Rural and urban students’ attitudes toward physics: a comparative study using Rasch analysis

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Abstract. Physics education researchers have put out a large number of papers about attitudes. Yet, only few papers employed Rasch model to analyze data of attitudes. This paper reports a comparative study of students’ attitudes toward physics from rural and urban high schools (n=130). In order to collect data of attitudes toward physics, the Colorado Learning Attitudes about Science Survey (CLASS) was administered online to participated students. Obtained data were analyzed by using Rasch model and t-test. Prior Rasch analysis revealed that all items of the CLASS were fitted the Rasch model and had good psychometric properties. The present research found that there were no significant differences between rural and urban students in terms of attitudes toward physics. This result was in line with some earlier finding, but contrary to other previous result. One of variables probably affecting this outcome was teachers’ unawareness of technology usage and other school facilities to enhance teaching quality.

1. Introduction
Attitude studies is one of areas receiving much attention from physics education researchers [1]. A great number of papers reported the relationship between attitudes and achievement [2–4] and influences of teaching practices on student attitudes [5,6]. The findings of these previous researches indicate that attitudes are one of important variables which should be noticed by government and teachers especially when evaluating the teaching practices. Negative attitudes toward physics held by students can be a hint revealing that the students have less interest in physics learning and even their physics teachers [7]. Students who hold positive attitudes toward physics tend to be interested and active in their physics class. In other words, probably there are something wrong in a physics learning environment when students show negative attitudes toward physics.

Furthermore, few papers discussed whether or not school locations influence students’ attitudes. Urban schools usually have completed facilities to support teaching practices and learning processes, such as projectors, libraries, and laboratory equipment. These available tools are expected to be able to enhance the quality of teaching practices. Otherwise, schools located in rural areas have fewer facilities. This difference brings an assumption that students in urban schools will show more positive attitudes toward physics attitudes than rural students. In addition to this, Ibrahim et al [8] found that urban students showed more positive attitudes toward physics than rural students. On the other hand, the research conducted by Shah et al [9] revealed that school locations did not affect student attitudes. Inconsistent findings and deficiencies of comparative studies between rural and urban students about
attitudes toward physics indicate that there should be new researches discussing influences of school locations on students’ attitudes toward physics. To response this, the present research was conducted.

In attitude research, there are some prominent attitude measures usually used by researchers, namely the Maryland Physics Expectations Survey (MPEX) [10] and the Colorado Learning Attitudes about Science Survey (CLASS) [11]. These attitude measures employ Likert scales and produce ordinal data. When conducting comparative studies, we cannot use a sum of raw scores (ordinal data) because this will lead to inaccurate comparisons [12]. To overcome this problem, Rasch analysis can be used to obtain good interpretation [13]. In Rasch measurement, ordinal data are changed to interval data [12] which are comparable. For a detailed review on Rasch model see Ref. [14–16]. Yet, Rasch model is rarely employed to analyzed attitudes toward physics in publish papers [17]. Therefore, we conducted analyzes by using Rasch analysis on the current paper. To guide this research, we proposed a research question: How do attitudes toward physics differs between senior high school students from rural and urban areas?

2. Methods

2.1 Participants

A total of 130 tenth grade students from 4 senior high schools, two rural schools and two urban schools, were involved in the present study. Almost 80 % of the students were female. The students came from eight ethnic groups existing in Indonesia. For convenience, Table 1 shows the participants’ demographic variables of age, gender, ethnic group, and school location.

| Demographic     | Student | Percentage (%) |
|-----------------|---------|----------------|
| Age             |         |                |
| 15 years        | 56      | 43             |
| 16 years        | 74      | 57             |
| Gender          |         |                |
| Female          | 101     | 78             |
| Male            | 29      | 22             |
| Ethnic Group    |         |                |
| Batak           | 12      | 9.23           |
| Buginese        | 2       | 1.54           |
| Ende-Lio        | 1       | 0.77           |
| Javanese        | 31      | 23.85          |
| Kubu            | 1       | 0.77           |
| Malay           | 60      | 46.15          |
| Minangkabau     | 19      | 14.61          |
| Sundanese       | 4       | 3.08           |
| School Location |         |                |
| Rural           | 56      | 43.08          |
| Urban           | 74      | 56.92          |

2.2. Instrument

The Colorado Learning Attitudes about Science Survey (CLASS), administered online to all participants, was a survey tool in the study. The CLASS is a physics attitude scale developed by Adams et al [11] to measure students’ attitudes toward physics and toward learning physics as well. The questionnaire, 42 items in total, consisted of 26 items divided into eight constructs, 9 items not having specific constructs, 6 items not useful, and 1 item used to identify participants who do not read the survey. In this research, we decided to use only the items which have specific constructs, as Ringo and Samsudin [17] have done before.
2.3. Data Analysis
First, data of attitudes toward physics collected through the CLASS were quantitatively analyzed by using Rasch model. The software application employed to analyze the data was Winsteps version 3.73. Through this analysis, the attitude data were changed from ordinal data to interval data. Furthermore, Wright map was used to present the difficulty estimates of the items and ability estimates of the participants. More details about Wright map can be found in Ref. [15], [16]. The last, the interval data were analyzed using independent sample t-test through the Statistical Packages for the Social Sciences (SPSS).

3. Result and Discussion
3.1 Psychometric properties of the CLASS

| Construct                  | Item | Estimate | Infit MNSQ | Outfit MNSQ |
|----------------------------|------|----------|------------|-------------|
| Real World Connection      | S17  | -0.86    | 1.02       | 1.04        |
| (RWC)                      | S18  | -1.08    | 0.76       | 0.77        |
|                            | S21  | 0.44     | 1.27       | 1.28        |
|                            | S23  | -0.05    | 0.81       | 0.80        |
| Personal Interest          | S2   | -0.12    | 0.78       | 0.79        |
| (PI)                       | S6   | -1.21    | 1.33       | 1.32        |
|                            | S8   | -1.29    | 1.32       | 1.31        |
|                            | S15  | 0.03     | 0.78       | 0.79        |
|                            | S17  | -0.86    | 1.02       | 1.04        |
|                            | S18  | -1.08    | 0.76       | 0.77        |
|                            | S19  | -0.74    | 1.16       | 1.14        |
| Sense Making/Effort        | S6   | -1.21    | 1.33       | 1.32        |
| (SM)                       | S13  | 0.75     | 1.25       | 1.25        |
|                            | S14  | -2.18    | 1.27       | 1.26        |
|                            | S22  | -0.68    | 0.66       | 0.67        |
|                            | S24  | -0.39    | 0.66       | 0.67        |
|                            | S26  | -0.49    | 0.90       | 0.96        |
| Conceptual Connections     | S1   | 2.31     | 1.22       | 1.18        |
| (CC)                       | S3   | 1.33     | 1.15       | 1.14        |
|                            | S4   | 0.33     | 0.97       | 0.98        |
|                            | S7   | 0.80     | 1.03       | 1.02        |
|                            | S11  | 1.31     | 0.85       | 0.84        |
|                            | S19  | -0.74    | 1.16       | 1.14        |
| Applied Conceptual Understanding | S1   | 2.31     | 1.22       | 1.18        |
| (ACU)                      | S3   | 1.33     | 1.15       | 1.14        |
|                            | S4   | 0.33     | 0.97       | 0.98        |
|                            | S5   | 1.90     | 1.08       | 1.08        |
|                            | S11  | 1.31     | 0.85       | 0.84        |
|                            | S12  | 1.83     | 1.16       | 1.14        |
|                            | S25  | 1.91     | 1.38       | 1.38        |
| Problem Solving General    | S7   | 0.80     | 1.03       | 1.02        |
| (PSG)                      | S9   | -1.10    | 0.93       | 0.91        |
|                            | S10  | -1.86    | 0.98       | 0.97        |
|                            | S15  | 0.03     | 0.78       | 0.79        |
|                            | S16  | -0.92    | 0.68       | 0.70        |
|                            | S20  | 0.02     | 0.71       | 0.72        |
|                            | S25  | 1.91     | 1.38       | 1.38        |
|                            | S26  | -0.49    | 0.90       | 0.96        |
| Problem Solving Confidence | S9   | -1.10    | 0.93       | 0.91        |
| (PSC)                      | S10  | -1.86    | 0.98       | 0.97        |
|                            | S20  | 0.02     | 0.71       | 0.72        |
|                            | S25  | 1.91     | 1.38       | 1.38        |
| Problem Solving Sophistication | S3   | 1.33     | 1.15       | 1.14        |
| (PSS)                      | S11  | 1.31     | 0.85       | 0.84        |
|                            | S12  | 1.83     | 1.16       | 1.14        |
|                            | S15  | 0.03     | 0.78       | 0.79        |
|                            | S20  | 0.02     | 0.71       | 0.72        |
|                            | S25  | 1.91     | 1.38       | 1.38        |
Before analyzing data of attitudes obtained by using the CLASS, we must evaluate whether or not the items of the CLASS fitted the Rasch model. An item which does not fit the Rasch model should be deleted [15]. In order to evaluate this, we have to look round the infit and outfit mean squares of items [18]. For Likert scale, the values of infit and outfit mean square must be in the acceptable range of 0.6-1.4 [19]. Table 2 shows that the infit mean square of the items were between 0.66 and 1.38 and the outfit mean square values were between 0.67 and 1.38. These results revealed that all items fitted the Rasch model. Furthermore, item reliability and person reliability index were 0.99 and 0.66 respectively.

**Figure 1.** Wright map of students’ attitudes about physics and physics learning. Distribution of persons is in the left side and represented by the “#” mark. In the right side, each of the items appears to be a combination of the “s” word indicating a statement and the number of an item.

Figure 1 illustrates the Wright map of students’ attitudes about physics and physics learning. From this variable map, the distribution of person ability and item difficulty estimates can be observed [15]. The Wright map displays that the items covered the persons. S1 was the most difficult item for students to endorse and S14 was the easiest to agree with. From an instrument development point of view, these results reveal that all items of the CLASS had good targeting on the participants.
3.2 Attitudes toward Physics
The person estimate mean (+0.61 logits) falling above the mean of item difficult (0.0 logits) designates that the participating students generally found the CLASS easy to endorse (see Figure 1). Table 3 shows that the rural and urban students showed positive attitudes toward physics in PI, PSC, PSG, PSS, RWC, and SM, but less positive attitudes toward physics in ACU and CC. This result is in line with the finding of the preceding research [17].

Broadly speaking, students from urban areas had the measure average of attitudes toward physics higher than rural students did in four constructs, namely applied conceptual understanding (ACU), conceptual connections (CC), problem solving sophistication (PSS), and real world connection (RWC). In contrast, on the rest of the constructs, the rural students overcame the urban students. However, the t-test did not confirm any significant differences between the rural and urban students in every single construct of attitudes toward physics. This result is consistent with previous finding obtained by Shah et al [9], but contrary to the result of the attitudes toward learning physics study conducted by Ibrahim et al [8] in Malaysia. They found that urban students had more positive attitudes toward physics learning than students in rural areas. The similar attitudes toward physics between rural and urban students in our finding probably appeared because the physics teaching experience in the participated schools were not contrasting. Although schools in the urban areas had advanced technology or facilities than schools in the rural areas, urban teachers rarely used the facilities to improve their physics teaching. Consequently, physics teaching practices in the urban schools did not look different from those in the rural schools. In other words, teachers in urban school had not maximally employed available tools in schools to refine their teaching. Teachers’ unawareness of technology usage [20] and other useful facilities to enhance teaching quality should receive more attention from government.

| Construct | School Location | Person Ability Average | t     | p-value |
|-----------|----------------|------------------------|-------|---------|
| ACU       | Rural          | -1.0202                | -0.649| 0.517   |
|           | Urban          | -0.9255                |       |         |
| CC        | Rural          | -0.3645                | -0.858| 0.392   |
|           | Urban          | -0.2326                |       |         |
| PI        | Rural          | 1.5911                 | 1.475 | 0.143   |
|           | Urban          | 1.3535                 |       |         |
| PSC       | Rural          | 1.3009                 | 1.692 | 0.093   |
|           | Urban          | 0.9686                 |       |         |
| PSG       | Rural          | 1.0496                 | 1.502 | 0.216   |
|           | Urban          | 0.8332                 |       |         |
| PSS       | Rural          | 0.4423                 | 0.683 | 0.496   |
|           | Urban          | 0.5496                 |       |         |
| RWC       | Rural          | 1.3205                 | -0.063| 0.950   |
|           | Urban          | 1.3338                 |       |         |
| SM        | Rural          | 1.5514                 | 0.329 | 0.743   |
|           | Urban          | 1.4923                 |       |         |

4. Conclusion
The current research found that there were no significant differences between rural and urban students in terms of attitudes toward physics. In general, rural and urban students showed positive attitudes in four attitudes toward physics constructs even though the person measures were not completely high. In contrast, the participated students found the items (Applied Conceptual Understanding and Conceptual Connections) difficult to endorse. One of the contributing factors in the similar attitudes between rural and urban students was teachers’ unawareness of available equipment to enhance teaching quality.
Government and physics teachers should pay a great deal of attention to this possible problem. However, we realized that there are several limitations in this comparative study. First, the sample was small and they came from the same grade. Therefore, there should be a future comparative study involving more students who come from different grades to confirm the finding in this present research.

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