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# THE EFFECT OF NUMBER'S ALTERNATIVE ANSWERS ON PARTIAL CREDIT MODEL (PCM) TOWARD ESTIMATION RESULT PARAMETERS OF POLITOMUS ITEM TEST

**Syukrul Hamdi**
STKIP Hamzanwadi Selong
*e-mail: syukrulhamdi@gmail.com, Hp: 081917737596*

## Abstract

*Item response theory is a review toward the test and item score based on related assumptions among parameters of the test item which reflecting the answers of the test items and the capabilities of participants. There are two terms known in IRT, they are dichotomous and politomus, the scoring through politomus on item response theory approach can be analyzed with the Partial Credit Model (PCM). This study uses a simulation method with politomus data (0,1,2,3) and politomus (0,1,2,3,4) with fixed number of examinees and the items. The number of examinees and items are determined by the simulation method. Politomus simulation data are generated using the Win-Gen program. Simulations carried out four times with different number of examinees, ie, N = 600 and N = 500, and the number of item = 10. Simulation result shows that the number of alternative answers have different correlations. Therefore, an analysis of the two alternative answers can be used as a basis for consideration in choosing alternative answers will be used.*

**Keywords:** *IRT, Politomus, PCM, Number of Alternative Answers*

## Introduction

Measurement is a process that must be implemented in an effort to improve the quality of education. Therefore, the process of preparing a tool or instrument used in the measurement should be carried out optimally, in order to provide valid and reliable results. The measurement of the instruments that have been made will be used as a basis for decision making with regard to development of learners and the learning process that have been implemented. That conditions are appropriate to the context. The measurement itself is defined as a number-determining activity for an object with systematic way (Djemari Mardapi, 2008:2).

Systematic procedure which includes the activities of collecting, analyzing, and interpreting the information that can be used to make inferences about the characteristics of a person or object is called assessment. In particular for education, Groundlound & Linn (2009: 28) define assessment is a general term that includes the full range of procedures used to gain information about student learning (observations, ratings of performances or projects, paper-and-pencil tests) and the formation of value judgments concerning learning progress. Assessment of learning outcomes which conducted continuously by the teacher to monitor

the process, progress, and improvement of the results by using an instrumental test or non-test.

In fact, some teachers do not understand the procedure or test preparation applications in the class. Based on that situation, it is necessary to do study on the various references and theories that have been submitted by the the expert of measurement until it can be used as foundation for the teacher. There are two instrument of the analysis to be note, they are qualitative analysis and quantitative analysis. Quantitative analysis uses classical test theory approach and modern test theory, known as the IRT.

In classical test theory approach, the calculation is done by sum overall score obtained by the students. This approach is not necessarily appropriate, because the level of difficulty of each step is not taken into account. One of alternative approach that can be used on the item response theory approach for politomus scoring is the Partial Credit Model (PCM). The partial credit model is an extension of the Rasch model for dichotomously scored test data to outcomes recorded in more than two ordered response categories. One approach to the analysis of polychotomously scored data is to group the ordered response categories and to carry out multiple dichotomous analyses. A preferable approach is to implement a model for ordered response categories directly. The partial credit model is a general polychotomous item response model belonging to the Rasch family of measurement models (Master & Keeves. eds, 1999:98). The scope of PCM in this paper focused on the effect of the number of alternative answers (alternatives 4 and 5) in partial credit model towards the results of parameter estimation on politomus item.

**Method**

This study used a simulation method conducted using politomus data at (0,1,2,3) and politomus (0,1,2,3,4) where the amount of participants and length of the test are fixed at first. Politomus simulation data is generated using the Win-Gen program.The simulation was performed four times with different sample sizes, the simulaton I (10 items with 500 participants and four scoring category for the answers), simulation II (10 items with 500 participants and five scoring category for the answers), III (10 items with 600 participants and 4 scoring category for the answers), and I (10 item with a 600 participants and 4 scoring category for the answers). Each simulation is calculated in term of correlations and compared with obtained results.

The instrument used: Wingen, Parscale, Microsoft Excel and Notepad. Wingen used to generate the data, Parscale used to analyze the generation items of Wingen, Microsoft Excel are used to analyze the Parscale results and find correlation of the obtained results and Notepad used in fixing the rules of data which will be analyzed.

**Disscussion**

A test is denned as an instrument or systematic procedure for observing and describing one or more characteristics of a student using either a numerical scale or a classification scheme (Nitko & Broolhart, 2011:5). The test also can be interpreted as a response to question with the aim of measuring the level of a person's ability or reveal certain aspects of the person as a subject of the test. The test is one of the tools to perform measurement and to collect the characteristics of an object (Eko, 2013:57). According to the expert the quality of the test is very important to measure the ability of a person or reveal certain aspects of the person as a subject of the test.

Base on the scoring system, test can be categorized into two, namely the objective test and a subjective test (Eko, 2013: 57). Objective tests usually consist of two categories of scoring answer which commonly referred as dichotomous item response. On the other hand, the subjective test which consist of more than two response categories is called as polytomus item response.

The dichotomous model is designed for the analysis of test items for which only two levels of outcome are defined (x = 0 and $x = 1$) (Master & Keeves. Eds, 1999:104). Dichotomous scoring models cannot be used to find errors made by students, for all the wrong option was given a score of 0. In fact, the mistakes made by students can vary. To be able to find mistakes made by students, needed scoring politomus. The polytomous model is designed for the analysis of test items that have more than two categories (DeMars, 2010:22). Several models have been proposed and used for polytomous items: Samejima's Graded Response (GR) model and Muraki's Generalized Partial Credit (GPC) model, a generalization of Master's Partial Credit (PC) model.

According to Linden & Hambleton Eds, (1997 : 101) the Partial Credit Model (PCM) is a unidimensional model for the analysis of responses recorded in two or more ordered categories. Another point of view said that The partial credit model is an extension of the Rasch model for dichotomously scored test data to outcomes recorded in more than two ordered response categories (Master & Keeves. eds, 1999:98).

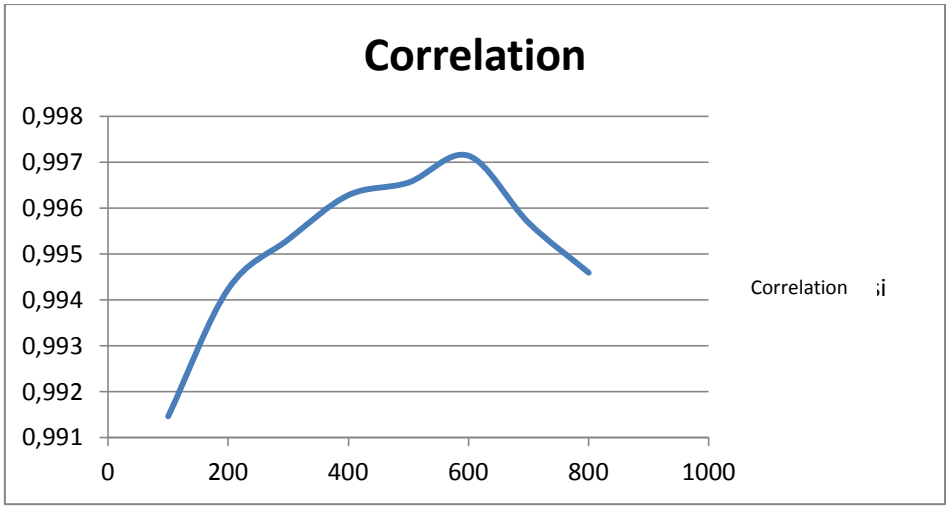
Two of those opinions revealed that the scoring category on the PCM indicates the number of steps that have to complete correctly. Higher score category shows greater ability than a lower score categories. In PCM, if an items has two categories, then it is become inclided into Rasch equations model. As a result, the PCM can be applied to politomus and dichotomous items. This paper will focus on politomus items with 4 and 5 categories using fixed number of N and the items .

The basis for determining the number of N in the simulation is very important, therefore the author at the beginning of the discussion will briefly describe the relevant number of N in the simulation. Simulation result on the number of N towards the items politomus estimation of *partial credit* model, as follows:

Table 1
Correlation based on the number of N

| The number of N | **Correlation** |
|---|---|
| **100** | 0.991458 |
| **200** | 0.994236 |
| **300** | 0.995314 |
| **400** | 0.996281 |
| **500** | 0.996556 |
| **600** | 0.997139 |
| **700** | 0.995677 |
| **800** | 0.99459 |

These results indicate that the high number of *N* is not always analogous with the *correlation*. It is clear from the table above that the number of N = 600 has the highest correlation while in another N score the value has declined but will climb back on certain number of N. By considering that way, the author use N = 600 as a basis and 600 and another N = 500 for comparison. The clarification of the correlation level are showed by the following graphic:



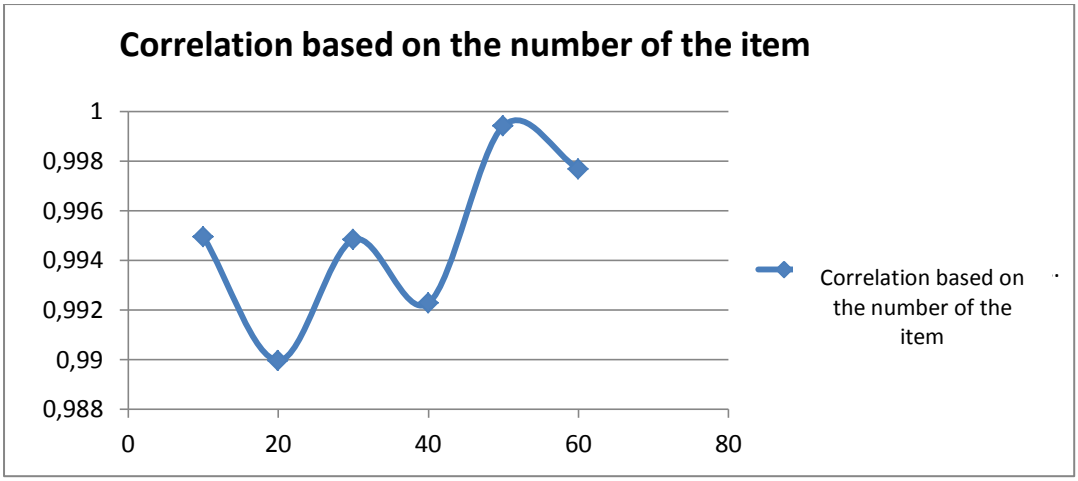

Graphic 1
Correlation based on 'N' number

In addition to the basis for determining the number of "N", the author also describes the basis for determining the number of the items. The simulation results of correlation from the number of test items by the number "N" and the same number of alternative answers are presented in the following table:

Table 2.
Correlation based on the number of item

| Number of items | **Correlation** |
|---|---|
| **10** | 0.994953 |
| **20** | 0.9899689 |
| **30** | 0.994835 |
| **40** | 0.992281 |
| **50** | 0.999423 |
| **60** | 0.997684 |

From Table 2 it can be seen that the number of items 20 have the lowest correlation and the number of item of 50 have the highest correlation, while the number of item of 10 have a correlation in between 50 and 20 (precisely in the middle of all the simulation results shown in the table). This is the basis of simulation which using the 10 item of questions. In practical way, the process is showed by the following graphic:




Graphic 2
Correlation based on the amount of the item

**Effect of the number's of alternative answers (4 and 5) on the PCM toward the Results of Estimation on Politomus Item Test Parameter.**

**1) Simulation Result 1**

The first simulation results will be summarized in the two tables below, namely, table 3 and 4

Table 3
The true parameter result on the number's of alternative answer 4 with N=500

| | | | | | |
|---|---|---|---|---|---|
| 1 | PCM | 4 | -1.001 | -0.785 | 1.735 |
| 2 | PCM | 4 | 0.582 | 1.001 | 1.265 |
| 3 | PCM | 4 | -0.506 | 0.66 | 1.655 |
| 4 | PCM | 4 | -0.014 | 0.478 | 0.875 |
| 5 | PCM | 4 | -1.576 | -0.673 | 1.313 |
| 6 | PCM | 4 | -1.847 | -1.096 | 0.413 |
| 7 | PCM | 4 | -1.638 | -0.497 | -0.178 |
| 8 | PCM | 4 | -1.955 | -0.036 | 1.151 |
| 9 | PCM | 4 | -1.341 | -1.133 | 1.87 |
| 10 | PCM | 4 | -1.064 | -0.216 | 0.237 |

Table 4
The parameter estimation result on the number's of alternative answer 4 with N=500

| ITEM | BLOCK | SLOPE | S.E. | LOCATION | S.E. | GUESSING | S.E. |
|---|---|---|---|---|---|---|---|
| **1** | 1 | 0.59 | 0.017 | -0.121 | 0.077 | 0 | 0 |
| **2** | 2 | 0.59 | 0.017 | 0.814 | 0.074 | 0 | 0 |
| **3** | 3 | 0.59 | 0.017 | 0.567 | 0.075 | 0 | 0 |
| **4** | 4 | 0.59 | 0.017 | 0.388 | 0.071 | 0 | 0 |
| **5** | 5 | 0.59 | 0.017 | -0.422 | 0.077 | 0 | 0 |
| **6** | 6 | 0.59 | 0.017 | -1.045 | 0.078 | 0 | 0 |
| **7** | 7 | 0.59 | 0.017 | -0.917 | 0.074 | 0 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **8** | 8 | 0.59 | 0.017 | -0.337 | 0.077 | 0 | 0 |
| **9** | 9 | 0.59 | 0.017 | -0.307 | 0.081 | 0 | 0 |
| **10** | 10 | 0.59 | 0.017 | -0.558 | 0.072 | 0 | 0 |

Table 3 shows the results of the parameters for N = 500 and the number's of 4 alternative answers, the results will be analyzed by finding the average value from three right-hand column. The average is correlated with the "LOCATION" column in Table 4 to produce a correlation of 0.996718.

**2) Simulation Result 2**

The second simulation results will be summarized in the two tables below, namely, table 5 and 6

Table 5
The true parameter result on the number's of alternative answer 5 with N=500

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | PCM | 5 | -1.001 | -0.785 | 0.422 | 1.735 |
| 2 | PCM | 5 | 0.582 | 1.001 | 1.265 | 1.687 |
| 3 | PCM | 5 | -1.133 | -0.506 | 0.66 | 1.655 |
| 4 | PCM | 5 | -0.014 | 0.282 | 0.478 | 0.875 |
| 5 | PCM | 5 | -1.576 | -0.673 | 0.996 | 1.313 |
| 6 | PCM | 5 | -1.847 | -1.117 | -1.096 | 0.413 |
| 7 | PCM | 5 | -1.638 | -0.919 | -0.497 | -0.178 |
| 8 | PCM | 5 | -1.955 | -0.036 | 1.151 | 1.878 |
| 9 | PCM | 5 | -1.341 | -1.133 | -0.259 | 1.87 |
| 10 | PCM | 5 | -1.064 | -0.216 | 0.237 | 0.848 |

Table 6
The parameter estimation result on the number's of alternative answer 5 with N=500

| ITEM | **BLOCK** | **SLOPE** | **S.E.** | **LOCATION** | **S.E.** | **GUESSING** | **S.E.** |
|---|---|---|---|---|---|---|---|
| **1** | 1 | 0.603 | 0.018 | -0.001 | 0.068 | 0 | 0 |
| **2** | 2 | 0.603 | 0.018 | 0.974 | 0.069 | 0 | 0 |
| **3** | 3 | 0.603 | 0.018 | 0.133 | 0.068 | 0 | 0 |
| **4** | 4 | 0.603 | 0.018 | 0.331 | 0.064 | 0 | 0 |
| **5** | 5 | 0.603 | 0.018 | -0.062 | 0.068 | 0 | 0 |
| **6** | 6 | 0.603 | 0.018 | -1.094 | 0.071 | 0 | 0 |
| **7** | 7 | 0.603 | 0.018 | -0.933 | 0.067 | 0 | 0 |
| **8** | 8 | 0.603 | 0.018 | 0.123 | 0.07 | 0 | 0 |
| **9** | 9 | 0.603 | 0.018 | -0.313 | 0.07 | 0 | 0 |
| **10** | 10 | 0.603 | 0.018 | -0.223 | 0.065 | 0 | 0 |

Table 5 shows the results of the parameters for N = 500 and the number of 5 alternative answers, the results will be analyzed by finding the average value from four right-hand column. The average is correlated with the "LOCATION" column in Table 6 to produce a correlation of 0.996857.

### 3) Simulation Result 3

The third simulation results will be summarized in the two tables below, namely, table 7 and 8

Table 7
The true parameter result on the number's of alternative answer 4 with N=600

| | | | | | |
|---|---|---|---|---|---|
| 1 | PCM | 4 | -1.001 | -0.785 | 1.735 |
| 2 | PCM | 4 | 0.582 | 1.001 | 1.265 |
| 3 | PCM | 4 | -0.506 | 0.66 | 1.655 |
| 4 | PCM | 4 | -0.014 | 0.478 | 0.875 |
| 5 | PCM | 4 | -1.576 | -0.673 | 1.313 |
| 6 | PCM | 4 | -1.847 | -1.096 | 0.413 |
| 7 | PCM | 4 | -1.638 | -0.497 | -0.178 |
| 8 | PCM | 4 | -1.955 | -0.036 | 1.151 |
| 9 | PCM | 4 | -1.341 | -1.133 | 1.87 |
| 10 | PCM | 4 | -1.064 | -0.216 | 0.237 |

Table 8
The parameter estimation result on the number's of alternative answer 4 with N=600

| ITEM | **BLOCK** | **SLOPE** | **S.E.** | **LOCATION** | **S.E.** | **GUESSING** | **S.E.** |
|---|---|---|---|---|---|---|---|
| **1** | 1 | 0.582 | 0.016 | -0.16 | 0.071 | 0 | 0 |
| **2** | 2 | 0.582 | 0.016 | 0.823 | 0.068 | 0 | 0 |
| **3** | 3 | 0.582 | 0.016 | 0.567 | 0.069 | 0 | 0 |
| **4** | 4 | 0.582 | 0.016 | 0.367 | 0.065 | 0 | 0 |
| **5** | 5 | 0.582 | 0.016 | -0.488 | 0.072 | 0 | 0 |
| **6** | 6 | 0.582 | 0.016 | -1.064 | 0.072 | 0 | 0 |
| **7** | 7 | 0.582 | 0.016 | -0.919 | 0.068 | 0 | 0 |
| **8** | 8 | 0.582 | 0.016 | -0.326 | 0.07 | 0 | 0 |
| **9** | 9 | 0.582 | 0.016 | -0.339 | 0.074 | 0 | 0 |
| **10** | 10 | 0.582 | 0.016 | -0.502 | 0.066 | 0 | 0 |

Table 7 shows the results of the parameters for N = 600 and the number's of 4 alternative answers, the results will be analyzed by finding the average value from three right-hand column. The average is correlated with the "LOCATION" column in Table 8 to produce a correlation of 0.997139.

### 4) Simulation Result 4

The fourth simulation results will be summarized in the two tables below, namely, table 9 and 10

Table 9

The true parameter result on the number's of alternative answer 5 with N=600

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | PCM | 5 | -1.001 | -0.785 | 0.422 | 1.735 | 0.09275 |
| 2 | PCM | 5 | 0.582 | 1.001 | 1.265 | 1.687 | 1.13375 |
| 3 | PCM | 5 | -1.133 | -0.506 | 0.66 | 1.655 | 0.169 |
| 4 | PCM | 5 | -0.014 | 0.282 | 0.478 | 0.875 | 0.40525 |
| 5 | PCM | 5 | -1.576 | -0.673 | 0.996 | 1.313 | 0.015 |
| 6 | PCM | 5 | -1.847 | -1.117 | -1.096 | 0.413 | -0.91175 |
| 7 | PCM | 5 | -1.638 | -0.919 | -0.497 | -0.178 | -0.808 |
| 8 | PCM | 5 | -1.955 | -0.036 | 1.151 | 1.878 | 0.2595 |
| 9 | PCM | 5 | -1.341 | -1.133 | -0.259 | 1.87 | -0.21575 |
| 10 | PCM | 5 | -1.064 | -0.216 | 0.237 | 0.848 | -0.04875 |

Table 10

The parameter estimation result on the number's of alternative answer 5 with N=600

| ITEM | **BLOCK** | **SLOPE** | **S.E.** | **LOCATION** | **S.E.** | **GUESSING** | **S.E.** |
|---|---|---|---|---|---|---|---|
| **1** | 1 | 0.59 | 0.016 | -0.02 | 0.063 | 0 | 0 |
| **2** | 2 | 0.59 | 0.016 | 0.996 | 0.064 | 0 | 0 |
| **3** | 3 | 0.59 | 0.016 | 0.129 | 0.063 | 0 | 0 |
| **4** | 4 | 0.59 | 0.016 | 0.316 | 0.059 | 0 | 0 |
| **5** | 5 | 0.59 | 0.016 | -0.11 | 0.063 | 0 | 0 |
| **6** | 6 | 0.59 | 0.016 | -1.132 | 0.066 | 0 | 0 |
| **7** | 7 | 0.59 | 0.016 | -0.949 | 0.062 | 0 | 0 |
| **8** | 8 | 0.59 | 0.016 | 0.152 | 0.065 | 0 | 0 |
| **9** | 9 | 0.59 | 0.016 | -0.342 | 0.064 | 0 | 0 |
| **10** | 10 | 0.59 | 0.016 | -0.187 | 0.059 | 0 | 0 |

Table 9 shows the results of the parameters for N = 600 and the number's of 5 alternative answers, the results will be analyzed by finding the average value from four right-hand column. The average is correlated with the "LOCATION" column in Table 10 to produce a correlation of 0.997922.

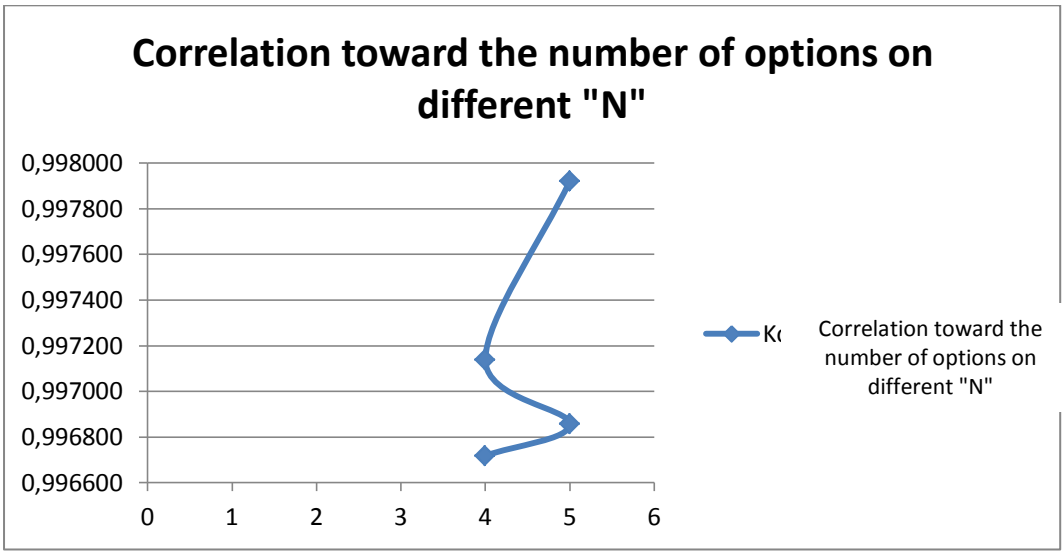
The table below is about simulation results of the effect on the amount of alternative answers (4 and 5) of PCM toward estimation results of politomus item test parameter .

Table 11

Correlation result based on "N" number and options

| "N" Number | Options | Correlation |
|---|---|---|
| **600** | 5 | 0.997922 |
| **600** | 4 | 0.997139 |
| **500** | 5 | 0.996857 |
| **500** | 4 | 0.996718 |

The results presented in Table 11 indicate that the number of option 5 has a higher correlation compared with the number 4 on any choice of N as evidenced from the different number of N, that is N = 500 and N = 600 which lead to the same conclusion. So the number of alternative answers of 5 is more recommended to be used. To clarify the correlation based on the number of optional answer with different amount of "N" is depicted in the following graph:




Graphic 3
Correlation toward the number of options on different "N"

**Conclusion and Suggestion**

Dichotomous scoring models cannot be used to find the mistake made by students, because all the wrong answer was given a score of 0. In fact, the mistakes made by students were vary. To be able to find mistakes made by students, politomus scoring was required. In politomus items, the number of alternative answers could also contribute an effect. The simulation results showed that the number of alternative answers of 5 were better than the number of alternative answers of 4 which indicated from the resulting correlations. The results of this simulation can be used as a consideration for teachers in making questions using a 4 or 5 alternative answers on PCM. PCM model is suitable to be applied on achievement tests, for instance, in Math or Physics that require stage of problem identification until final solution and also for questionnaire which using the likert scale or personality scale.

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