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RASCH MODEL ON ECONOMICS MATHEMATICS BELIEF SCALE

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ABSTRACT

This study aims to apply the Rasch Model to the Economics Mathematics Belief Scale (EMBS) instrument involving 144 student respondents from the Faculty of Economics. Instrument development was carried out by compiling items, testing, and analyzing using the Rasch Model with the WINSTEP application to identify unidimentionality, item fit, person fit, distribution on item/person map, and description of the EMB dimensions, namely self-confidence, belief in the mathematics learning process, and supportive social context during the mathematics learning process in economics. The results of the analysis show that this instrument has a high item separation reliability, which is 0.98 for item reliability and 0.88 for person reliability. In the item fit analysis, there are 5 items included in the unfit category based on the MNSQ and PT-Measure Correlation criteria. Descriptive analysis shows that 73% of students have confidence in their own abilities, 78% of students have confidence in the learning process in learning economic mathematics, and 81% of students have confidence in the role of lecturers and the application of mathematics in everyday life. This study contributes to developing an instrument to measure economics mathematics belief (EMB). Further development of this EMBS instrument is needed for better instrument results.

Keyword: Economics mathematics belief scale, Rasch model, Measurement in education

ABSTRAK

Penelitian ini bertujuan untuk menerapkan Rasch Model pada instrumen *Economics Mathematics Belief Scale* (EMBS) yang melibatkan 144 responden mahasiswa yang berasal dari Fakultas Ekonomi. Pengembangan instrumen dilakukan dengan penyusunan item, uji coba, dan analisis menggunakan Rasch Model dengan aplikasi WINSTEP untuk mengidentifikasi unidimentionality, item fit, person fit, sebaran pada item/person map, dan deskripsi dari dimensi EMB yaitu kepercayaan pada diri sendiri, keyakinan terhadap proses pembelajaran matematika, dan konteks sosial yang mendukung selama proses pembelajaran matematika di bidang ekonomi Hasil analisis menunjukkan bahwa instrumen ini memiliki yang item separation reliability yang tinggi, yaitu sebesar 0.98 untuk item reliability dan 0.88 untuk person reliability. Pada analisis item fit terdapat 5 butir yang termasuk dalam kategori unfit dengan didasari kriteria MNSQ dan PT-Measure Correlation. Analisis deskriptif menunjukkan bahwa 73% siswa memiliki kepercayaan terhadap kemampuan pada diri sendiri, 78% siswa memiliki kepercayaan terhadap proses pembelajaran dalam pembelajaran matematika ekonomi, dan 81% siswa memiliki kepercayaan terhadap peran dosen dan penerapan matematika dalam kehidupan sehari-hari. Penelitian ini memberikan kontribusi dalam mengembangkan instrumen untuk mengukur *economics mathematics belief* (EMB). Pengembangan lebih lanjut terhadap instrumen EMBS ini sangat diperlukan untuk hasil instrumen yang lebih baik.

Kata kunci: *Economics mathematics belief scale*, Rasch model, Pengukuran pendidikan

INTRODUCTION

Tests are measuring instruments that function to measure a person's completeness in a particular field. The use of tests as a measuring instrument is commonly applied in various fields, especially in the field of education which uses tests to measure the completeness of student learning. Other measuring instruments to measure respondent attributes are non-tests. The application of non-test measuring instruments can be done in the world of education. One of them is in mathematics learning. Mathematics plays an important role in economics, both in data analysis, forecasting, and in strategic decision making. Understanding and applying the right mathematical concepts can affect the results of economic analysis and the decisions taken.

However, the reality in the field shows that many students and economics practitioners have difficulty in understanding and applying mathematical concepts. This is often caused by various factors, one of which is belief in mathematics itself. Belief in mathematics covers various aspects, such as belief in one's own abilities in mathematics, perceptions about the usefulness of mathematics, and attitudes towards learning mathematics. A study by Beswick and Chapman (2020) highlighted that lecture with a deep understanding of mathematics content and a positive belief in the subject's applicability are more likely to employ effective teaching strategies that promote conceptual understanding. These beliefs can influence motivation, learning strategies, and ultimately, academic and professional achievement in economics. However, in economics, research on mathematical beliefs is still limited. Therefore, a valid and reliable instrument is needed to measure mathematical beliefs in students in learning economic and business mathematics. This instrument is expected to help understand how beliefs about mathematics affect the learning and application of mathematics in the context of economics. Mathematics is an essential component in economics. Many economic concepts require an understanding and application of mathematics, including statistics, econometric modelling, and quantitative analysis. However, a person's ability to use mathematics in an economic context depends not only on their technical understanding but also on their beliefs about mathematics itself. Mathematical beliefs include various aspects such as beliefs about one's own abilities in mathematics, beliefs about the nature and function of mathematics, and beliefs about the teaching and learning of mathematics. These beliefs can influence an individual's motivation, attitude, and performance in mathematics.

In the context of economics education, positive mathematics beliefs are very important. Geist (2015) showed that students who have positive beliefs about their mathematics abilities tend to have better academic performance in economics courses that require mathematical applications. These positive beliefs also encourage students to be more involved in learning and overcome any mathematics anxiety they may experience. Research consistently shows that positive mathematics beliefs correlate with higher achievement and better learning outcomes. For example, a study by Chai et al. (2020) found that students who believe in the incremental nature of mathematical ability (growth mindset) tend to achieve higher in mathematics compared to those with a fixed mindset. Similarly, positive affective beliefs, such as enjoyment and interest in mathematics, were linked to better performance and greater engagement (Kucian et al., 2020).

In addition, gender can also be considered to influence a person's mathematics beliefs as stated by previous research that gender differences in mathematics belief have been a focal point in educational research. A study by Gaspard (2015) stated that when assessing intervention effects separately by gender, evidence for stronger effects for females than for males was found. Beliefs are also related to technology, Ocak and Uluyol (2020) indicated that the use of educational technology, such as dynamic geometry software and interactive simulations, can enhance students' conceptual understanding and foster positive beliefs about mathematics. However, research on mathematical beliefs in the context of economics is still limited. Therefore, the development of valid and reliable instruments to measure mathematical beliefs in economics students is important. The other study from Ndlovu et al. (2020) show that that self-efficacy beliefs had the strongest influence on Pre-Service Teacher (PST) control on ICT integration, the most recurrent self-efficacy theme from interviews was PST's plea for training in the use of ICT tools. A wide range of ICT tools were identified as applicable to mathematics classrooms. It means that mathematics belief is not only about learning process from students, but also the teacher competence. That situation shows us the important things in developing instrument of Economics Mathematics Belief Scale (EMBS) to measure the economics mathematics belief in economics learning processes. Therefore, this study aims to apply the Rasch Model to the EMBS instrument involving student respondents from the Faculty of Economics.

LITERATURE REVIEW

Belief is a term that has the meaning of belief that can be connected to various other psychological aspects, as stated by Price (2014) that belief is a large and complicated subject. It supposed to be an epistemological subject, whereas the relation of mind and body is metaphysical one. Ning and Downing (2015) showed that interventions designed to increase mathematical self-efficacy can result in significant improvements in the academic achievement of economics students. Geist (2015) found that economics students who had positive beliefs about mathematics showed better academic achievement and were more motivated to complete mathematical tasks. Daher and Anabousy (2021) identified that economic practitioners with positive beliefs about mathematics were more likely to use mathematical analysis tools effectively in their work, improving professional performance and decision-making. A new scale developed by King and Witzel (2018) specifically to measure mathematical beliefs in the context of economics. EMBS measures dimensions of self-belief, perceptions of the relevance of mathematics in economics, and attitudes toward learning mathematics in the economics curriculum.

The Rasch model is one of the models in Item Response Theory (IRT) that is used to analyze data from tests and questionnaires that measure abilities, attitudes, or other characteristics. This model is named after Georg Rasch, a Danish statistician, and has become an important tool in education, psychometrics, and social research. The software used to assist in Rasch analysis is WINSTEP, Adams and Wu (2020) discussed these developments, noting the impact of enhanced computational power and algorithm efficiency on the model's application in large-scale assessments and surveys. According to Bond and Fox (2015), the Rasch model has three main assumptions: Unidimensionality: The items being measured must measure one construct or dimension. Local independence: Responses to one item are independent of responses to other items. Monotonicity: The relationship between ability and probability of answering correctly must be monotonically increasing. Boone et al. (2014) explain the use of the Rasch Model in the development of reliable instruments to measure student ability in various subjects. They emphasize the importance of item validation and calibration to ensure that the test accurately measures the intended construct. Wright and Masters (2016) highlight the use of the Rasch Model to analyze test data, including identifying nonconforming items and adjusting scales to create more accurate and equitable measurements.

In addition to education, the Rasch Model is also widely used in social research to measure attitudes, perceptions, and quality of life. Bond and Fox (2015) used the Rasch Model to measure attitudes and perceptions in a psychometric study, allowing for more precise and valid assessments of psychological constructs. Tennant and Conaghan (2020) reviewed its application in health outcome measures, emphasizing the model's ability to produce interval-level measurements from ordinal data, thus facilitating more precise assessments of patient-reported outcomes. Challenges and Opportunities in Rasch Model Applications Complexity of Theory: Understanding and applying the Rasch Model requires a deep understanding of the underlying theory and statistics (Engelhard, 2013). Model Assumptions: Failure to meet the basic assumptions of the model can lead to bias in the analysis results (Bond & Fox, 2015).

METHOD

This study uses a descriptive quantitative method using the Rasch modelling approach with the help of WINSTEP software. The data collection technique uses a belief mathematics instrument questionnaire filled out by 144 students of the Faculty of Economics using the purposive sampling technique. The dimensions contained in belief mathematics include, (1) Self-ability, (2) Learning Process, and (3) Social Context. The questionnaire used in this study can be seen in Table 1.

Table 1. Research Questionnaire

Dimension	Statement
Self-ability	1. Mathematics consists of concepts that can be used in economics and business. 2. I gain new knowledge by studying mathematics. 3. Concepts in mathematics help me solve other problems in economics and business. 4. I am challenged in studying mathematics 5. I am able to solve mathematical problems on my own. 6. Concepts in mathematics are interrelated. 7. The lecturer in the economic mathematics course provides explanations that can help me understand mathematics 8. Studying mathematics in groups helps me understand mathematics 9. Learning media can help me understand mathematical concepts. 10. My intelligence helps me in working on math problems 11. I try with my own ability in working on math problems
Learning Process	12. The attention and motivation given by the lecturer make me enthusiastic about learning mathematics. 13. The classroom conditions are conducive during mathematics learning 14. I can easily understand mathematics related to the use of symbols, numbers, or formulas 15. I am enthusiastic about studying mathematics 16. I have difficulty understanding mathematics. 17. I am lazy to study mathematics. 18. I am unable to study mathematics on my own. 19. I do not know the benefits of studying mathematics 20. I feel hopeless in solving mathematical problems related to economics and business. 21. I depend on my friends' help in solving math problems
Social Context	22. Mathematics is a subject of memorizing complicated formulas 23. I am bored with learning mathematics 24. Symbols and formulas in mathematics confuse me. 25. Facilities and infrastructure on campus do not support the process of learning mathematics 26. I feel annoyed when given math assignments 27. The presence of lecturers does not help me in learning mathematics 28. Class conditions are not conducive during mathematics learning. 29. My friends cannot help me in learning mathematics 30. I do not use mathematical concepts in everyday life.

All data were analyzed using the Rasch model approach equipped with descriptive statistics. Based on recommendation by Sumintono and Widhiarso (2015) the following are the criteria used in the analysis with the Rasch Model:
The accepted Outfit Mean Square (MNSQ) is in the interval 0.5 < MNSQ < 1.5
The accepted Outfit Z-standard (ZSTD) is in the interval -2.0 < ZSTD < +2.0
The accepted Point Measure Correlation is in the interval 0.4 < PMC < 0.85

RESULTS AND DISCUSSION

There are several items that *unfit*, but this is thought to be caused by several things, one of which is the number of respondents is still small, so this can be anticipated by adding a larger number of respondents. Another way that can be done is by eliminating or improving unfit items. Some of these things are done depending on the conditions, limitations, and scope of the research that has been carried out. Item analysis using the Rasch Model is based on the prerequisites of unidimentionality so that it can be analyzed with the required output. The following are the results of analysis

Item Unidimensionality

Analysis using the Rasch model requires a prerequisite test, namely unidimensionality. The following are the results of the unidimensionality test on the EMBS instrument. Based on the results of the unidimensionality test in Figure 1, it was obtained that the raw variance value was 45.7% so that the unidimensionality of the belief mathematics instrument had moderate criteria. This shows that the unidimensionality prerequisite test has been met.

```
INPUT: 144 Person  30 Item  REPORTED: 144 Person  30 Item  5 CATS WINSTEPS 4.0.1
--------------------------------------------------------------------------------

     Table of STANDARDIZED RESIDUAL variance in Eigenvalue units = Item information units
                                           Eigenvalue   Observed   Expected
Total raw variance in observations     =      55.2530 100.0%         100.0%
  Raw variance explained by measures   =      25.2530  45.7%          45.4%
    Raw variance explained by persons  =       8.1542  14.8%          14.7%
    Raw Variance explained by items    =      17.0989  30.9%          30.7%
  Raw unexplained variance (total)     =      30.0000  54.3% 100.0%   54.6%
    Unexplned variance in 1st contrast =       3.6644   6.6%  12.2%
    Unexplned variance in 2nd contrast =       3.4586   6.3%  11.5%
    Unexplned variance in 3rd contrast =       2.2838   4.1%   7.6%
    Unexplned variance in 4th contrast =       1.8745   3.4%   6.2%
    Unexplned variance in 5th contrast =       1.6649   3.0%   5.5%
```

Figure 1. Output Table of Unidimensionality Test

Summary Statistics

The results of the statistical summary analysis include two main components, namely the statistical summary of the person being measured and the item being measured, which are presented in the Figure 2 and Figure 3. Based on the Figure 3, it can be seen that based on the Real RMSE, the person reliability of 144 people is 0.88 and measured 30 items is 0.98. This shows that reliability has a high category.

```
INPUT: 144 Person  30 Item  REPORTED: 144 Person  30 Item  5 CATS WINSTEPS 4.0.1
--------------------------------------------------------------------------------

     SUMMARY OF 144 MEASURED Person
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     115.8      30.0        1.35     .27      1.01    -.3   1.00    -.3 |
| P.SD      12.1        .0         .90     .05       .60    2.0    .57    1.9 |
| S.SD      12.2        .0         .91     .05       .61    2.0    .57    1.9 |
| MAX.     145.0      30.0        4.53     .50      3.46    6.5   3.50    6.3 |
| MIN.      78.0      30.0        -.74     .22       .22   -4.1    .27   -3.8 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .31 TRUE SD     .85  SEPARATION  2.77  Person RELIABILITY  .88 |
|MODEL RMSE    .27 TRUE SD     .86  SEPARATION  3.14  Person RELIABILITY  .91 |
| S.E. OF Person MEAN = .08                                                   |
-------------------------------------------------------------------------------
Person RAW SCORE-TO-MEASURE CORRELATION = .98
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .89  SEM = 3.95
```

Figure 2. Output Table of Measuring Person

```
     SUMMARY OF 30 MEASURED Item
-------------------------------------------------------------------------------
|          TOTAL                          MODEL         INFIT         OUTFIT    |
|          SCORE      COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     555.9      144.0        .00     .12        .99    -.2   1.00    -.1 |
| P.SD      68.8         .0       1.00     .02        .23    1.7    .24    1.8 |
| S.SD      70.0         .0       1.02     .02        .23    1.7    .24    1.8 |
| MAX.     665.0      144.0       1.74     .17       1.59    3.9   1.67    4.4 |
| MIN.     410.0      144.0      -1.97     .10        .65   -3.0    .66   -2.9 |
|-----------------------------------------------------------------------------|
| REAL RMSE     .13 TRUE SD     .99  SEPARATION  7.63  Item   RELIABILITY  .98 |
|MODEL RMSE     .13 TRUE SD     .99  SEPARATION  7.93  Item   RELIABILITY  .98 |
| S.E. OF Item MEAN = .19                                                     |
-------------------------------------------------------------------------------
```

Figure 3. Output Table of Measured Items

Item Fit

Analysis of statement items with the Rasch Model can be seen from Sumintono and Widhiarso (2015) review of item fit based on several criteria used in the Rasch Model, namely: The accepted Outfit Mean Square (MNSQ) is in the interval 0.5 < MNSQ < 1.5; The accepted Outfit Z-standard (ZSTD) is in the interval -2.0 < ZSTD < +2.0; The accepted Point Measure Correlation is in the interval 0.4 < PMC < 0.85. The results of the item fit analysis are presented Table 2.

Table 2. Item Fit (MNSQ, ZSTD, and PMC)

ITEM	MNSQ		ZSTD		PMC	
	Value	Decision	Value	Decision	Value	Decision
BME29	1.58	UnFit	0.5	Fit	0.5	Fit
BME8	1.59	UnFit	0.44	Fit	0.44	Fit
BME27	1.37	Fit	0.45	Fit	0.45	Fit
BME18	1.17	Fit	0.56	Fit	0.56	Fit
BME25	1.13	Fit	0.51	Fit	0.51	Fit
BME28	1.14	Fit	0.48	Fit	0.48	Fit
BME30	1.12	Fit	0.53	Fit	0.53	Fit
BME7	1.04	Fit	0.37	Fit	0.37	Fit
BME13	1.09	Fit	0.45	Fit	0.45	Fit
BME12	1.04	Fit	0.42	Fit	0.42	Fit
BME11	1.05	Fit	0.44	Fit	0.44	Fit
BME22	0.99	Fit	0.57	Fit	0.57	Fit
BME17	0.97	Fit	0.51	Fit	0.51	Fit
BME10	1.02	Fit	0.5	Fit	0.5	Fit
BME16	0.94	Fit	0.58	Fit	0.58	Fit
BME26	1.01	Fit	0.49	Fit	0.49	Fit
BME20	0.98	Fit	0.53	Fit	0.53	Fit
BME21	0.99	Fit	0.53	Fit	0.53	Fit
BME4	0.95	Fit	0.47	Fit	0.47	Fit
BME23	0.9	Fit	0.52	Fit	0.52	Fit
BME6	0.8	Fit	0.4	Fit	0.4	Fit
BME19	0.87	Fit	0.47	Fit	0.47	Fit
BME2	0.85	Fit	0.38	Fit	0.38	UnFit
BME9	0.76	Fit	0.39	Fit	0.39	UnFit
BME1	0.79	Fit	0.35	Fit	0.35	UnFit
BME24	0.79	Fit	0.58	Fit	0.58	Fit
BME5	0.74	Fit	0.52	Fit	0.52	Fit
BME14	0.74	Fit	0.5	Fit	0.5	Fit
BME15	0.65	Fit	0.49	Fit	0.49	Fit
BME3	0.66	Fit	0.44	Fit	0.44	Fit

Based on the Table 2, it can be seen that BME29 and BME8 have an unfit category on the MNSQ criteria, while BME2, BME9, and BME1 have an unfit category on the PT-Measure Correlation criteria. This condition shows that most of the items on the BME instrument are fit in measuring students' belief mathematics at the Faculty of Economics. Statement items that are unfit can be anticipated in several ways, including increasing the number of research respondents or by making improvements to the related items.

Item Map and Person Map

Other outputs that can be seen from the BME analysis with the Rasch Model are item maps and person maps. Based on the item map, it can be seen that BME16, BME24, and BME 22 are the items that are most difficult for respondents to answer, while other items are easier for respondents to answer. Meanwhile, the person map shows that respondents 103W, 120W, and 116W are able to reach items with the highest level of difficulty in determining answers by respondents. However, on average, respondents are able to reach items with a medium to high level of difficulty. The following Figure 4, that illustrates the item map and person map on the BME instrument.

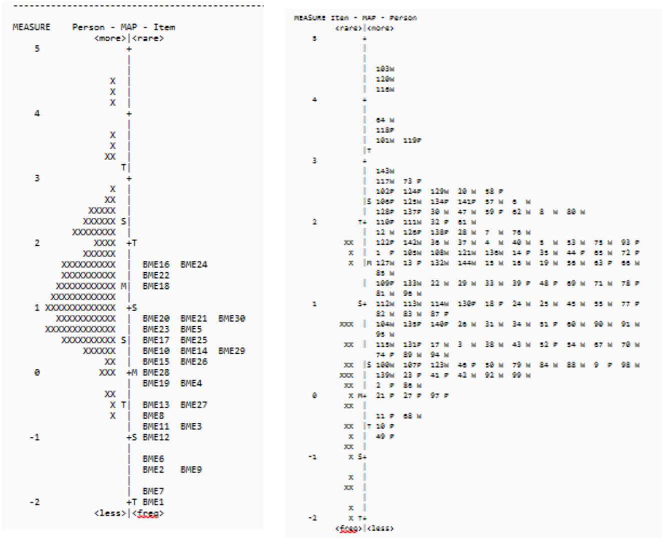

Figure 4. Item Map and Person Map

Discussion

Dimension 1. Self-Ability

The first dimension of BME is self-ability which is clarified by the main indicator being students' belief in their own ability in learning economic mathematics courses. Based on the descriptive data results, information was obtained that 73% of students have confidence in their own ability in economic mathematics courses. This is reviewed from students' belief in understanding economic mathematics courses, student motivation, belief in their ability to solve mathematical problems that are applicable in everyday life, students' knowledge of the benefits of studying mathematics, and students' ability to solve problems in mathematics. The study from Mutodi and Ngirande (2014b) shows that correlation analysis results showed strong positive relationships between performance and perception constructs such as self-confidence, interests in mathematics, teacher and learning support material as well as myths and beliefs. The other word, belief include in the psychological aspect in teaching and learning processes. Therefore, Mutodi and Ngirande (2014a) facilitators/teachers should strive to understand mathematics anxiety and implement teaching and learning strategies and study habits that can help them overcome anxiety.

Dimension 2. Mathematics Learning

The second dimension of BME is mathematics learning which is clarified by the main indicator being Student Assessment of Mathematics and matters related to the mathematics learning process. Based on the descriptive results of the data, information was obtained that 78% of students have confidence in the learning process in the mathematics economics course. This is reviewed from the paradigm regarding the value of mathematics, the benefits of studying concepts in mathematics, media or infrastructure in mathematics learning, and assignments applied to the learning of mathematics economics. Forgasz and Leder (2008) Belief mathematics therefore those which determine the autonomy of the mathematics teacher, and hence also the outcome of teaching innovations - like problem solving - which depend on teacher autonomy for their successful implementation. The study of Xiao et al. (2009) stated that the relationship between beliefs and affect along with achievement in math. Results showed differences for three dimensions (knowledge structure; learning ability; learning style) statistically significant related to grade and no difference related to gender. It also emerged that the four dimensions predicted positive feelings, negative feelings and achievement in mathematics to different extents

Dimension 3. Social Context

The third dimension of BME is the social context which is clarified by the main indicator being student beliefs which are reviewed from student assessments of the role of lecturers and the application of mathematics in everyday life. Self-ability in learning economic mathematics courses. Based on the descriptive results of the data, information was obtained that 81% of students have confidence in the role of lecturers and the application of mathematics in everyday life through economic mathematics courses. This is reviewed from beliefs in the role of lecturers and peers in learning mathematics, classroom conditions during the mathematics learning process, external motivation provided by the environment in learning mathematics, lecturer competence in delivering material and student knowledge of the application of mathematics in everyday life. Teachers have the important role in this dimension related to mathematics belief in teaching and learning process. Perera and John (2020) Social cognitive theory posits that teacher self-efficacy beliefs should be related to not only their own well-being outcomes but also classroom processes and student outcomes in the general ecology of the classroom environment. Hannula et al. (2016) the main findings suggest: (1) Teachers' expertise and experience positively influence noticing and teachers' noticing can be successfully fostered by (video-based) professional development programs. (2) Pre-service teachers struggle with perceiving and interpreting students' work. Thereby, their mathematical knowledge plays an important role. (3) Teachers' in-the-moment decision-making is influenced by their knowledge, beliefs and goals. (4) Teachers' knowledge and belief facets predict their situation specific-skills which in turn correlate with aspects close to instructional practice. (5) Teachers have difficulties interpreting tasks and identifying their educational potential. Methods and implication of this systematic review are thoroughly discussed.

CONCLUSION AND RECOMMENDATION

Based on the output results of the Rasch Model and descriptive statistics in the BME instrument of 30 statements, it can be said that the reliability value of the instrument is included in the high category, which is 0.98 for items and 0.88 for persons. This indicates a good level of reliability in the BME instrument. However, when viewed based on the MNSQ and PT-Measure Correlation values, there are still 5 items that are detected as unfit. The dimensions contained in the BME include self-ability, mathematics learning, and social context which show that 73% of students have confidence in their own abilities in the mathematics economics course, 78% of students have confidence in the learning process in the mathematics economics course, and 81% of students have confidence in the role of lecturers and the application of mathematics in everyday life through the mathematics economics course. The conditions above show that there are still five items that have the unfit category, so further treatment is needed for the development of the BME instrument such as adding the number of respondent samples or making improvements and re-development related to items that are still unfit. In addition, the explanation of bias in respondents and items is also interesting to discuss, such as gender bias.

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