

Application of Analytical Hierarchy Process (AHP) in the Curriculum

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Abstract

AHP model as one of the most efficient techniques and as a comprehensive system designed to the multi-criteria decisions possibility of formulating provides natural complex to hierarchy. This model is a simple calculation on the matrix that begins for identifying and prioritizing the elements of decision making. Curriculum is a process including: identifying goals, choosing content, teaching, and learning strategies. The programmer is inevitable to decision making in each of these stages. In many of stages of the curriculum, to considering political, social and economic factors, decision making is become difficult. We can use the AHP model in these situations (or normal) and also convert them to adapting with humans mind and nature in simple form. In other words, Analytical Hierarchy Process calculates levels of decisions adjusting and judge about being good and bad or acceptable and unacceptable choices. Thus, this article study application of AHP model in curriculum and introduces it as an adequate way for decision-making in curriculum process. At last this study indicates application of AHP model in an example according to teaching-learning strategy.

Keywords: Curriculum, Analytical Hierarchy Process, selecting content, teaching - learning strategies, identifying goals

1. Introduction

Nowadays dynamic implementation of educational systems and its favorable continuity is influenced by quality of planning strongly. The curriculum considered as the most important component of educational systems in every countries. Based on the importance of this, the process of curriculum planning attends literature of curriculum to itself (Fathi, 2006). This needs decision making as the continuous process in terms of its quality and methods. Decision making has comprehensive territory in terms of planning and different groups strive to influence it participation in the curriculum-related decisions (Gouya and Izadi, 2002). In the curriculum process, starts with circles of assessment and finally leads to review, the planner and related-factors should participate in decision making processes. There are some factors that lead to difficulties in each step of decision making process and difficult the correct decisions making. Indeed, it is needed to another factor to choose favorable

option and decision, because of multi-criteria decisions and lack of human's mental balance in order to choosing the best option.

In the nowadays complex and advanced world, the correct and timely decision making has very important and determinant role in the quality and successfulness of each project. There are some factors such as number of measures, data complexity, and environmental dynamics, that difficult issue of decision making. The hierarchically decisions provide which resolutions that have short-lived and are ineffective that based on Toffler die before birth (Narimani, 2009). If the uncertainly dimension of human beings decisions don't consider, its results could lead to misdirection. Some of our daily terms such as probably and maybe that we use them in our daily dialogues refer to different levels of uncertainly (Tsaur et al., 2002).

The curriculum plan is a rational and logical process that should perform correctly and consciously. Also it is should remember that curriculum is the results of decision making about the following issues: goal statement, choosing and organizing content, learning style and educational experiences, choosing and organizing areas of curriculum. The planner should decide about needs, culture, and philosophy, ideology of life, learner psychology, and innovation in order to develop purposes. Also they should develop especial, assessable, accessible, and timely purposes. The curriculum should answer some questions in terms of choosing content such as, how the content chosen? In other words what are the criteria of choosing content? Whether the issue is beneficial? Whether the role of issue is important in excellence of curriculum society? And generally an overall criteria should is meaning, reliability, social belonging, beneficial, learning competency, and interest. The content that is based on the society needs is very important. These needs include political, social, communicational, economical, rationality, technological, morality, beliefs, and aesthetics that each of needs could priorities based on its status and is more important than others (Rezvanfar, 2008).

If the criterion of decision making is more and more, then the problem wills more complex. Also adoption of a decision requires accepting its outcomes. If the technical, economical, and social outcomes of the curriculum decision are more, then this problem being consider more important. When number of criterion and complexity of decision are more than a threshold level, then human's mind unable to consider all of its dimensions and their relationships with each other simultaneously (Hale et al., 1382). Therefore utilization of techniques of decisions especially analytical hierarchical process (AHP) in curriculum planning is inevitable.

There are many internal and external studies that conducted through AHP and much of its application is in terms of management, geographic, economics, and engineering. Nazemi and others (2010) in their study entitled "application of combinative model AHP and SWOT in high educations strategic planning" utilized these methods to evaluation of internal and external factors and the weight of each factor calculated through QSB. The results of this study indicated that the strengths, opportunity, threats, and weakness are more important than other factors in strategic planning and environmental analysis. Abtahi and Torabian (2010) in their study entitled "the examination of realization of high education through AHP" described utilization of AHP models in terms of high educations and finally identified effective factors and measures on goals. Mehregan and others (2008) in their study entitled "offering multi-dimensional model in order to allocating teachers to primary schools through MODM, they also utilized fifteen measures in order to allocating teachers, they also utilize AHP in order to

measuring weights. Hoseynzade (2011) utilized AHP and DEA in order to evaluating performance of high educational centers in Sistan va Baluchistan province and then identified the most important inputs and outputs. Also it is should remember that there isn't any internal study in terms of curriculum through AHP.

2. Method of analytical hierarchical process (AHP)

Theoretical fundamentals of analytical hierarchical process (AHP)

The flexible decision making process is a method that transform complex problem to hierarchy and matrixes with respect to one or more measures. The method of AHP has been used in terms of decision making issues such as governmental, business, industrial, health, and educational issues (Saaty, 2008), (Raharjo et al., 2009), (Linkov et al., 2007), (Jyrki et al., 2008), (Forman and Gass, 2001), (Borouhaki and Malczewski, 2008). This is one of the most efficient methods of multi-criteria decision making techniques that introduced by Thomas L. Saaty (2008) for the first time and nowadays utilize as one of the systematic approach in order to resolving multidimensional and complex problems in terms of qualitative data (Vargas, 1990; Lai et al., 1999; Cheng et al., 2005). AHP includes three steps in order to solving problem (decision making): decomposition, comparative judgments, and synthesis of priorities (Shyi et al., 2007). This method is based on paired comparisons of factors and provides examination of different scenarios for planners. This technique is one of the more comprehensive systems that designed in terms of multi-criteria decision making, because this technique leads to formulation of complex problem in hierarchical form and then leads to consideration of different qualitative and quantitative measures in each problem (Saaty, 1986, 1994). The main characteristics of AHP could describe as following: 1) analytical: this refers to utilizing numbers and figures in inferential analysis, 2) hierarchical: this refers to decomposition of complex situations with respect to priorities, goals, measures, and options, and 3) process: refers to this issue that adoption of decision requires multi-criteria examination by different individuals during different meetings and also apply their viewpoints to resulting (Slahi Sadaghiani, 2001).

Lee and others (2008) described AHP in six steps: 1) defines the unstructured problem and determine goals and outcomes clearly, 2) transforms complex problem trough components of decision to hierarchical structure, 3) compares measures through paired comparisons between decision's components, 4) utilizes Eigen values of comparisons matrix to estimate relative weights of decision components, 5) examines compatibility criteria of scales to ensure that decision maker's judgments are integrate, and 6) totalizes relative components of decision and calculates the final value of options.

Generally the following steps should pass in order to achieving goals (decision making):

The hierarchical structure is a graphic show of actual complex problem that the problem is in itshead and other levels of it are measures, sub-measures, and options. In this step, we can transform complex problems to simple form that is compatible with human's metal and natures through decomposing it (Cimren, 2007). Generally hierarchical structure maybe consider as one of the following forms (Bowen, 1990; Dyer, 1991; Mau, 2005) 1: goal- measure- options, 2: goal- measure- sub measure- options.

Overall steps of AHP includes: 1) formation of decision tree or hierarchical structure, 2) formation of paired comparison matrix for all levels, 3) calculating especial vector for all matrixes, and 4) calculating final weight of options and ranking them.

With respect to existing conditions and characteristics of educational systems in Iran, Maleki (2007) offered the model with 17 steps to guide practice. These steps include 1) assessment, 2) direct value, 3) determination of goal, 4) determination of property of goals with educational instruments and activities, 5) choosing content, 6) organizing content, 7) choosing and organizing learning experiences, 8) choosing teaching-learning strategies, 9) determination of assessment system, 10) determination of teacher's role in plan, 11) educational materials, 12) genesis assessment, 13) broadcasting educational plan, 14) implementation of educational plan, 15) monitoring and controlling educational plan, 16) final evaluation and 17) reviewing and modifying educational plan.

With respect to this fact that AHP could conduct in each of these steps, two examples of them have been indicated, in the following sections teaching-learning strategy has been described in details.

1: choosing content: this is the main step in curriculum. There are measures that utilize to choosing content. Some of these include importance, reliability, interest, benefit, learning competency, flexibility, and attention to knowledge structure. Each of these measures is prioritized with respect to their importance and their weight and importance should attend. For instance "importance" introduced as one of the main measures and also has the most weight in weighting step (Maleki, 2007). There are different methods in order to choosing content such as empirical method, analytical method, agreement method, and arbitration method. In these, methods of group discussion focused such as planner's viewpoint and analysis to choosing content and this helps to individual's participation in terms of choosing content. For instance, in the arbitration method, individual's (planner) judges and finally evaluation conduct based on individual and collective viewpoints and group discussion. Therefore these strategies are based on mental judgment and the content is complex and comprehensive and the decision couldn't conduct based on decision making mentality and inevitably to utilization of scientific methods (Rezvanfar, 2008).

2: choosing teaching-learning strategy: curriculum planners and teachers choose different methods of teaching with respect to different factors. Some of these factors include curriculum goals, necessary learning experiences, student's interest, learning principles, facilities, resources, and instruments (Maleki, 2007). Also there are some factors that have more weight in this step such as curriculum goals and comprehensive interest.

The hierarchical structure of this instance includes following steps (based on fig 1, 2):

Level 1: is the head of hierarchical and its main goal is to choose content (fig 1) and choose teaching-learning strategy (fig 2)

Level 2: this level includes measures such as importance, reliability, interest, benefit, learning competency, flexibility, and attention to knowledge structure (fig 1), and curriculum goals, necessary learning experiences, student's interest, learning principles, instruments, resources, and facilities (fig 2).

Level 3: this level includes options and has three contents (fig 1). These include exploratory learning, speech, and role playing (fig 2). The hierarchical structure of paired comparison matrix conducts for all levels done after formation of decision tree or hierarchical structure. Then calculation of especial vector done for all matrixes and finally their weights measure and their ranks calculate.

[Insert **Fig1** about here]

[Insert **Fig 2** about here]

2-3: weighting factors: in the AHP, measure of weighting to each informational unit is based on which role that this unit plays in this layer, and the most weight is for which layer that has maximum effect in determination of goal (Lopez and others, 1991) (table 1).

[Insert Table 1 about here]

2-4: Development of paired comparison matrixes and normalization of factors

In order to weighting effective factors in prevention of addiction and judging them based on their importance, paired comparison matrixes and normalization of factors with rate 9 for measures and rate 36 for options have been developed. In the next step, values of each of paired comparison matrixes' columns were pluralized and each component in paired matrixes divided to its column. This is done in order to normalization of paired comparison matrixes (see equation 1). Then average of components in each row of normalized matrixes calculated that finally weight vector has been developed (see equation 2).

Equation 1: equation 2:

$$r_{ij} = \frac{a_{ij}}{\sum_{j=1}^m a_{ij}} \quad W_i = \frac{\sum_{j=1}^m r_{ij}}{n}$$

M= number of columns, n= number of rows, a_{ij}= paired comparison matrix r_{ij}= normalized matrix and W= weigh of options

2-5: determination of factor's final rate (priorities and preferences): in order to this, the principle of hierarchical combination has been used that leads to identifying prioritized vectors based on the all judgments in all hierarchical levels (Moreno et al., 2005; Bertolini et al., 2006) (equation 3).

Equation 3:
$$V_H = \sum_{k=1}^n W_k (g_{ij})$$

V_H= final rate of option, W_K= eight of each measure, g_{ij}= weight of options with respect to measures

Examination of compatibly or incompatibly of system

Controlling compatibly of system is one of the important advantages of AHP. In other words, amount of system compatibly could measure and judge about its favorably or unfavorably and its acceptance or inacceptance. In order to measuring rate of compatibly, paired comparison matrix (A) multiply with weight vector (W), then good estimation of λ_{max} W has been calculated, in other words A×W= λ_{max} W. then amount of incompatibly measure calculated through equation 4 (Ghodsipour, 2008: 71-73).

Equation 4:
$$I.I. = \frac{\lambda_{max} - n}{n-1}$$

Equation 5:
$$I.R. = \frac{I.I.}{I.I.R.}$$

[Insert Table 2 about here]

If the rate of incompatibly is 0.1 or less than it, compatibly of system is acceptable, but if this is more than 0.1, decision makers should review in their judgments and modify it (Dey et al., 2000).

In the following section, an example of choosing teaching-learning strategy through AHP has been described. The results of paired comparison of choosing teaching-learning strategy and prioritizing these factors have been offered at the table 3 and 4 and in fig 3 and 4.

[Insert Table 3 about here]

[Insert Fig 3 about here]

[Insert Table 4 about here]

The final weight of choosing teaching-learning strategy in AHP calculated from multiplying measure's weight in option's weight. The results of these indicated in equations 6, 7, 8, 9, 10, and 11 and fig 4.

Equation 6: weight of exploratory learning $(0.45 * 0.118) + (0.448 * 0.201) + (0.277 * 0.681) = 0.3321$

Equation 7: Weigh of speech $(0.261 * 0.118) + (0.095 * 0.201) + (0.277 * 0.681) = 0.2389$

Equation 8: Weigh of role playing $(0.058 * 0.118) + (0.273 * 0.201) + (0.072 * 0.681) = 0.1114$

[Insert Fig 4 about here]

3. Conclusion

Today, because of multiplicity of standards, diversity of needs, interests of students, variety of teaching – learning methods, the effect of social, political and economic factors, diversity of content, lesson planning has become changed into a complex system.

So, planners should pay enough attention to the efficiency and effectiveness of their programs. Due to a wrong and nonscientific decision, Programs may be performed incorrectly and doesn't have necessary efficiency. Whatever lesson planning is more logical and subtly, the result would be more logical.

Curriculum is a rational, reasonable and responsible process and should be done carefully and intelligently .In program planning specifically curriculum planning, Speculation and guess has no place.

Thus, all aspects of the decisions and the criteria of planning and its factors should be considered and the best options to choose according to scientific method, especially in the selection of content and teaching- learning strategies.

In this selection, Analytical Hierarchy Process can be the most efficient method because in this process, according to scientific method, Objectives and sub criteria are selected and prioritized.

However, this method can be used in any phase of lesson planning but the best usage is in a situation that there are many criteria and selecting is difficult.

Many groups are involved in curriculum planning (interested, competent, influential) which their cooperation improves the quality of programs and the carelessness of their ideas would reduce the efficiency and effectiveness of the programs. It shows the personal and non-scientific decision making. While in Analytical Hierarchy Process (AHP), cooperation of them and even their influence is considered. So AHP as a suitable method can help to select the right decisions in all phases and Procedures of curriculum planning process.

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Table 1: weighting factors based on priority

| Priorities (oral judgment) | Value |
|---|---------|
| Highly preferred, highly important, or highly favorable | 9 |
| preferred, important, or very strongly favorable | 7 |
| Preferred, important, or strongly favorable | 5 |
| Relatively preferred, relatively important, or relatively favorable | 3 |
| preferred, important, or similar favorable | 1 |
| Priorities between strongly distances | 2,4,6,8 |

Table 2: I.I.R values for random matrixes

| N | 1 | 2 | 3 | 4 | 5 | 6 | 7 | ... |
|-------|---|---|------|-----|------|------|------|-----|
| I.I.R | 0 | 0 | 0.58 | 0.9 | 1.12 | 1.24 | 1.32 | ... |

Table 3: paired comparison matrix, its normalization, and estimation of weight to choosing teaching-learning strategy

| Interest | Learning | Speech | Role | Learning | Speech | Role | Estimation of weight |
|--|----------|--------|------|----------|--------|-------|----------------------|
| Exploratory learning | 1 | 3 | 6 | 0.650 | 0.510 | 0.610 | 0.710 |
| Speech | 0.333 | 1 | 5 | .250 | .350 | 0.350 | 0.230 |
| Role | 0.166 | 0.2 | 1 | 0.100 | 0.140 | 0.040 | 0.060 |
| Sum | 1.986 | 4.967 | 16.5 | 1 | 1 | 1 | 1 |
| Rate of incompatibly= 0.0023, compatibly of matrix is acceptable | | | | | | | |

Table 4: paired comparison matrix, normalization, vector of measure's weight

| Vector of weight | Facilities | Goals | Interest | Facilities | Goals | Interest | Measures |
|--|------------|-------|----------|------------|-------|----------|------------|
| 0.117 | 0.200 | 0.090 | 0.175 | 0.200 | 0.500 | 1 | Interest |
| 0.203 | 0.111 | 0.150 | 0.200 | 0.250 | 1 | 2 | Goals |
| 0.680 | 0.689 | 0.760 | 0.625 | 1 | 4 | 5 | Facilities |
| 1 | 1 | 1 | 1 | 1.45 | 5.5 | 8 | Sum |
| Rate of incompatibly= 0.0017, compatibly of matrix is acceptable | | | | | | | |

Fig 1: hierarchical structure of choosing content

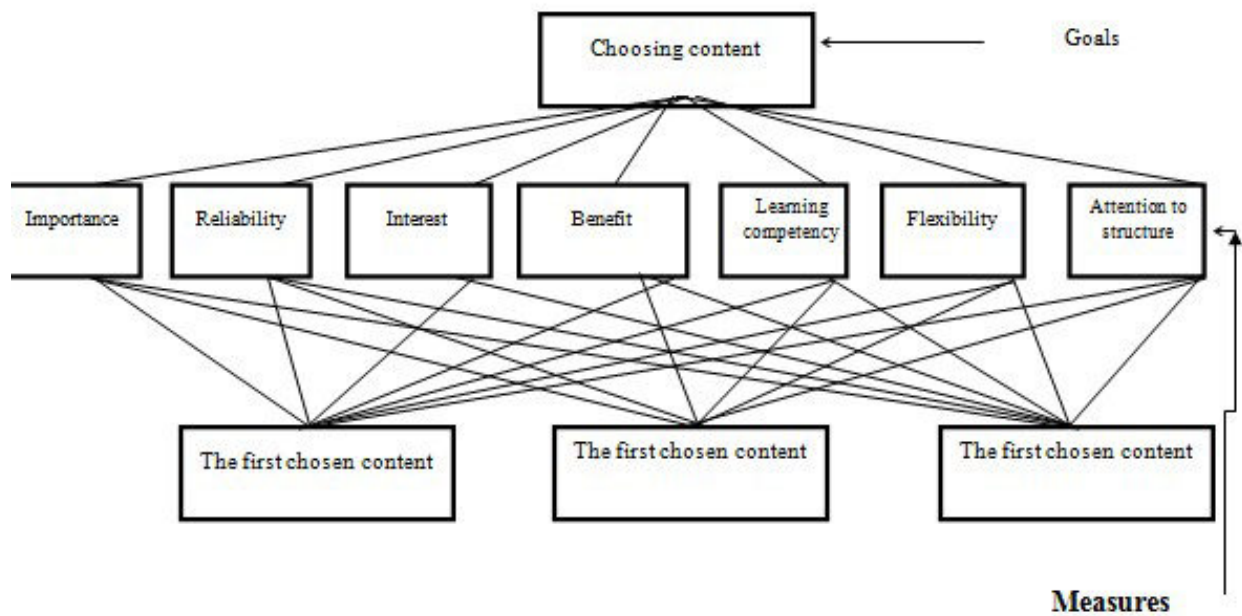


Fig 2: hierarchical structure of choosing teaching-learning strategy

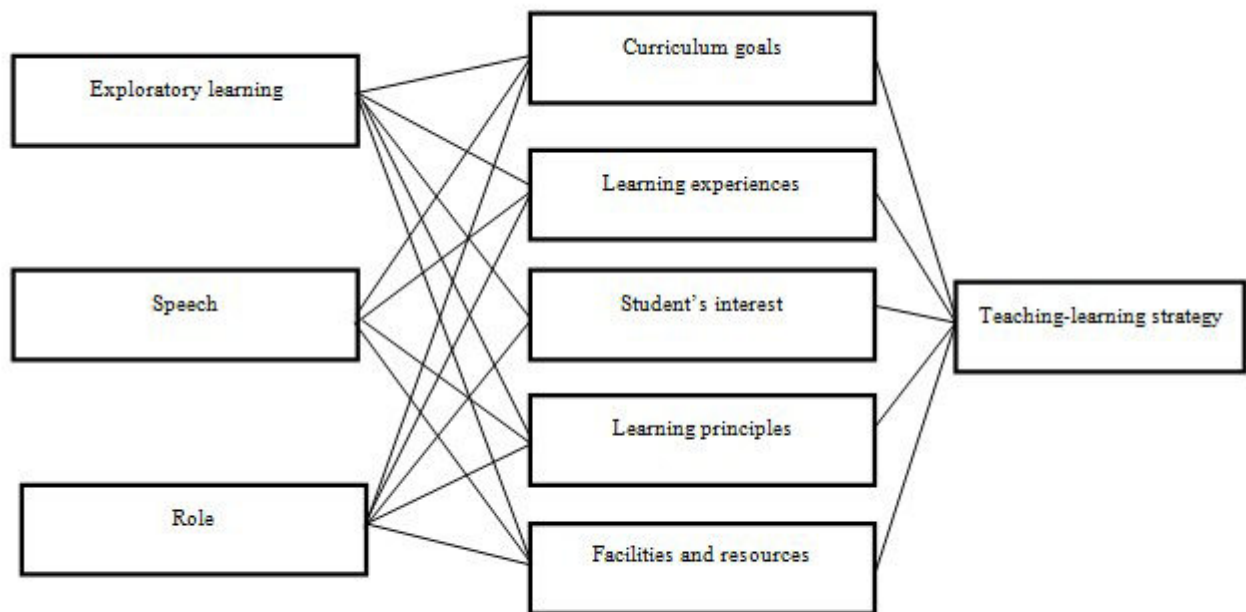


Fig 3: relative weight of prioritization of choosing teaching-learning strategy

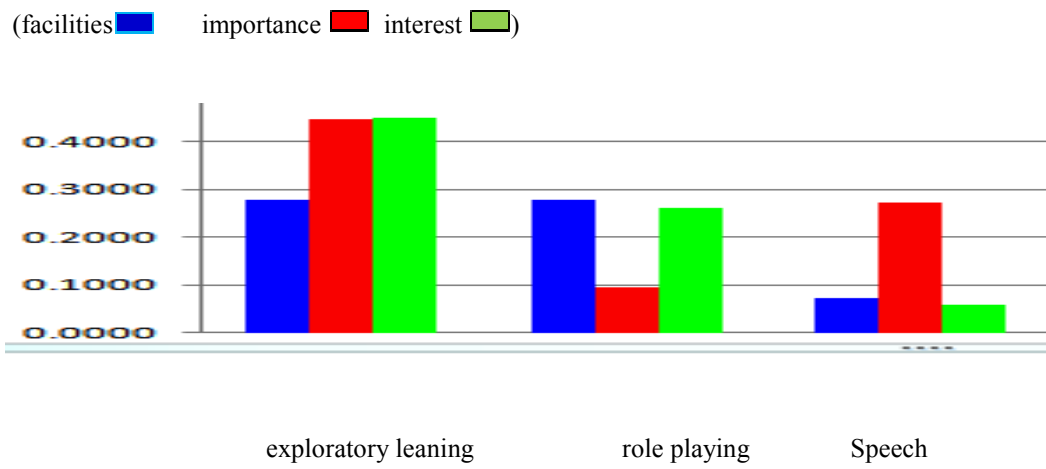


Fig 4: the final weight of choosing teaching-learning strategy and their priorities