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Evaluation of Students' Achievement in the Development of Innovative Learning Tools for PPG Computer Engineering and Informatics Students Using the Rasch Model

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ABSTRACT

This research aims to measure students' performance from the Teacher Professional Education Program (PPG) in Category 1 Batch 2 Computer and Informatics Engineering at Manado State University in 2023 using the Rasch Model. The Rasch Model was chosen as a measurement method because it can provide a more accurate picture of individual student abilities, as well as identify the level of difficulty and differentiating power of each evaluation item. The research method involves collecting student performance data through various evaluation instruments, such as written exams, projects, and practical assignments. The collected data is then analyzed using the Rasch Model to evaluate the quality of the measurements and understand the extent to which the evaluation instrument can describe students' true abilities. The research results are expected to provide in-depth insight into the abilities of PPG students in Category 1 Batch 2 Computer Engineering and Informatics, as well as provide recommendations for improvements to the evaluation instruments used. Applying the Rasch Model in measuring student performance is expected to increase objectivity and accuracy in assessing students' abilities, which in turn can support improving the quality of education at Manado State University.

Keywords: Informatics, Performance Measurement, PPG, Rasch Model, Students

INTRODUCTION

The field of Informatics is a sector that continues to grow rapidly, with demands for teacher expertise who can integrate information technology into the learning process. Therefore, it is important to ensure that prospective Informatics teachers produced by the PPG program have the skills and knowledge relevant to the times' demands. Teacher Professional Education (PPG) plays a central role in supporting the quality of education in Indonesia. Through PPG, prospective teachers are given the knowledge, skills, and attitudes needed to become professional and qualified educators. Manado State University as a higher education institution is committed to continuing to improve the standards and quality of teacher education, especially in the field of Informatics. Therefore, this research was carried out to measure the performance of PPG students in Category 1 Batch 2 Computer and Informatics Engineering in 2023, with a focus on using the Rasch Model as a measurement tool.

The importance of measuring PPG student performance is not only limited to fulfilling academic requirements but also to ensuring that prospective teachers have adequate competence following the demands of the modern educational era (Belawati, 2020). The success of a PPG program does not only depend on the learning process carried out, but also on the effectiveness of the evaluation tools used to measure student competency achievement (Darmawan, 2018). Therefore, this research will contribute to identifying the extent to which the evaluation instruments currently used can provide an accurate picture of the abilities of PPG students in Category 1 Batch 2 Computer and Informatics Engineering at Manado State University.

In this context, the Rasch Model is a relevant choice as a measurement method that can provide a holistic and in-depth picture of individual abilities, as well as identify the characteristics of each evaluation item. The use of the Rasch Model in measuring student performance is the main concern of this research (Bond & Fox, 2015). The Rasch Model is considered a sophisticated and accurate method for measuring individual abilities in the context of educational testing and evaluation. This model can produce in-depth information about each student's abilities and the characteristics of evaluation items, providing a more accurate and objective picture of learning achievement (Boone, & Staver, 2015). By adopting this approach, this research seeks to answer the challenges in measuring the performance of PPG students in Category 1 Batch 2 Computer and Informatics Engineering. Through an in-depth understanding of student abilities, it is hoped that this research can provide valuable input for curriculum development, the preparation of more effective evaluation instruments, and policy improvements at the PPG program level.

It is hoped that the findings from this research will not only be useful for universities in improving the quality of teacher education but can also contribute to the development of more objective and comprehensive evaluation methods at the national level. As an expert and senior professor in the field of PPG, this research is an integral part of efforts to improve the quality of teacher education, following the vision and mission of Manado State University in producing competent and adaptive teaching staff to developments in technology and science. The results of this research will not only contribute to academic literature but also make a real contribution to the professional development of prospective Informatics teachers. Through an in-depth understanding of the performance of PPG students, Manado State University is expected to continue to improve the quality of education and make a positive contribution to producing teachers who can meet the demands of the modern world of education.

THEORETICAL FRAMEWORK

Teacher Professional Education

PPG or Professional Teacher Education is an educational program organized to prepare Bachelor of Education and Bachelor of Education/D-IV Non-Education graduates who have the talent and interest to become teachers to fully master teacher competencies following Teacher Education Standards. The PPG program aims to produce teachers as professional educators who are devoted to God Almighty and have a noble character, are knowledgeable, adaptive, creative, innovative, and competitive with the main task of educating, teaching, guiding, directing, training, assessing, and evaluating participants. educate. The PPG program is designed systematically and applies quality principles starting from selection, learning, and assessment processes, to competency tests, so it is hoped that it will produce professional future teachers who can produce graduates who are superior, competitive have character, and love their country. and at the same time, it is hoped that it will be able to answer the educational problems facing the Indonesian nation today (Hamalik, 2010). The aim of the Teacher Education Program (PPG) is to produce teachers who have pedagogical, social, personality, and scientific competencies who can adapt educational knowledge and methods following developments in culture, science, technology, and national education policy (Media Center Temanggung 2020). Apart from that, PPG aims to improve the qualifications of teaching staff, increase teacher competency, and prepare teachers to face the educational problems facing the Indonesian nation today.

Some of the specific objectives of PPG include: Developing professional teachers with global competitiveness who can adapt educational knowledge and methods following developments in culture, science, technology, and national education policies. Organizing the governance of the PPG Study Program effectively and efficiently and partnering with other institutions to support improving the quality of the Teacher Professional Education (PPG) program. Strengthen and develop the governance of the PPG Study Program effectively and efficiently and foster mutually beneficial collaboration with other institutions at national and international levels to support the implementation of learning processes, research, and publication of scientific works, and community service. To achieve this goal, PPG uses various strategies, such as implementing problem-based learning and project-based learning models and activities to build problem-solving, critical, and creative abilities in prospective professional teachers.

PPG is a form of further education after formal undergraduate education. It emphasizes the development of skills, knowledge, and attitudes more specifically related to the teaching profession. PPG aims to develop the professional competence of prospective teachers. This includes mastery of subject matter, understanding of educational principles, teaching skills, and the ability to interact with students, parents, and the school environment (Priatna, 2013). Education in the PPG context is designed to reflect classroom realities and the challenges that teachers may face in the field. It includes practical training, direct observation in schools, and application of theory in real experience. PPG has a special focus on preparing prospective teachers to become professionals in the field of education. This includes understanding teacher ethics, social responsibility, and involvement in sustainable self-development (Sagala, 2013). PPG is expected to prepare prospective teachers to face technological developments and innovations in education. It involves integrating information technology and innovative methodologies in the teaching process. As part of PPG, evaluating and monitoring prospective teacher performance is an important component. This involves various forms of assessment, both formative and summative, to ensure that teacher candidates meet established competency standards. Through professional teacher education, it is hoped that prospective teachers will not only have a strong theoretical understanding but also practical skills that they can apply in real-world contexts at school. PPG aims to create teachers who are competent, reflective, and able to adapt to dynamic changes in the world of education.

Rasch Model

The Rasch Model is a measurement model used to measure an individual's ability or performance in a particular domain, such as the ability to read, write, or speak a foreign language. This model was developed by Georg Rasch in the 1960s and is used in various fields, including education, psychology, and social sciences. The Rasch Model allows for more accurate and objective measurements by taking into account the level of difficulty of each test item and the ability of the individual being measured (Andrich, et.al, 2010). This model also allows a comparison between the individual abilities measured and the level of difficulty of the test items measured. The Rasch Model is often used in the development of standardized tests and evaluation of educational programs (Researcher, 2023). The Rasch Model is a statistical model used to measure the abilities or latent characteristics (which cannot be measured directly) of individuals based on their responses to a series of items or questions (Linacre, 2017). This model is especially used in the context of measuring student performance, test evaluation, or research in various fields of education and psychometrics (Saifuddin, 2006).

The Rasch Model is rooted in item response theory (IRT) and aims to measure individual latent characteristics, such as abilities or skills, without bias from individual variations in tests or evaluation instruments. The Rasch model has a relatively simple mathematical formulation, by modeling the probability of a correct response to an item as a logarithmic function of the ratio between individual ability and item difficulty (Smith, 2016). This model takes into account the probability that someone with a certain level of ability will answer an item correctly (Saidfudin, et.al, 2010). The Rasch Model assigns a value called “difficulty” to each item, which reflects the degree to which the item is difficult or easy. In addition, this model measures the "discriminating power" of items, namely the extent to which the item can differentiate between individuals with high and low ability. The results of the Rasch Model are expressed on a logit scale, which is a unit of measurement for latent characteristics (Purnomo, 2016). This scale allows a more precise comparison between individual ability and item difficulty. The Rasch Model has the property of invariance, which means that the measurement results should not be influenced by the demographic or contextual characteristics of the individuals being measured. This ensures that the model provides an objective measure of ability (Siti Aminah, et.al, 2011).

The advantages of the Rasch Model include its ability to produce more accurate measurements, especially in the case of tests involving a variety of items and different levels of difficulty. This model is also sensitive to small changes in individual abilities. The Rasch Model has been widely used in various fields, including academic performance measurement, health assessment, and instrument evaluation outside the field of education (Shahrir, et.al, 2008). The application of the Rasch Model in the context of Teacher Professional Education (PPG) can provide deeper insight into student abilities and the effectiveness of evaluation instruments used in teacher education programs. This model can help increase objectivity and accuracy in evaluating student achievement and design more effective measurements in supporting the development of teacher professionalism.

The Rasch Model can help PPG improve teacher competency by measuring individual abilities or performance in a particular domain accurately and objectively. In the PPG context, the Rasch Model can be used to measure the abilities of prospective teachers in various fields, such as the ability to teach, guide, and evaluate students. By using the Rasch Model, PPG can develop evaluation instruments that are more accurate and reliable for measuring the abilities of prospective teachers. Apart from that, the Rasch Model can also help PPG identify the weaknesses and strengths of prospective teachers in certain fields so that they can provide appropriate guidance and training to improve the competency of prospective teachers. Thus, the Rasch Model can help PPG achieve its goal of producing teachers who have pedagogical, social, personality, and scientific competencies who can adapt educational knowledge and methods following developments in culture, science, technology, and national education policies.

METHODS

Types of research

This research uses an observational research design type of research which involves measuring the performance of PPG students in Category 1 Class 2 Computer and Informatics Engineering at Manado State University. Design the research to be cross-sectional so that it can measure student performance at a certain point in time (Sugiyono, 2019).

Data Collection Instruments and Techniques

The data in this research use primary data and secondary data. The data collection method used is data collected from evaluation instruments which cover various aspects of student abilities, following PPG objectives and competencies. The instrument adapted into the format follows the Rasch Model.

Data collection techniques are obtained through written exams, projects, and practical assignments, to measure student performance.

Population and Sample

The population in this study is the population of PPG students in Category 1 Class 2 Computer and Informatics Engineering at Manado State University in 2023.

The representative sample size was 26 participants and was large enough to produce reliable generalizations

Data analysis

Data analysis was carried out by applying the Rasch Model to analyze student performance data. Researchers use statistical software that supports the Rasch Model to be used correctly. Evaluation of model suitability and reliability of measurement instruments was carried out using the Rasch Model.

Researchers conducted a descriptive analysis to provide a general picture of student performance. Rasch data analysis was carried out to produce estimates of student abilities and characteristics of evaluation items. Researchers interpreted the results of the Rasch Model to gain in-depth insight into individual student abilities and evaluation characteristics.

RESULTS AND DISCUSSION

The results of this research show that as a result of the Rasch Model analysis in Winsteps, a Person-Item Distribution Map (PIDM) was created. The output of the analysis is presented as shown in Figure 1. The map details the actual position of each student about their respective CO. Rasch models tabulate people; namely the student on the right side and the item; course outcomes (CO) are plotted on the left side of the map in the same logit scale. Latent Trait Theory provides an accurate picture of student achievement in each CO. This will provide a clearer picture of students' abilities regarding the difficulty of the questions (Azrilah, et.al, 2008).

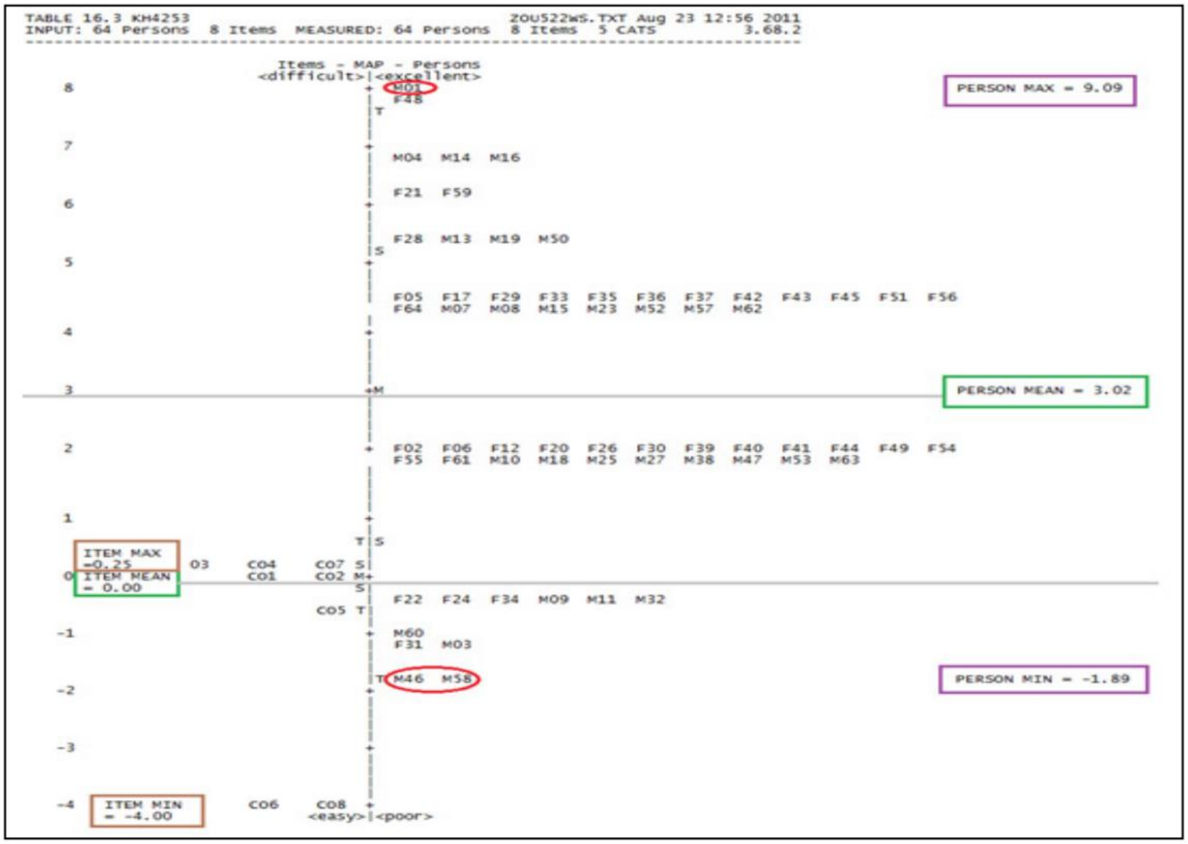

Figure 1. Person-item distribution map

In PIDM, item mean, Meanitem serves as a threshold and is set to zero on the logit scale. The higher the item location of the Meanitem the more difficult the item is compared to items in lower locations. The same thing applies to the distribution per person, where high-achieving students are at the top of the map while poor students are at the top and the bottom of the map. Therefore, a person's level of ability can be determined from PIDM by looking at the separation between people and items on the map. The greater the separation, the more capable a person is likely to be at achieving the item (Bradley, et.al, 2010). PIDM revealed that CO3, CO4, and CO7 were the subjects that were most difficult for students to achieve. The easiest items were CO6 and CO8. There is a large separation between easy and difficult questions as indicated by a large gap between CO5 and the lowest for CO6 and CO8. This shows the level of difficulty of the item that students must face during project completion. The ends of items that are very difficult also have hollow areas that need to be repaired to close the gap so that student achievement levels can be evenly distributed (Kamsuriah, et.al, 2011).

The findings of this research show that student achievement in all COs and the level of CO difficulty are the same as the results reported by (Siti Aminah, et all, 2011) using conventional methods. Comparative analysis of the percentage of student learning achievement in each CO also has almost the same pattern when compared with the conventional method CO where the highest percentage is for CO6 and CO8 while the lowest percentage is for CO7.

Figure 1 shows that the mean value of the Person, Meanperson for this analysis is 3.02 which is far above the threshold value, Meanitem = 0. In addition, as many as 53 students (82.8%) were found to be above the Meanitem and the highest person managed to score logit 9.09. This shows that the overall performance of students is above the expected performance and students have good knowledge of the expected CO. These students were able to achieve all the measured COs and this shows that the students have exceeded the respective level of difficulty. The students' CO performance shows that they have obtained and completed the assigned projects and almost all students have performed well in this course. In contrast, only 11 students (17.2%) were below the Meanitem and had difficulty achieving all COs except CO5, CO6, and CO8 which were the easiest items. Five students had the lowest ability because they were only able to do the easiest questions (CO6 and CO8) and had the lowest score (-1.89 logit). These students had difficulty completing the project and understanding the course. Special corrective actions must be taken for these students to improve their achievement in this course (Rozeha, et.al, 2007), (Saifudin, et.al, 2008). From PIDM it can also be seen that MO1 was the best student in the course since then he has been at the top with the highest score (9.09 logit) and had the highest ability compared to other students. On the other hand, M46 and M58 are the poorest students for this course because they are located at the bottom of the map and have the lowest scores (-1.89 logit).

Table figure 2 shows summary statistics for the person and item categories for the course. Based on the table, the Cronbach-α value = 0.66 which is slightly higher than the acceptable level of 0.6. This validates that the model is acceptable. From the analysis, it was also found that Person Reliability was 0.57 and Item Reliability was 0.00, which is quite low. Therefore, both categories of people and goods require further examination. The student separation score is also rather low at 1.16 and this is not enough to separate them into different performance levels.

```
     SUMMARY OF 64 MEASURED (EXTREME AND NON-EXTREME) Persons
-------------------------------------------------------------------------------
|          RAW                          MODEL         INFIT        OUTFIT    |
|          SCORE      COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      24.5        6.0       3.02    1.43                               |
| S.D.       2.1         .0       2.46     .68                               |
| MAX.      30.0        6.0       9.09    2.33                               |
| MIN.      17.0        6.0      -1.89     .34                               |
|-----------------------------------------------------------------------------|
| REAL RMSE   1.61  ADJ.SD    1.86  SEPARATION  1.16  Person RELIABILITY  .57 |
|MODEL RMSE   1.59  ADJ.SD    1.88  SEPARATION  1.18  Person RELIABILITY  .58 |
| S.E. OF Person MEAN = .31                                                   |
-------------------------------------------------------------------------------
Person RAW SCORE-TO-MEASURE CORRELATION = .91 (approximate due to missing data)
CRONBACH ALPHA (KR-20) Person RAW SCORE RELIABILITY = .66 (approximate due to missing data)

     SUMMARY OF 6 MEASURED (NON-EXTREME) Items
-------------------------------------------------------------------------------
|          RAW                          MODEL         INFIT        OUTFIT    |
|          SCORE      COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     260.8       64.0        .00     .30       .94    -.8    .73    -.9 |
| S.D.       3.0         .0        .28     .02       .90    2.5    .65    1.5 |
| MAX.     267.0       64.0        .25     .33      2.83    3.9   1.99    1.8 |
| MIN.     258.0       64.0       -.59     .28       .22   -3.3    .18   -2.6 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .34  ADJ.SD     .00  SEPARATION   .00  Item    RELIABILITY  .00 |
|MODEL RMSE    .30  ADJ.SD     .00  SEPARATION   .00  Item    RELIABILITY  .00 |
| S.E. OF Item MEAN = .12                                                     |
-------------------------------------------------------------------------------
 MINIMUM EXTREME SCORE:      2 Items
UMEAN=.000 USCALE=1.000
```

Figure 2. Course outcomes students' assessment: person item statistic

The distribution of logit scale items from Figure 2 shows that the maximum item value, CO7 is at +0.25 logit and the minimum item value, CO6 and CO8 is at -10.86 logit. The difference between logitmax and logitmin is δ =11.11. This shows that the level of item difficulty is spread over 11.11 logit (evaluation) units.

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TABLE 13.1 KH4253                                ZOU522WS.TXT Aug 23 12:56 2011
INPUT: 64 Persons   8 Items  MEASURED: 64 Persons  8 Items  5 CATS        3.68.2
--------------------------------------------------------------------------------
Person: REAL SEP.: 1.08  REL.: .54 ... Item: REAL SEP.: .00  REL.: .00

        Item STATISTICS:  MEASURE ORDER

-------------------------------------------------------------------------------------------
|ENTRY   TOTAL                          MODEL|   INFIT  |  OUTFIT  |PT-MEASURE |EXACT MATCH|      |
|NUMBER  SCORE   COUNT   MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.| OBS%  EXP%| Item |
|------------------------------------+----------+----------+-----------+-----------+------|
|     7    258      64       .25    .28|2.83   3.9|1.99   1.8|  .62   .57| 63.5  81.7| CO7  |
|     3    259      64       .17    .29| .33  -2.7| .25  -2.2|  .65   .57| 93.7  82.4| CO3  |
|     4    259      64       .17    .29| .46  -1.9| .41  -1.5|  .65   .57| 87.3  82.4| CO4  |
|     1    261      64       .00    .30| .61  -1.2| .38  -1.6|  .42   .57| 87.3  83.2| CO1  |
|     2    261      64       .00    .30| .22  -3.3| .18  -2.6|  .66   .57| 96.8  83.2| CO2  |
|     5    267      64      -.59    .33|1.19    .7|1.19    .6|  .71   .58| 74.6  82.5| CO5  |
|     6    320      64    -10.86   1.85|     MINIMUM MEASURE|  .00   .00|100.0 100.0| CO6  |
|     8    320      64    -10.86   1.85|     MINIMUM MEASURE|  .00   .00|100.0 100.0| CO8  |
|------------------------------------+----------+----------+-----------+-----------+------|
| MEAN   275.6    64.0     -2.71    .68| .94   -.8| .73   -.9|           | 83.9  82.6|      |
| S.D.    25.7      .0      4.71    .67| .90   2.5| .65   1.5|           | 11.5    .5|      |
-------------------------------------------------------------------------------------------
```

Figure 3. Point measure correlation: item validity

Further analysis regarding CO (content) validity can also be carried out through Point Measure Correlation (PMC) as shown in Figure 3. In Rasch analysis, item values are considered inappropriate only if all three controls (Point Measure, MNSQ, and ZSTD) for each respective CO are not within that range. From the table, Point Measure values for CO6 and CO8 = $0.0<0.4$. Therefore, it is necessary to carry out further checks regarding the acceptable Point values. The size must be between $0.4<x<0.8$. This may mean that respondents behaved otherwise and the measurements taken on CO were derived from peer assessment. Usually, the trend in giving peer assessment grades is always to produce the highest grades and sometimes does not represent the true value of the data. The next step is to verify the respondents by looking at the Outfit Mean Square (MNSQ) = y value where this value must be in the range $0.5<y<1.5$ otherwise it will be difficult to obtain accurate results (Siti Aminah, Oet.al, 2011). From Figure 3, it can be seen that CO7, CO3, CO4, CO1, and CO2 have MNSQ that are not in the appropriate range. The final check will be performed in z-standard Clothing (ZSTD) and the value must also be in the range $-2<z<2$ or further checks are required. From the analysis results, only CO3 and CO2 have ZSTD values outside the fit range. Since none of the COs have values outside the appropriate range for the three control items mentioned above, all COs are considered within the appropriate range review is not necessary.

CONCLUSION

This research concludes that the learning outcomes of PPG student performance can be said to be good and can be measured using the Rasch measurement model and the findings also have a similar pattern to conventional methods. From Rasch's analysis, students are classified according to their achievements in each learning performance, which reflects their learning ability in this course. This research shows that the Rasch model can produce patterns of associations between students and performance levels for each learning performance that cannot be produced using standard measurement methods. This makes the Rasch Model a better assessment model for measuring learning performance. The output from Rasch's analysis can be used as a guide for lecturers in monitoring their students' performance. This research also concludes that the Rasch Model can be used as a valid and good measurement instrument that can be applied to performance measurement systems that focus on quality because of its ability to analyze student performance more accurately, making evaluations clearer to read and easier to understand.

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REFERENCES

Andrich, D., Sheridan, B., & Luo, G. (2010). RUMM2030: Rasch Unidimensional Measurement Models. Perth: RUMM Laboratory.

Azrilah, A.A., Azlinah, M., Azami, Z., Sohaimi, Z., Hamzah, A. G., & Mohd Saidfudin, M. (2008). Evaluation of Information Professionals Competency Face Validity Test Using Rasch Model. 5th WSEAS / IASME International Conference on Engineering Education (EE'08). July 22-24, 2008

Belawati, T. (2020). Pembelajaran Online. Tanggerang Selatan: Universitas Terbuka.

Bond, T. G., & Fox, C. M. (2015). Applying the Rasch Model: Fundamental Measurement in the Human Sciences. Routledge.

Boone, W. J., & Staver, J. R. (2015). Rasch Analysis in the Human Sciences. Springer.

Bradley,K.D., Cunningham, J., Haines, T., Mueller, C.E., Royal, K.D., Sampson, S.O., Singletary, G., & Weber, J.A. (2010). Constructing and Evaluating Measures: Applications of the Rasch Measurement Model.

Darmawan, D. (2018). Pengembangan Instrumen Penilaian Hasil Belajar. Rajawali Pers.

Hamalik, O. (2010). Kurikulum dan Pembelajaran. Bumi Aksara.

Kamsuriah, A., Nazlena, M. A. & Suhaila, Z. (2011). An Improved Course Assessment Measurement for Analyzing Learning Outcomes Performance Using Rasch Model. Procedia Social and Behavioral Sciences 18 442-449. Elsevier Ltd.

Linacre, J. M. (2017). A User's Guide to WINSTEPS MINISTEP Rasch-Model Computer Programs: Program Manual 3.94.0. Chicago: MESA Press.

Media Center Temanggung. (2020). Guru Ikuti PPG Dalam Jabatan Tahun 2020 Secara Daring. https://mediacenter.temanggungkab.go.id/berita/detail/guru-ikuti-ppg-dalam-jabatan-tahun-2020-secara-daring.

Peneliti, A. (2023). Instrumen Pembelajaran Daring dengan Rasch Model - Proceedings UIN Raden Fatah Palembang. Retrieved from http://proceedings.radenfatah.ac.id/index.php/iec/article/download/18/17/187.

Priatna, N. (2013). Pengembangan Profesi Guru. Bandung: PT Remaja Rosdakarya.

Purnomo, S. (2016). Pengembangan Soal Matematika Model Pisa Konten Space and Shape untuk Mengetahui Level Kemampuan Berpikir Tingkat Tinggi Berdasarkan Analisis Model Rasch. Tesis.

Rozeha, A. R., Azami, Z. & Mohd Saidfudin, M. (2007). Application of Rasch Measurement in Evaluation of Learning Outcomes: A Case Study in Electrical Engineering. Regional Conference on Engineering Mathematics, Mechanics, Manufacturing & Architecture 2007 (EM3ARC).

Sagala, S. (2013). Kemampuan Profesional Guru dan Tenaga Kependidikan. Bandung: Alfabeta.

Saifuddin, A. (2006). Reliabilitas, Validitas, Interpretasi dan Komputasi. Yogyakarta: Liberty.

Saifudin, M., Ghulman, H. A., Razimah, A. & Rozeha, A. (2008). Application of Rasch-based ESPEGS Model in Measuring Generic Skills of Engingeering Students: A New Paradigm. WSEAS Transactions on Advances in Engineering Education, Issue 8 Vol 5, WSEAS Press. Pp. 591-602, August 2008

Saidfudin, M., Azrilah, A.A., Rodzo'an, N. A., Omar, M.Z., Zaharim, A. & Basri, H. (2010). Easier Learning Outcomes Analysis using Rasch Model in Engineering Education Research. EDUCATION'10 Proceedings of the 7th WSEAS International Conference on Engineering Education. Pp 442-447.

Shahrir, A., Riza Atiq Abdullah, O.K. R, Azami, Z., Norhamidi, M., Baba, M.D., Noorhisham, T.K., Mardina, A., Mazlan, M.T., Andanastuti, M. & Che Husna, A. (2008). Implementing Continual Review Of Programme Educational Objectives and Outcomes For Obe Curiculum Based on Stakeholders' Input. Proceedings Of The 7th WSEAS International Conference On Education And Educational Technology (Edu'08), Venice Italy 21-23 Nov 2008.

Smith, R. M. (2016). Understanding Rasch Measurement: Theory, Model, Equating, and Scaling. Springer.

Siti Aminah, O., Othman, J., Wan Hamidon, W.B. & Riza Atiq Abdullah, O.K.R. (2011a). Course Outcomes (COs) Evaluation for Civil Engineering Design II Course. Prosiding Kongres Pengajaran & Pembelajaran UKM, 18 – 20 Disember 2011.

Siti Aminah, O., Wan Hamidon, W.B., Kamarudin, A.T., Abdul Khalim, R. & Roszilah, H. (2011b). The Program Outcomes Achievement for Basic Reinforced Concrete Design Course between Two Different Sessions. Procedia Social and Behavioral Sciences 18 (2011) 260–265. Elsevier Ltd. 2011

Siti Aminah, O., Wan Hamidon, W.B., Roszilah, H., Kamarudin, A.T., Noraini, H. & Othman, J. (2011c). Assessment On Students Performance Using Rasch Model In Reinforced Concrete Design Course Examination. Proceedings of 10th WSEAS Internation Conference on Education and Educational Technology (EDU '11). October 3-5, 2011

Sugiyono. (2019). Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Alfabeta.