}^1,...,x_{j_q}^q$$

Shi (1995) further defined the synthetic optimal solution as follows, $x_{j_k}^k$ is the optimal solution of Eq. 1

$$x^{**} = \left(x_{j_1}^1,...,x_{j_q}^q,0....0\right) \in R^n$$

4.3 The model of resources allocation

A teaching problem of integrating IT into instruction involving 2 levels of grades: K3-4 and K5-6, in quantities x_1 and x_2, each of them consuming five different resources. The data are summarized as following (see Table 1).

Table 1
K3-4 and K5-6 requirement material resource

Unit price $	Resources		Resource requirement		No. of units (Resource portfolio)
			x_1	x_2	
260	Human resources	Staff training	5	12	30
100	Hardware resources	Computer and network equipment	14	8	38
40	Hardware resources	Consumables	6	6	15
120	Software resources	Teaching materials	6	7	35
30	Software resources	Application software	1	1	5

The costs of the given resources portfolio
(260*30)+(100*38)+(40*15)+ (120*35) + (30*5)=$16650

Unit costs of maintaining one unit of each of the two levels
x_1 = (260*5) + (100*14) + (40*6) + (120*6) + (30*1) =$3690
x_2 = (260*12) + (100*8) + (40*6) + (120*7) + (30*1) =$5030

Expected profit margins (price-cost) are
x_1 =$4090-$3690=$400/unit
x_2 =$5330-$5030=$300/unit

Maximizing total value of function f_1
$$f_1 = 400x_1 + 300x_2$$

Maximizing total quality index f_2
$$f_2 = 6x_1 + 8x_2$$

Maximizing levels of two grades can be calculated by mathematical programming

$$\begin{aligned} \max \quad & f_1 = 400x_1 + 300x_2 \\ \max \quad & f_2 = 6x_1 + 8x_2 \\ s.t. \quad & 5x_1 + 12x_2 \le 30 \\ & 14x_1 + 8x_2 \le 38 \\ & 6x_1 + 6x_2 \le 15 \\ & 6x_1 + 7x_2 \le 35 \\ & x_1 + x_2 \le 5 \\ & x_1, x_2 \ge 0 \end{aligned}$$

Maximum f_1 in profit
max
$$f_1 \to x_1 = 1.6875, x_2 = 1.7968$$
$$f_1^* = 400 \times 1.6875 + 300 \times 1.7968 = 1214.04$$

Maximum f_2 in total quality index
Max
$$f_2 \to x_1 = 1.6875, x_2 = 1.7968$$
$$f_2^* = 6 \times 1.6875 + 8 \times 1.7968 = 24.4994$$

Minimizing the total cost by considering the following constraints

$$\begin{aligned} \min \quad & 3690x_1 + 5030x_2 \\ s.t. \quad & f_1 = 400x_1 + 300x_2 \ge 1214.04 \\ & f_2 = 6x_1 + 8x_2 \ge 25.6334 \end{aligned}$$

Maximum f_1 in profit

max $f_1 \to x_1 = 1.4445, x_2 = 2.1208$;
$$f_1^* = 400 \times 1.4445 + 300 \times 2.1208 = 1214.04$$

Maximum f_2 in total quality index
max $f_2 \to x_1 = 1.4445, x_2 = 2.1208$;
$$f_2^* = 6 \times 1.4445 + 8 \times 2.1208 = 25.6334$$

Cost of the newly designed system
(260*20.4) + (100*57.12) + (40*24.48) + (120*24.48) + (30*4.08) =$15055.2 < $16650

The new portfolio of resources proposed by the consultant is as following (see Table 2).

4.4 Discussion

De Novo programming can re-modify system and adjusting requirement resources portfolio for resources allocation projects of integrating IT into instruction. This planning can do best optimal resources allocation that push school reduce resource lost and promote school competitiveness. In this empirical case, we find De Novo programming do the optimal resources allocation (Hardware resources, Software resources and Human resources) for integrating IT into instruction in school. There are some findings at following.

(1) Human resources allocation

At human resources allocation, the unit price of resource is higher than the others resources. But human resource is the most important key resource in teaching activities of integrating IT into instruction. And the higher grades need the more professional technology human resources. School put much more human resources in K5-6. There are more profession subject such society, nature & science, computer and foreign language at K5-6 levels. They need different methods of integrating IT into instruction in their courses. So we suggest that K5-6 professional subject teachers have the priority to enhance their IT abilities.

Table 2
The new K3-4 and K5-6 requirement material resource

Unit price $	Resources		Resource requirement x_1	Resource requirement x_2	No. of units (Resource portfolio)
260	Human resources	Staff training	5	12	20.4
100	Hardware resources	Computer and network equipment	14	8	57.12
40	Hardware resources	Consumables	6	6	24.48
120	Software resources	Teaching materials	6	7	24.48
30	Software resources	Application software	1	1	4.08

(2) Software resources allocation

At software resources allocation, we suggest that school can allocate software resources flexibly. The original allocation project is to allocate the exclusive teaching materials to the different professional subjects of integrating IT into instruction. After redesigning the software resources allocation project with De Novo programming, we find that teachers can share their teaching materials and methods to other teachers. The teaching materials have the characteristic which may recycle. Teachers can use the same teaching materials by different teaching method at different class and grade in school. So school should reduce resources on teaching materials, and put more resources to the most demand aspect to reach the goal of optimal resources allocation.

5. Conclusions and suggestion

This study discovered that school can build a model of optima education resources allocation planning model with De Novo programming. If utilizes a efficiency planning model De Novo programming not only can get the optima resources allocation but also can enhances performances of teaching activities. We focus on three aspects (Hardware, Software and Human resources) of integrating IT into instruction to analyze the problems of education resources allocation. This study analyzes the empirical case and suggests (1) to cultivate the professional subject teachers at first; (2) and to share teacher's teaching materials to each other. In this study, we can break out limitations to achieve the goal of optima education resources allocation with De Novo programming. And we discuss how to achieve the best performance goals of teaching under a changing education environment.

As the process of learning and training technology to students becomes the main focus in education, school should build an optima planning model of education resources allocation for integrating IT into instruction with De Novo programming. In the future, this study can extend to analyze if hardware resources changes, how influence to software resources and human resources.

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