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Construction of an Item Bank Using Rasch Analysis

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Abstract

Constructing examination papers has been a lengthy and tedious procedure that is commonly raise by issues with content validity, reliability, and fairness. Therefore, investigating alternative methods such as item banking using Rasch analysis may present a more practical and efficient approach for creating assessments. This study aims to demonstrate how to develop an item bank using Rasch analysis and assess the reliability and validity of the final exam paper for a statistics course that uses item bank as its foundation. In this research, Statistics course which consist of 7 questions are divided into 21 items based on test specification table (TST). The results from Rasch analysis are recorded in an item bank interface created by using excel. The item bank interface facilitates easy access to a large variety of pretested items, allowing for the creation of diverse and balanced exam papers. A well-developed item bank will be a great assistance to exam setters as it makes the process of creating tests easier, faster, and more efficient, which leads to higher-quality examination questions paper.

Keywords item bank, rasch-analysis, reliability

INTRODUCTION

In the dynamic landscape of education and evaluation, the creation of a reliable item bank is crucial. According to [1], an item bank described as "a collection of coordinated questions that measure, establish, and characterize a common trend, providing a practical explanation of a variable". For each an item bank consists of a comprehensive collection of test items or questions that assess various aspects of a specific domain or skill. These items form the foundation for generating assessments that accurately measure an individual's knowledge, abilities, or performance [2]. The item bank provides benefits not only to students in their teaching and learning endeavors, but also aids in the administrative aspect. The development of a hierarchical question bank to support the Outcome-Based Education (OBE) examination assessment process proves beneficial, easing the creation and management of high-quality test items, thus addressing the laborious, time-consuming, and expensive nature of exam administration, with its usability extending beyond the institution of origin [3]. The use of item banks is important in psychological and educational evaluation, offering a systematic approach to create and manage a variety of test items for different assessment purposes. Using item banks is an effective strategy in creating accurate and reliable assessment, allowing exam setters to select a good item from extensive collections of pretested items to construct multiple test patterns. The item bank can also be utilized to facilitate the advancement of students' knowledge and abilities, thereby enhancing their learning experience. It can be designed for interactive polling using clicker remotes or smartphone apps showing successful implementation to enhance student

engagement, comprehension, and satisfaction [4]. However, constructing an item bank is a challenging process that involves carefully examining each item's psychometric characteristics.

Rasch analysis has become a popular method for creating item banks. According to [5], the Rasch analysis is useful for linking the scale and identifying the misfit. The Rasch analysis can help us give information on the item difficulty and the ability of the test-takers, which enables the construction of an item bank with items that can measure the level of knowledge or ability of test-takers accurately. The quality of the gathered items significantly relies on the quality of the questions posed. To ensure the collection of dependable and valid items that assess students' understanding across different proficiency levels, it is crucial to have a substantial pool of questions that collectively represent the diverse levels of comprehension.

With the Rasch model, researchers can evaluate each item's performance and its relationship to others in the bank. Biased or unreliable items are identified and improved or removed. The Rasch model also establishes a common measurement scale, enabling precise calibration of item difficulty and accurate estimation of individual abilities, leading to fair assessments. After the Rasch analysis, the item bank is refined and items are placed on a difficulty continuum. This item bank can be used to create a wide range of assessments, including adaptive tests tailored to individuals' abilities and goals, improving the quality and fairness of assessments.

In conclusion, item banking has many benefits, including increased test efficiency, improved measurement precision, and reduced test development time and cost. In a meanwhile using Rasch analysis to construct an item bank is an innovative approach that enhances assessment precision and effectiveness [6]. It provides valuable insights into individuals' abilities and knowledge, benefiting both learners and educators alike.

This study will show how to use Rasch analysis to create an item bank and evaluate the validity and reliability of the final exam paper for a statistics course based on the item bank. By presenting this construction process, the study aims to provide educators, researchers, and practitioners with a clear understanding of how to create an item bank that is calibrated on common logit scale, facilitating fair and precise assessments across various proficiency levels. On top of that, the study aims to verify accuracy and consistency of the examination paper in measuring paper in measuring the intended learning outcome.

MATERIALS AND METHODS

This section outlines the approaches employed to achieve all the objectives of this research paper. This study employed quantitative approach which involved two distinct fundamental stages, which are the item bank construction and item bank selection process.

Item Bank Construction

Fig. 1 below shows the overview of the adopted methodology to construct an item bank

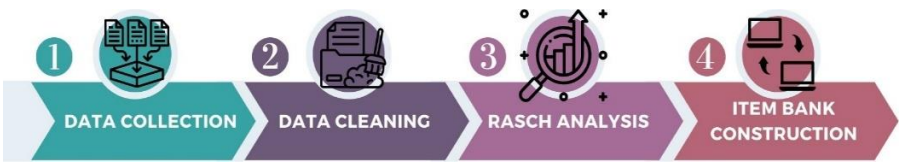

Fig. 1. Overview of the adopted methodology

There are four steps in constructing the item bank. The first step to construct an item bank started from collecting the data. The instrument used in this research was in the form of a final examination question for Statistics course, consisting of 7 questions and divided further into 21 items with a total of 70 marks. The final examination question was developed from a total coverage of 7 topics following standardized format of Test Specification Table (TST) by the examination committees from the Department of Mathematics, CFSIIUM. In this research, 344 students' results were analyzed.

The second step is the data cleaning. The purpose of data cleaning is to ensure there are no out of range values which may potentially result to the extreme values of the data [7]. The data cleaning process is divided into two steps. In the first step, the marks for each item will be systematically arranged into an Excel template that meet to the format utilized by Winsteps. The next step is to filter, identify and remove extreme marks.The third step to create an item bank is to run the Rasch analysis using WINSTEPS Version 3.72.1. Then, all pertinent output required for the item bank will be collected based on the result of the Rasch analysis.Finally, the fourth step is the construction of an item bank template in Excel. The item bank interface is as shown in **Fig. 2**.

ITEM BANK STATISTICS : MAT0144

CHAP: 1, 2, 3, 4, 5, 6, 7
DIFFICULTY LEVEL: D, E, M
RASCH DIFFICULT...: D, E, M

QUESTION CODE	CHAP	DIFFICULTY LEVEL	MARKS	SUMMARY	ITEM RASCH OUTPUT							REMARKS	REUSED
					ITEM RELIABILITY	PERSON RELIABILITY	MEASURE	CORR (0.4,0.85)	INFIT (0.5,1.5)	OUTFIT (0.5,1.5)	RASCH DIFFICULTY LEVEL		
2122_S3_Q1a	1	E	3	Find percentile rank from grouped data	0.99	0.87	0.08	0.6	1.22	1.05	M		2324_S2_Q1a
2122_S3_Q1b	1	E	2	Find frequency from grouped data	0.99	0.87	0.79	0.58	0.61	0.49	M		
2122_S3_Q2a	3	E	3	find probability using Poisson Distribution(in between)	0.99	0.87	-0.34	0.67	0.64	0.68	M		
2122_S3_Q2b	4	M	5	find probability using Normal Approx to the Poisson Dist (less than)	0.99	0.87	-1.43	0.75	1.15	1.18	E		
2122_S3_Q3ai	4	M	4	find k using given probability normal distribution	0.99	0.87	-0.79	0.59	0.94	1.11	M		
2122_S3_Q3aii	5	M	4	Find n suing CLT	0.99	0.87	0.49	0.52	1.29	0.96	M		
2122_S3_Q3b	6	E	3	Find sample size for sample proportion	0.99	0.87	-0.69	0.68	0.77	0.75	M		
2122_S3_Q4ai	6	E	2	find unbiased estimator for sigma unknown	0.99	0.87	0.85	0.45	1.02	0.95	M		
2122_S3_Q4aii	6	E	2	estimate standard error for mean (sigma unknown)	0.99	0.87	1.41	0.42	0.88	0.53	D		
2122_S3_Q4bi	6	E	4	find CI for Mean (sigma unknwon)	0.99	0.87	-0.76	0.71	0.6	0.66	M		
2122_S3_Q4bii,iii	6	M	3	interpretation on claimed CI	0.99	0.87	-0.41	0.6	0.84	1	M		
2122_S3_Q5ai	2	E	2	find P(A) using venn diagram	0.99	0.87	-0.14	0.35	1.13	2.46	M	REVISE THE QUES	
2122_S3_Q5aii	2	D	4	find P(AeB) using addition rule	0.99	0.87	0.26	0.47	1.71	1.64	M		
2122_S3_Q5bi	2	E	2	find probability using multiplication rule	0.99	0.87	-0.32	0.52	0.85	1	M		
2122_S3_Q5bii	2	E	3	find conditional probability	0.99	0.87	0.43	0.45	1.31	1.3	M		
2122_S3_Q5biii	3	M	3	find using binomial (atleast 1 case)	0.99	0.87	-0.31	0.61	1.03	0.96	M		
2122_S3_Q6ai	7	M	7	hypothesis testing (sigma known)	0.99	0.87	-3.18	0.7	1.65	1.44	E		
2122_S3_Q6aii	7	M	2	conclusion on hypothesis testing (sigma known)	0.99	0.87	-0.07	0.5	0.82	0.96	M		
2122_S3_Q6b	7	D	5	hypothesis testing (proportion)	0.99	0.87	-0.15	0.6	0.96	0.87	M		
2122_S3_Q7a	3	D	5	poisson approximation to the binomial dist (more than)	0.99	0.87	0.68	0.53	0.85	0.6	M		

Fig. 2. Item Bank Interface

The item bank template has eight key columns, including Question Code, Chapter, Difficulty Level, Marks, Summary, Rasch Output, Remarks, and Reused. Furthermore, the Rasch output has seven additional columns that further delineate the seven major findings of the analysis: item reliability, person reliability, measure, correlation, infit mean square, outfit mean square, and Rasch difficulty level, as shown in **Fig. 2**

Item bank selection process

There are several steps we need to accomplish on the item bank selection process as shown in **Fig. 3.**

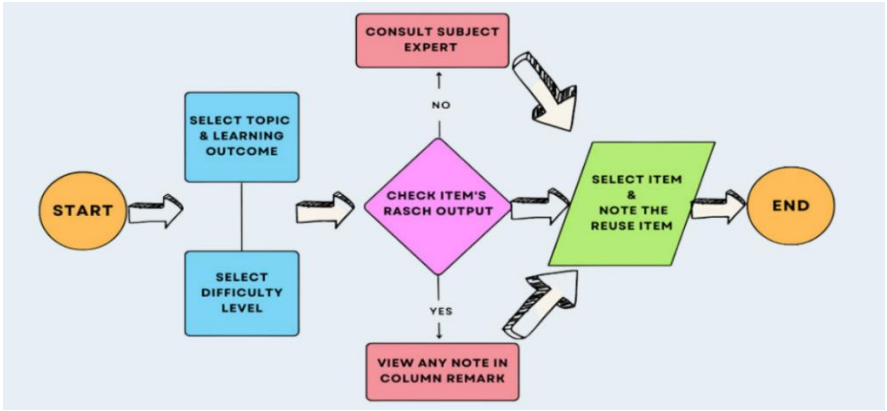

Fig. 3. Steps on item bank selection process

The first step is to select the topic and learning outcome. The column labelled "chapter" can be accessed and a specific chapter such as Chapter 2 can be selected. When Chapter 2 is clicked upon, the corresponding items related to that chapter will be made visible. In Step 2, the difficulty level of the item will be chosen. This can be accomplished by employing the Table Specification Test (TST) to determine the item's difficulty level. There are three difficulty levels available for selection: easy, moderate, or difficult. In Step 3, the Rasch output will be examined. In order to select a suitable item, at least one of the three criteria, namely the correlation, infit, and outfit values, must be met. The correlation should be within the range of 0.4 and 0.85.

Furthermore, both the infit and outfit values should ideally fall between 0.5 and 1.5. These criteria assist in the identification of items that exhibit appropriate characteristics and fit well within the Rasch model, thereby ensuring the quality and effectiveness of the item bank. To choose the desired item, the provided hyperlink can simply be clicked, resulting in the appearance of the item in a read-only Word format, which prevents inadvertent alterations to the file.

For record-keeping purposes, make sure to note the item as a "reuse item" by writing the designated session, semester, and item number (e.g., 2324_S2_Q1a) in the "REUSE" column of the item bank interface. This will help to identify and track reused items effectively.

RESULTS AND DISCUSSION

The construction of an item bank will have an impact on two main stakeholders in academic field which are the educators and the students. According to [8], the item bank improves validity, which ensures that a test measures what is supposed to be measured, and reliability which the consistency of the results of an assessment. Since an item bank provides substantial choices of existing test items that have been designed, reviewed and analyzed by Rasch analysis, its effectiveness in item analysis and assessing uni-dimensionality ensure the quality and alignment of test items for accurate and comprehensive evaluations. This allows the educators to select, organize, and match the new test items fit to the curriculum standard and learning objectives.

Furthermore, the item bank benefits the educators in saving time and effort on constructing new test items quickly and efficiently. Initially, constructing an item bank requires significant effort on collaboration among educators, subject matter experts and curriculum committees. However, once the item bank is established, it becomes a valuable resource that can be utilized over multiple assessments cycles. Educators no longer need to create new questions from scratch for every test since they can use it from the established item bank. Hence, this enables educators to dedicate more attention to other important teaching and learning matters.

Based on [9], computerized testing using item banks need a substantial number of items due to continuous administration and subsequent exposure which is needed to maintain the test security. On the other hand, in our study, the items are securely stored and controlled in the item bank where it is authorized only for educators. Therefore, it reduces the risk of item exposure, unauthorized access and leakage of the test content.

Implementing the item bank also has implications for students. An item bank covers a wide range of topics and difficulty levels within a particular subject area which ensures the students are assessed on various aspects of the curriculum and align with the course and learning objectives. Additionally, the use of an item bank on the students serves as a significant tool in monitoring the progress of students learning [10]. Educators are responsible for creating reports that highlight items that need to be revised or maintained correspond to the Rasch Analysis on students' knowledge levels, strength and areas that need improvement. Lastly, since the item bank has been carefully calibrated, assessments can be designed to be fair and equitable for all students. Educators can select standardized items that ensure the test constructed are free from bias and measure the intended learning objectives. A well-developed item bank enhances effective measurements because the test items can be improved in both validity and reliability to meet the intended purpose of the assessment.

CONCLUSION

By utilizing item banks, we have the potential to greatly elevate the standards of educational measurement. It is crucial to re-evaluate how closely our item bank reflects the measured construct regularly to ensure that improvement. Regular elimination of invalid items and inclusion of valid items can result in a more enhanced and precise reflection of the measured construct.

In conclusion, the development of an item bank has numerous benefits for educators and students alike. It provides educators with a valuable resource to create assessments efficiently and effectively. The item bank has organized and archived a wide range of pre-existing test items,

categorized by subject, topic, and difficulty level that assist them in the selection process. This enables educators to tailor assessment to meet specific instructional goals and differentiate instruction to address the needs of individual students.

The use of an item bank ensures the quality of assessments as the questions within the bank are often well-vetted, validated, and aligned with curriculum standards. Therefore, the test constructed based on the item bank will be able to accurately measure student learning outcomes. Furthermore, educators can make informed instructional decisions based on the analysis of test results. By utilizing the item bank, educators can enhance the overall quality of their teaching and assessment practices.

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