Analyzing Attitude Test with the Model Analysis Technique

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Abstract. This study aims to investigate the distribution of students' attitudes to physics problem-solving by using the model analysis technique. Data were collected by the Attitudes and Approaches to Problem Solving (AAPS) survey from over 700 Thai university students from five different levels, namely the entering science students, the first-year science students, and the second-, third- and fourth-year physics students. It revealed that the student mental states were generally mixed. The largest gap between physics experts and all levels of the students was about the role of equations and formulas in physics problem-solving, and in views towards difficult problems.

1 Introduction

Students' attitudes, beliefs, expectations, and approaches to learning affect how they respond in classes, and this plays a key role in successful learning [1-3]. It is of particular concern when the students' attitudes essentially differ from those of physics experts. This study applies the model analysis technique to explore Thai students 'attitudes and approaches to physics problem-solving, and how those attitudes and approaches change with more experiences in studying physics. The instrument for data collection was the Attitudes and Approaches to Problem Solving (AAPS) survey [2]. It consists of 33 survey items with the five-level Likert scale and categorized into ten clusters [3]. The model analysis technique, developed by Bao and colleagues, was generally used in physics education research to analyze models of well-designed content knowledge questions [4-6]. In this work, we demonstrate that the model analysis can be beneficial to the interpretation of a Likert-scale survey. We used a cluster of equivalent view items in the AAPS to activate the students' ideas. Students will apply different ideas to the diverse items, and their probabilities of using the common models of perspectives can be estimated.

2 Data Analysis

The AAPS survey was given to five groups of Thai students in faculty of science in one public university, as shown in table 1 .

Table 1 .Summary of the participant groups tested

Rank	Groups	N	Descriptions
1	enterSc	698	entering science students
2	1stSc	655	first-year science students
3	2ndPhy	35	second-year physics students
4	3rdPhy	32	third-year physics students
5	4thPhy	26	fourth-year physics students

The students' responses to AAPS were classified into three main sets, namely "strongly agree" and "agree" in one set, "neutral" forms one set, and "disagree" and "strongly disagree" are put together. These three main responses are defined to be the three common models, represented by three orthonormal vectors in a linear vector space : $\mathrm{e}_1 = \begin{pmatrix} 1 & 0 & 0 \end{pmatrix}^T$, $\mathrm{e}_2 = \begin{pmatrix} 0 & 1 & 0 \end{pmatrix}^T$ and

$\mathrm{e}_3 = \begin{pmatrix} 0 & 0 & 1 \end{pmatrix}^T$, where $\mathbf{e}_1$ is defined as the experts' favorable idea) model 1(, $\mathbf{e}_2$ is the neutral idea (model 2), and $\mathbf{e}_3$ is the experts' unfavorable idea)model 3(. Responses from a single student to AAPS are used to construct a student model state with a vector of unit length)$\mathbf{u}$ (in the model space. The individual student vector is used to construct a single student density matrix)$\mathbf{D}_k$ (, where $\mathbf{D}_k = \mathbf{u}_k \otimes \mathbf{u}_k^T$ .The class density matrix)$\mathbf{D}$(is the average of the individual student density matrices in the class,

$$\mathbf{D} = \frac{1}{N}\sum_{k=1}^{N}\mathbf{D}_k = \frac{1}{N.m}\begin{bmatrix} n_1^k & \sqrt{n_1^k n_2^k} & \sqrt{n_1^k n_3^k} \\ \sqrt{n_2^k n_1^k} & n_2^k & \sqrt{n_2^k n_3^k} \\ \sqrt{n_3^k n_1^k} & \sqrt{n_3^k n_2^k} & n_3^k \end{bmatrix} = \begin{bmatrix} \rho_{11} & \rho_{12} & \rho_{13} \\ \rho_{21} & \rho_{22} & \rho_{23} \\ \rho_{31} & \rho_{32} & \rho_{33} \end{bmatrix} \qquad (1.$$

3 Results and Conclusion

Diagonal elements in three models of the class density matrix)$\mathbf{D}$(are plotted, as examples in figure 1. The results indicated that the physics students enjoy more the challenge of solving physics problems and try a different approach (cluster 3) than other groups. All levels of the samples believed that being able to handle the mathematics is the most important part of physics problem-solving, represented by $\mathbf{e_3}$ of cluster 5 [7]. Overall, we have learned from the model analysis technique for exploring the Likert scale data that it can facilitate to discover distribution and movement of the data in details beyond the conventional normalized method.

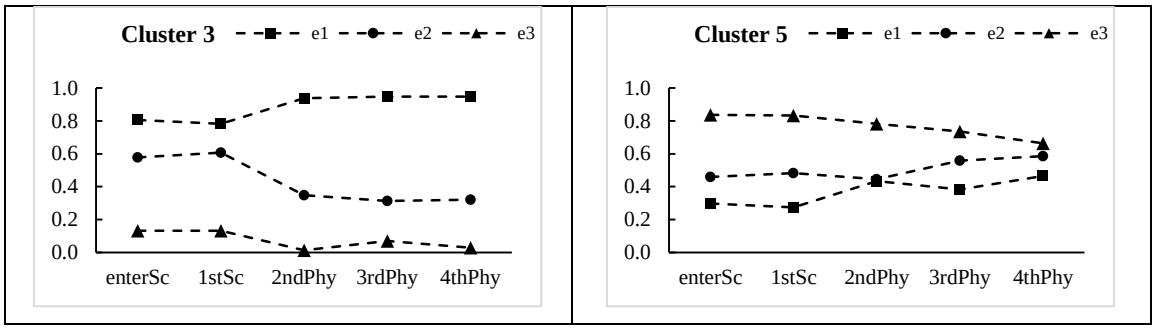

Figure 1. Diagonal elements in three models: $\mathbf{e_1}$(favorable), $\mathbf{e_2}$(neutral), and $\mathbf{e_3}$(unfavorable) for five groups: entering science students (enterSc), first-year science students (1stSc), second-year physics students (2ndPhy), third-year physics students (3rdPhy), and fourth-year physics students (4thPhy), in clusters 3 and 5.

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