Research on Learning Effect based on Outer P- set

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***Abstract*—Teaching approach is important during teaching process, and different teaching approaches can result in different teaching effect. This paper analyzes learning effect generated by three different teaching methods, which including traditional-teaching, case-teaching, problem--resolving and coaching, from the factors of basic knowledge level, application ability, computing ability, memorizing ability, analysis ability, understanding ability, and self-learning ability. Furthermore the whole learning effect generated by the three teaching methods are compared based on outer P-set's theory, and the conclusion is helpful for mathematics teacher to choose suitable teaching method during teaching process. outer P-set's theory has dynamic characteristics, with which comparing learning effect generated by different teaching methods has more impersonality than other theory because outer P-set theory does not need any pretest knowledge.**

***Index Terms* --learning effect, teaching method, outer P-set, dynamic characteristics**

I. INTRODUCTION

Teaching approach plays an important role during teaching process as every knows, and under the same condition, different teaching approaches are chosen by different teacher, so teaching effect generated is distinguishing from the view of students and teachers. However, existing measurement methods have their fault so that they can not reflect teaching effect impersonally. This paper chooses the theory of P-sets as the tool of comparing learning effect generated by three different teaching methods ,which are traditional teaching approach, case-teaching approach, and problem-resolving and coaching approach, because teaching effect has similar characteristics with P-sets. Furthermore, it analyzes teaching effect from seven factors including basic knowledge level, application ability, computing ability, memorizing ability, analysis ability, understanding ability, and self-learning ability. It is illustrated with a case that the conclusion generated by this approach given in the paper is helpful for mathematics teacher to choose suitable teaching method.

In 2008, Refs.[1,2] originated P-sets $(X^{\bar{F}}, X^{F})$ by introducing dynamic characteristic into general set X (Cantor set). P-sets are set pair composed of the internal P-set $X^{\bar{F}}$ and outer P-set X^{F} together, so they have dynamic characteristics. P-sets are a new approach to the research of dynamic information system. Based on features of P-sets, the concepts of information set, F -data set ， and measurement between two F -data sets. Using these results compare students' learning effect generated by different teaching methods.

To facilitate the discussion and acceptance of the results we give in this paper, P-sets and its simple structure are introduced into the following section as theoretical preparation.

II. P-SETS AND THEIR STRUCTURE

Let $X=\{x_1,x_2,\cdots,x_m\}\subset U$ be a finite general set(Cantor set) , and $\alpha=\{\alpha_1,\alpha_2,\cdots,\alpha_k\}\subset V$ be the attribute set of X , $X^{\bar{F}}$ is called internal packet set of X , called internal P-set for short, moreover

$$X^{\bar{F}}=X-X^{-}, \tag{1}$$

X^{-} is called $\bar{F}$ -element deleted set of X , moreover

$$X^{-}=\{x\mid x\in X,\bar{f}(x)=u\bar{\in}X,\bar{f}\in\bar{F}\}, \tag{2}$$

if the attribute set α^{F} of $X^{\bar{F}}$ satisfies

$$\alpha^{F}=\alpha\bigcup\{\beta\mid f(\beta)=\alpha'\in\alpha,f\in F\} \tag{3}$$

where $\beta\in V,\beta\bar{\in}\alpha$, $f\in F$ turns β into $\alpha'=f(\beta)\in\alpha$. V is a nonempty finite attribute universe and U is a nonempty finite element universe.

Given $X=\{x_1,x_2,\cdots,x_m\}\subset U$, and $\alpha=\{\alpha_1,\alpha_2,\cdots,\alpha_k\}\subset V$ is the attribute set of X , X^{F} is called outer packet set of X , called outer P-set for short, moreover

$$X^{F}=X\bigcup X^{+} \tag{4}$$

and X^{+} is called F -element supplemented set, moreover

$$X^{+}=\{u\mid u\in U,u\bar{\in}X,f(u)\in x'\in X,f\in F\} \tag{5}$$

if the attribute set $\alpha^{\bar{F}}$ of X^{F} satisfies

$$\alpha^{\bar{F}}=\alpha-\{\alpha_i\mid\bar{f}(\alpha_i)=\beta_i\notin\alpha,\bar{f}\in\bar{F}\} \tag{6}$$

where, $\alpha_i\in\alpha$, $\bar{f}\in\bar{F}$ turns α_i into $\bar{f}(\alpha_i)=\beta_i\bar{\in}\alpha$.

$f\in F$ and $\bar{f}\in\bar{F}$ are element transfers,

$F=\{f_1,f_2,\cdots,f_m\}$ and $\bar{F}=\{\bar{f}_1,\bar{f}_2,\cdots,\bar{f}_m\}$ are element transfer families[4-16]; $\alpha^{\bar{F}}\neq\varnothing$.

The set pair which is composed of internal P-sets $X^{\bar{F}}$ and outer P-sets X^{F} is called P-sets (packet sets)

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generated by the general set X, called P-sets for short, moreover

$$(X^{\bar{F}}, X^{F}) \tag{7}$$

where the general set X is called the ground set of P-sets $(X^{\bar{F}}, X^{F})$

More concepts and features of *P*-sets can be obtained from Refs. [1-3].

From expressions (1)-(7), we can easily get the relation between P-sets and the general set, such as

$$(X^{\bar{F}}, X^{F})_{\bar{F}=F=\varnothing} = X \tag{8}$$

P-sets has the following features:

1°. If attribute sets α_i^F of the sequence of internal P-sets $X_i^{\bar{F}}$ fulfill

$$\alpha_1^F \subseteq \alpha_2^F \subseteq \cdots \subseteq \alpha_{n-1}^F \subseteq \alpha_n^F , \tag{9}$$

then $\mathrm{card}(X_n^{\bar{F}}) \le \mathrm{card}(X_{n-1}^{\bar{F}}) \le \cdots \mathrm{card}(X_2^{\bar{F}}) \le \mathrm{card}(X_1^{\bar{F}})$.

2°. If attribute sets $\alpha_j^{\bar{F}}$ of the sequence of outer P-sets X_j^F fulfill

$$\alpha_n^F \subseteq \alpha_{n-1}^F \subseteq \cdots \subseteq \alpha_2^F \subseteq \alpha_1^F , \tag{10}$$

then $\mathrm{card}(X_1^F) \le \mathrm{card}(X_2^F) \le \cdots \mathrm{card}(X_{n-1}^F) \le \mathrm{card}(X_n^F)$.

In formulas (9)and(10), $\mathrm{card}(*)$ means cardinal number.

III. F -DATA SET AND DYNAMIC MEASUREMENT ABOUT OUTER P-SET

Let $X = \{x_1, x_2, \cdots, x_m\} \subset U$ be a finite set, for $k \in \{1,2,\cdots,m\}$, w_k is called data set generated by $x_k \in X$, moreover

$$w_k = \{y_{k,1}, y_{k,2}, \cdots, y_{k,n}\} \tag{11}$$

y is called data set generated by X, moreover

$$y = \{y_1, y_2, \cdots, y_n\} = \left\{\sum_{i=1}^{m} y_{i,1}, \sum_{i=1}^{m} y_{i,2}, \cdots, \sum_{i=1}^{m} y_{i,n}\right\} , \tag{12}$$

in which $y_{k,\lambda}$ .in v_k is the attribute value of $x_k \in X$, $y_{k,\lambda} \in \mathbf{R}^+$, $\lambda = 1,2,\cdots,n$.

Given $X^F = \{x_1, x_2, \cdots, x_{m+1}, \cdots, x_{m+t}\} \supseteq X$, y^F is called F-data set generated by X^F, if

$$y^F = \{y_1^f, y_2^f, \cdots, y_n^f\} = \left\{\sum_{i=1}^{m+t} y_{i,1}, \sum_{i=1}^{m+t} y_{i,2}, \cdots, \sum_{i=1}^{m+t} y_{i,n}\right\} \tag{13}$$

in which X^F is an outer *P*-sets[1-3] of $X \subset U$.

According to formulas (11)-(13), let $y = \{y_1, y_2, \cdots, y_n\}$ be a data set composed of y_λ, then there exists an F-data set $y^F = \{y_1^f, y_2^f, \cdots, y_n^f\}$ satisfying

1. The existence of $y_\lambda^f \in y^F$ has nothing to do with $\mathrm{card}(y)$.

2. $\forall \lambda$, $y_\lambda^f \in y^F$ and $y_\lambda \in y$ fulfill

$$y_\lambda \le y_\lambda^f , \tag{14}$$

where $y^F = \{y_1^f, y_2^f, \cdots, y_n^f\}$ is an F-data set generated by $X^F = \{x_1, x_2, \cdots, x_{m+1}, \cdots, x_{m+t}\}$, $y_\lambda^f \in \mathbf{R}^+$.

Let $y = \{y_1, y_2, \cdots, y_n\}$ and $y^F = \{y_1^f, y_2^f, \cdots, y_n^f\}$ be data sets, they are generated by set X and outer P-set X^F respectively. θ^F is called extension degree of F-data set data to data set y, moreover

$$\theta^F = \| y^F - y \| = \left[\sum_{i=1}^{n} (y_i^f - y_i)^2\right]^{\frac{1}{2}} \tag{15}$$

ζ^F is called extension coefficient of F-data set data to data set X, moreover

$$\zeta^F = \theta^F / \| y \| = \left[\sum_{i=1}^{n} (y_i^f - y_i)^2\right]^{\frac{1}{2}} / \left[\sum_{i=1}^{n} y_i^2\right]^{\frac{1}{2}} \tag{16}$$

If y^F and y'^F are F-data sets generated by outer X^F and X'^F of X respectively, let $X^F \subseteq X'^F$, then y^F and y'^F fulfill

$$\theta^F \le \theta'^F , \tag{17}$$

$$\zeta^F \le \zeta'^F , \tag{18}$$

in which θ^F and θ'^F are extension degree of y^F and y'^F, ζ^F and ζ'^F are extension coefficient of y^F and y'^F respectively.

Obviously, the bigger ζ^F is, the bigger θ^F is.

IV. COMPARE LEARNING EFFECT GENERATED BY DIFFERENT TEACHING METHODS

Choose freshmen in engineering specialty, and divided them into three similar degree classes according to factors including basic knowledge level, application ability, computing ability, memorizing ability, analysis ability, understanding ability, and self-learning ability. Class No.1 is treated as compared class which is taught advanced mathematics with traditional-teaching approach, No.2 with traditional and case-teaching approach, No.3 with problem-resolving and coaching approach.

Suppose three similar degree classes are denoted as set $X_i = \{x_{i1}, x_{i2}, \cdots, x_{i45}\}$, $i = 1,2,3$, in which $x_{ij} \in X_i$, $j = 1, 2, ..., 45$ represents students in class No. i. basic knowledge level, application ability, computing ability, memorizing ability, analysis ability, understanding ability, and self-learning ability are denoted as $\alpha_1, \alpha_2, ..., \alpha_7$ respectively, $y_i = \{y_{i1}, y_{i2}, \cdots, y_{i7}\}, i = 1,2,3$ is data set generated by X_i, in which $y_{i1}, y_{i2}, \cdots, y_{i7}$ represent value of the whole class about $\alpha_1, \alpha_2, ..., \alpha_7$ respectively, and $y_{ij} = \sum_{k=1}^{45} v_{ijk}$, $v_{ijk}, k = 1,2,...,45$ is denoted as the value of $x_{i,k}$ about α_k. The evaluating result is as table Ⅰ.

After an academic year we evaluate the three classes on $\alpha_1, \alpha_2, ..., \alpha_7$. The evaluating result is as table2.

Table 1. Evaluating result of three classes about $\alpha_1, \alpha_2, ..., \alpha_7$ when students are enrolled

	α_1	α_2	α_3	α_4	α_5	α_6	α_7
y_1	0.56	0.65	0.68	0.70	0.69	0.72	0.69
y_2	0.57	0.65	0.68	0.71	0.70	0.71	0.69
y_3	0.56	0.64	0.69	0.70	0.71	0.72	0.68

Table 2. Evaluating result of three classes about $\alpha_1, \alpha_2, ..., \alpha_7$ after a year's learning.

	α_1	α_2	α_3	α_4	α_5	α_6	α_7
y_1^F	0.66	0.68	0.71	0.70	0.69	0.72	0.70
y_2^F	0.67	0.71	0.74	0.72	0.70	0.71	0.73
y_3^F	0.70	0.74	0.74	0.73	0.71	0.85	0.82

According to knowledge in section Ⅲ,we can compare learning effect of students in each class in order to judge which teaching approach is helpful to improve students' seven abilities. Their extension degrees are

$$\theta_1^F = \| y_1^F - y_1 \| = [\sum_{j=1}^{7} (y_{1,j}^F - y_{1,j})^2]^{\frac{1}{2}} = 0.11$$

$$\theta_2^F = \| y_2^F - y_2 \| = [\sum_{j=1}^{7} (y_{2,j}^F - y_{2,j})^2]^{\frac{1}{2}} = 0.21$$

$$\theta_3^F = \| y_3^F - y_3 \| = [\sum_{j=1}^{7} (y_{3,j}^F - y_{3,j})^2]^{\frac{1}{2}} = 0.23$$

And their extension coefficients are

$$\zeta_1^F = 0.34\%, \zeta_2^F = 0.68\%, \zeta_3^F = 0.72\%$$

So learning effect of students in class No3 is best. Hence the problem-resolving and coaching approach is suitable to improve students' seven abilities. This result is fit to anticipation. Because the traditional-teaching method mainly is to teach during the whole lesson, students only negatively listen. Teacher plays key role. The traditional and case-teaching method gives students certain time to consider and analyze the case , so it can improve their analysis ability, understanding ability, etc. The problem-resolving and coaching method can stimulate students to actively analyze the problem, search related materials, look for the approaches to resolve the problem, and find the best one. In the end they can correct their thinking method and the answer by teacher's coaching, and so on. In the whole process, students' activities are active and effective, so the teaching method can excise students' various abilities.

V. CONCLUSION

Teaching effect is a measurement of teaching level and teaching ability, also is reflection of students' learning grads. Choosing suitable teaching approach is one of important teaching factors. Comparing teaching effect generated by different teaching approaches impersonally and correct conclusion are key to teachers. Because outer P-set is a new mathematics tool to analyze dynamic data , Using it , the paper presents a new method of comparing learning effect of students generated by different teaching methods, and got reasonable result. It is guidance to choose teaching approaches.

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