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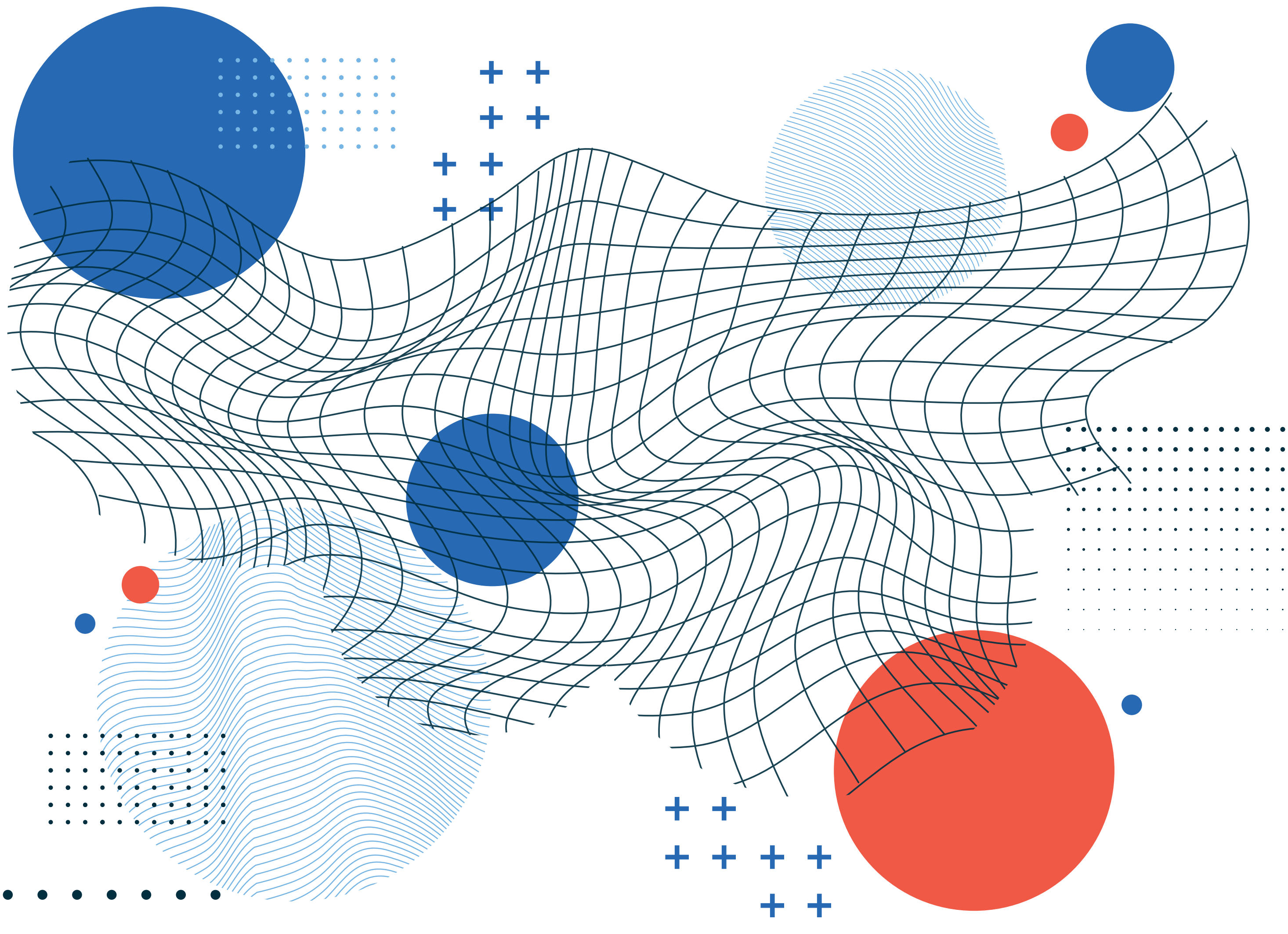

A Digital Assessment Framework for Professional Sensory Training: An Application of the Rasch Model

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Abstract

This study aims to explore the application of the Rasch measurement model as a robust psychometric framework to enhance the objectivity and scientific rigor of sensory assessment, a critical component of food and product evaluation. This study collected data on coffee assessment during the license renewal of Q on August 26, 27, 2025, in Taiwan. There are 18 participants who evaluate six different coffee samples using the SCA coffee value assessment descriptive form. The results demonstrate that the Rasch model effectively transforms traditional ordinal scale assessment into a linear interval scale (Logit scale), thereby overcoming the limitations associated with in subjective biases and non-linear scaling. The results also demonstrate that the model's effectiveness and quantifiable measures of evaluator competence and item difficulty (i.e., flavor attributes). This study investigates how the Rasch measurement model can serve as a robust digital assessment framework for sensory evaluation training, enhancing objectivity, scale validity, and scientific rigor while advancing the digitalization of professional certification in vocational education by providing data-driven, personalized feedback for learners.

Keywords: Rasch model; Sensory evaluation; Objective measurement; Vocational Education.

Introduction

Coffee quality evaluation plays a pivotal role in the certification system and coffee industry. For practitioners, the ability to identify sensory attributes with objectivity and consistency is essential for professional standing. Traditional sensory assessment in the coffee industry still relies on subjective evaluation often aggregated using ordinal rating scales. A challenge in evaluation research is that these ordinal data may lead to inconsistent and unreliable outcomes due to sensory biases and the limitations of non-linear scales. Therefore, there is an improving methodological need across various evaluation fields to establish objective, linear measurement systems that align with the digital transformation of professional training. In recent years, global coffee assessment practices have increasingly moved toward standardization and scientific rigor. A key example is the Coffee Value Assessment (CVA) proposed by the Specialty Coffee Association (SCA) in 2024, which emphasizes an objective, concrete, and high-resolution approach to evaluating the distinctive attributes of coffee. Despite these advancements, evaluators still face challenges. When dealing with complex and nuanced flavor profiles, subjective assessments and sensory biases may compromise the consistency and reliability of evaluation outcomes. This shift is critical for achieving rigorous measurement. By moving beyond ordinal scoring, the Rasch model provides true, interval-level measures where the difference between any two points on the scale is uniform and meaningful, analogous to metrics in the physical sciences.

To address this study introduces the Rasch model—a psychometric framework traditionally used in educational testing—as a digital assessment engine to quantitatively calibrate evaluator competencies and item difficulties. As a competence-oriented measurement tool, the Rasch model is a criterion-referenced measurement approach that enables the differentiation of evaluators' ability to recognize specific sensory attributes. It provides concrete estimates of both person ability and item difficulty, thereby contributing to a more objective and scientifically grounded evaluation system.

This study was conducted during the Q Grader license renewal event held in Taiwan on August 26–27, 2025. Sensory evaluation data were collected from 18 certified evaluators who assessed six different coffee samples. The research aims to validate the Rasch model as a tool for learning analytics in sensory education, providing data-driven insights to optimize professional certification systems and personalized training modules in the digital age.

Literature Review

Sensory evaluation is an indispensable tool in food quality control and product development. Despite the rapid advances in sensory science, sensory evaluation continues to be recognized as a scientific discipline that systematically evokes, measures, analyzes, and interprets human responses to products as perceived through the senses of sight, smell, touch, taste, and hearing (Stone & Sidel, 1993). This foundational approach has informed both objective and consumer-focused assessments in contemporary food and beverage research.

Stone et al.（2020）divide sensory evaluation into two categories,

1. Objective evaluation: well-trained evaluators assess the products' differences and actual attributes.
2. Subjective evaluation: measures target consumers' preferences and emotional reactions.

Sensory evaluation is a common tool for food quality management and product development, and it uses a systematic procedure to collect evaluators subjective feedback on different attributes of flavor, aroma, and taste. Gosal et al. (2021) proposed that people use five senses to assess a product, which in turn motivates their desires. Therefore, attractive sensory cues can promote a positive purchasing decision.

Nascimento et al. (2024) also proposed that several sensory quality attributes of specialty coffee, such as aroma, flavor, and aftertaste, are associated with higher market prices, highlighting the importance of rigorously evaluating these sensory characteristics during product development.

In the coffee industry, sensory assessment serves as a main reference for classifying coffee and describing its flavor, influencing market prices and licensing systems. Traditional descriptive sensory analysis has a long history in coffee assessment, providing a structured procedure and methodology. Therefore, it is an approach to analyze coffee flavor and understand coffee-specific sensory attributes through accurate identification and quantification (Pereira et al. 2021). However, with the continuous changes in coffee varieties, processing methods, and consumer preferences, as well as changes in production and consumption within the coffee industry, there is an increasing demand for sensory evaluation of high-quality coffee (Li & Sakamoto, 2021). The Speciality Coffee Association's coffee value assessment is the standard and universal means in the global coffee evaluation system, encompassing over 30 flavors and defect description items (SCA, 2024).

Subjective bias and differences arise from the evaluator's experience and training in sensory assessment, and these issues have become a concern in academia and industry (Lawless & Heymann, 2010). Nascimento et al. (2024) conducted a systematic literature review and highlighted the importance of procedures and quality control in the application of Quantitative Descriptive Analysis (QDA) to Arabica coffee. The research also indicated that there existed a bias risk during preliminary preparation, sample preparation, testing, and data collection in sensory assessment. Therefore, they strongly recommended utilizing scientific assessment continuously, improve the accuracy and reliability, and provided the empirical evidence supporting sensory assessment training and teaching practices.

Recently, various studies have attempted to strengthen the quantification and professional training to perform cross-validation in order to enhance the explanatory power and objectivity of the evaluation system. Gunaratne et al. (2019) used the facial expression analysis system to observe the consumers' autonomic nervous system response to chocolate's basic taste, and this confirms that physical data can be a supplementary basis for traditional sensory assessment. Combining subjective reports and objective physical and emotional responses is useful for taking a deeper understanding of consumers' true reactions and acceptance, enabling a more comprehensive assessment. Savela-Huovinen et al. (2023) indicated that the learning of professional evaluators occurs within the environment of teamwork and knowledge co-construction. The study emphasized that it's not a single professional skills training, vocabulary correction, and the standard co-construction continuity are major factors to influence the establishment of objective evaluation. Urugo et al. (2025) conducted an in-depth study on traditional sensory assessment combined with modern instruments and artificial intelligence, providing a mixed model that integrates the advantages of both assessment methods. This approach is helpful to facilitate rapid, repeatable, and quantifiable quality control, and also provides instructions on methodologies and technologies to enhance the scientific credibility in sensory assessment training.

Methodology

1. Rasch Model

We briefly introduce the mathematical concept of the Rasch model; for more details of the Rasch model, please refer to Andrich (1980). Let a dichotomous random variable $X_{ni} = x \in \{0,1\}$, where 1 denotes a feature *i* of a coffee that is identified by the *n*th person or evaluator, while 0 denotes that the evaluator does not identify the feature. The identification of features of coffee beans relies on an evaluator's ability and the difficulty of identifying these features. Let β_n represent the ability of the *n*th evaluator, and δ_i the identifying difficulty of the *i*th feature of coffee beans. The function $f(\beta_n, \delta_i) = \beta_n - \delta_i$ can be regarded as a utility function that evaluates the evaluator's ability against the difficulty of identifying the feature. According to the Rasch model for dichotomous data, the probability of the outcome $X_{ni} = 1$ is given by:

$$P \ \{X_{ni} = 1\} = \frac{e^{f(\beta_n, \delta_i)}}{1 + e^{f(\beta_n, \delta_i)}}$$

$$= \frac{e^{\beta_n - \delta_i}}{1 + e^{\beta_n - \delta_i}}.$$

Let P_{ni} denote $P \ \{X_{ni} = 1\}$. $P \ \{X_{ni} = 1\}$ is the probability of identification upon interaction between the evaluator and feature item. Then we take the logit form (or log odds) of the probability of identification by an evaluator to a feature, shown as follows:

$$logit(P_{ni}) = ln\left(\frac{P_{ni}}{1 - P_{ni}}\right) = \beta_n - \delta_i.$$

To calibrate the parameters, we utilize the maximum likelihood method to obtain β_n, and δ_i. Next, we elaborate on the mathematical procedure of obtaining the parameters by the maximum likelihood method. Given a set of parameters $(\beta_n, \ \delta_i)$, the probability of the event that the *n*th evaluator identifies the *i*th feature can be represented as a Bernoulli experiment:

$$P_r(X_{ni} | \beta_n, \delta_i) = P_{ni}^{x_{ni}} (1 - P_{ni}^{x_{ni}})^{(1 - x_{ni})} \ ,$$

where $x_{ni} \in \{0,1\}$. The likelihood is written as

$L(\beta_n, \delta_i) = \prod_{n=1}^{N} \prod_{i=1}^{I} P_{ni}^{x_{ni}} (1 - P_{ni}^{x_{ni}})^{(1 - x_{ni})}$; then taking the logarithm of the likelihood, we obtain the following results.

$$\mathcal{L}(\beta_n, \delta_i) = \ln L(\beta_n, \delta_i),$$

$$= \ln\left(\prod_{n=1}^{N}\prod_{i=1}^{I} P_{ni}^{x_{ni}}(1-P_{ni}^{x_{ni}})^{(1-x_{ni})}\right),$$

$$= \sum_{n=1}^{N}\sum_{i=1}^{I} x_{ni}\cdot(\beta_n-\delta_i) - \ln(1+e^{\beta_n-\delta_i}).$$

To maximize the above function, the first-order conditions are

$$\frac{\partial \mathcal{L}}{\partial \delta_i} = \sum_{n=1}^{N}(-x_{ni}+P_{ni}) = 0,$$

$$\frac{\partial \mathcal{L}}{\partial \beta_n} = \sum_{j=1}^{J}(x_{ni}-P_{ni}) = 0.$$

Since $x_{ni}$is binary, and $P_{ni}$is positive, each term of the summation should be greater than or equal to zero; thus, it follows that $x_{ni} = P_{ni}$. It means that when the theoretical probability equals the actual case, the logarithm of the likelihood reaches its maximum. The maximum likelihood estimates $(\beta_n,\ \delta_i)$ must be obtained by numerical maximization of $L(\beta_n, \delta_i)$; however, efficient computer programs exist that enable one to get these estimates rather easily.

Data Collection and Analysis

This study collected the data on coffee assessment in the course of the license renewal of Q on August 26, 27, 2025. By applying the Rasch model, the study transforms ordinal response data into linear logit-scale measures, enabling objective calibration between learner competence and task difficulty. There are 18 participants who evaluate six different coffee samples using the SCA coffee value assessment descriptive form. Table 1 presents representative numbers and features of six coffee beans. These coffee samples originate from Ethiopia, Panama, Costa Rica, Mandheling, and Taiwan, respectively. Among the 6 coffee samples, 3 are natural processed, numbered 263, 493, and 958; 2 are washed processed, numbered 102 and 731; while 884 is wet-hulled.

Table 1 The features of six coffee beans

Representative number of coffee	Features of coffee
102	Ethiopia, Washed
263	Panama, Natural
493	Panama, Natural
731	Costa Rica, Washed
884	Mandheling, Wet-Hulled
958	Taiwan, Natural

Coffee 102

Table 2 Item difficulties by MLE

Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12
-9.81	-31.48	-7.02	-5.38	-9.39	11.85	11.85	11.85	-5.38	11.85	11.85	11.85
Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24
11.85	-5.91	11.85	-5.38	11.85	-7.02	-5.91	-5.91	11.85	-8.15	-5.38	-6.34

According to the results in Table 2, the easiest feature to identify is **fruity**, and the rarest features to identify are sour/fermented, sour, fermented, others, chemical, musty/earthy, woody, cereal, tobacco, and spices.

Table 3 Person abilities by MLE

Person1	Person2	Person3	Person4	Person5	Person6	Person7	Person8	Person9
-7.18	-8.38	-8.33	-8.33	-8.33	-5.89	-7.71	-10.2	-6.72
Person10	Person11	Person12	Person13	Person14	Person15	Person16	Person17	Person18
-7.71	-7.71	-9.11	-8.33	-8.33	-6.3	-6.3	-9.11	-7.71

Since the figures of Table 3 are located in the interval (-11, -5) and no extreme values exist, it means that the number of identified features of all 18 evaluators is quite similar. The median of a person's abilities is -8.02. Therefore, item difficulties below -8.02 can be regarded as the consensus of the evaluators that the coffee bean associates with these features, shown as the figures marked in red in finger 1. These features consist of floral and fruity.

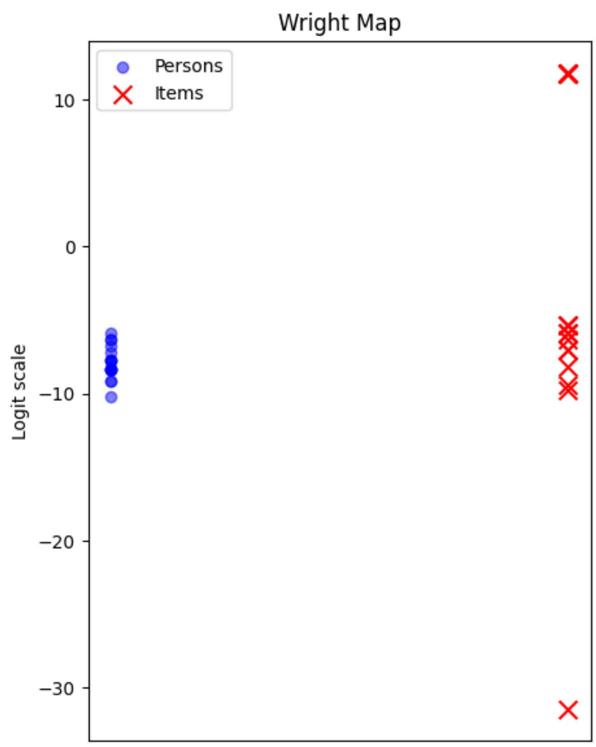

Figure 1 Wright map of coffee 102

Coffee 263

Table 4 Item difficulties by MLE

Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12
-4.28	-6.49	-3.53	-2.94	-4.28	2.07	13.68	-1.3	-2.07	-2.07	-1.3	-1.3
Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24
-2.07	-2.56	-2.07	-1.3	13.68	-3.53	-2.56	-2.56	13.68	-3.53	13.68	-2.94

According to the results in Table 4, the easiest feature to identify is also **fruity**, and the rarest features to identify are sour, tobacco, spices, and vanilla.

Table 5 Person abilities by MLE

Person1	Person2	Person3	Person4	Person5	Person6	Person7	Person8	Person9
-4.07	-4.45	-4.45	-5.55	-4.07	-4.07	-4.45	-4.45	-3.44
Person10	Person11	Person12	Person13	Person14	Person15	Person16	Person17	Person18
-4.45	-4.45	-3.44	-4.92	-3.73	-4.92	-3.16	-4.92	-4.07

Since the figures of Table 5 are located in the interval (-6, -3) and no extreme values exist, it means that the number of identified features of all 18 evaluators is quite similar. The median of a person’s abilities is -4.45. Therefore, item difficulties below -4.45 can be regarded as the consensus of the evaluators that the coffee bean associates with these features, shown as the figures marked in red in finger 2. The feature is fruit.

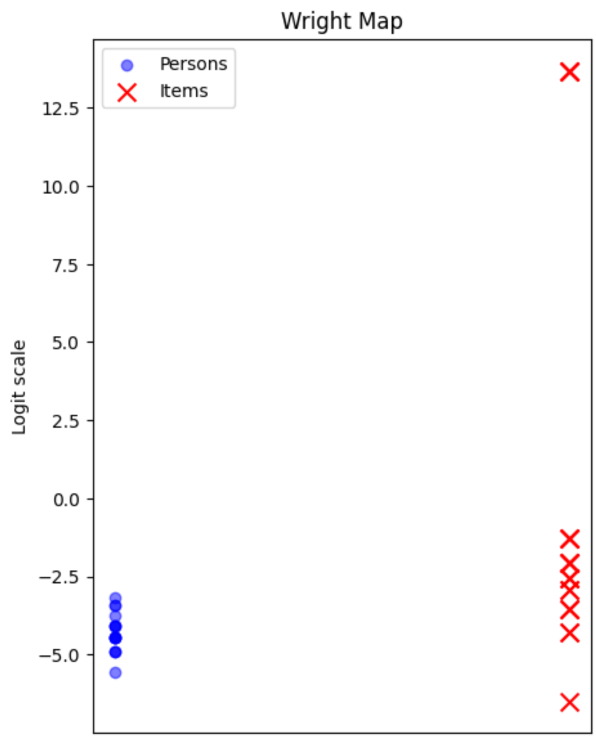

Figure 2 Wright map of coffee 263

Coffee 493

Table 6 Item difficulties by MLE

Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12
-6.01	-8.08	-2.66	-4.66	-6.27	-2.66	-2.66	12.66	12.66	-3.14	12.66	12.66
Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24
-3.44	-3.94	12.66	-2.66	-3.44	-5.75	-5.23	-2.66	-3.44	-4.66	12.66	-4.33

According to the results in Table 6, the easiest feature to identify is also **fruity**, and the rarest features to identify are fermented, green/vegetative, chemical, musty/earthy, cereal, and vanilla.

Table 7 Person abilities by MLE

Person1	Person2	Person3	Person4	Person5	Person6	Person7	Person8	Person9
-5.1	-6.46	-6.46	-5.49	-7.13	-4.74	-5.93	-6.46	-5.49
Person10	Person11	Person12	Person13	Person14	Person15	Person16	Person17	Person18
-5.49	-5.1	-5.1	-6.46	-5.49	-4.74	-4.41	-7.13	-6.46

Since the figures of Table 7 are located in the interval (-8, -4) and no extreme values exist, it means that the number of identified features of all 18 evaluators is quite similar. The median of a person's abilities is -5.49. Therefore, item difficulties below -5.49 can be regarded as the consensus of the evaluators that the coffee bean associates with these features, shown as the figures marked in red in finger 3. These features consist of floral, fruity, and nutty/cocoa.

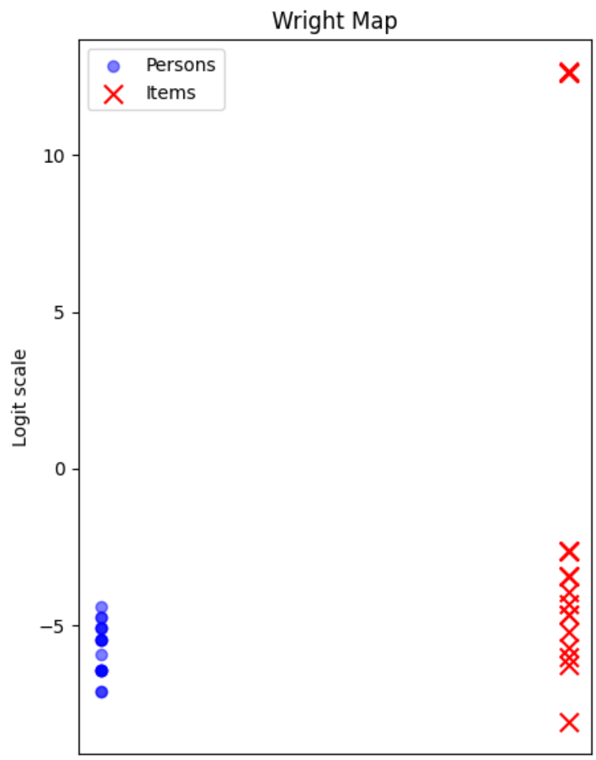

Figure 3 Wright map of coffee 493

Coffee 731

Table 8 Item difficulties by MLE

Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12
-3.49	-7.4	11.18	-5.52	-5.81	11.18	11.18	11.18	11.18	-6.61	11.18	11.18
Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24
-6.61	-7.13	-5.52	-5.52	-3.49	-8.4	-7.4	-4.79	-3.49	-4.79	11.18	-3.49

According to the results in Table 8, the easiest features to identify are **fruity**, **nutty/cocoa**, and **nutty**, while the rarest features to identify are berry, sour/fermented, fermented, green/vegetative, chemical, musty/earthy, and vanilla.

Table 9 Person abilities by MLE

Person1	Person2	Person3	Person4	Person5	Person6	Person7	Person8	Person9
-7.2	-7.69	-6.36	-7.2	-7.69	-5.21	-6.76	-7.69	-5.59
Person10	Person11	Person12	Person13	Person14	Person15	Person16	Person17	Person18
-7.2	-5.97	-7.2	-6.76	-6.36	-5.97	-5.21	-6.76	-5.97

Since the figures of Table 9 are located in the interval (-8, -4) and no extreme values exist, it means that the number of identified features of all 18 evaluators is quite similar. The median of a person's abilities is -6.76. Therefore, item difficulties below -6.76 can be regarded as the consensus of the evaluators that the coffee bean associates with these features, shown as the figures marked in red in finger 4. These features consist of fruity, roasted, nutty/cocoa, and nutty.

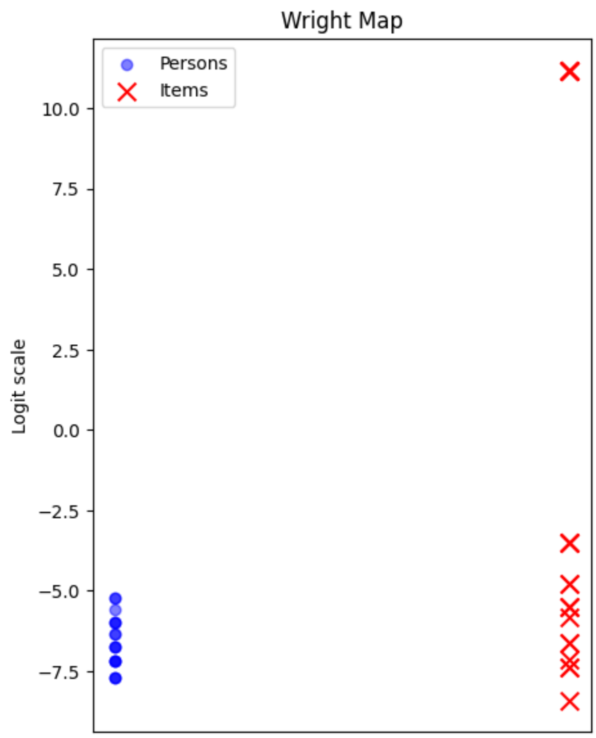

Figure 4 Wright map of coffee 731

Coffee 884

Table 10 Item difficulties by MLE

Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12
-0.52	-3.01	-0.52	-2.47	-0.52	-2.15	-1.29	-1.29	-3.26	-4.27	13.38	13.38
Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24
-4.27	-4.27	-2.75	-1.29	-1.29	-2.75	-2.15	-0.52	-0.52	-0.52	13.38	-0.52

According to the results in Table 10, the easiest features to identify are **others**, **woody**, and **roasted**, while the rarest features to identify are chemical, musty/earthy, and vanilla.

Table 11 Person abilities by MLE

Person1	Person2	Person3	Person4	Person5	Person6	Person7	Person8	Person9
-4.3	-4.3	-3.47	-3.47	-3.85	-2.52	-3.13	-3.85	-2.82
Person10	Person11	Person12	Person13	Person14	Person15	Person16	Person17	Person18
-3.13	-3.13	-3.47	-4.86	-4.3	-3.85	-3.13	-3.13	-2.52

Since the figures of Table 11 are located in the interval (-5, -2) and no extreme values exist, it means that the number of identified features of all 18 evaluators is quite similar. The median of a person's abilities is -3.47. Therefore, item difficulties below -3.47 can be regarded as the consensus of the evaluators that the coffee bean associates with these features, shown as the figures marked in red in finger 5. These features include others, such as woody and roasted.

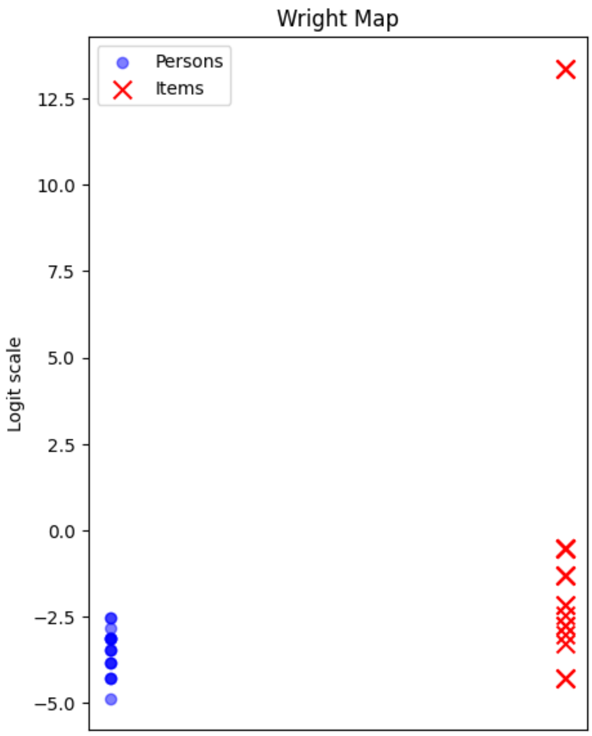

Figure 5 Wright map of coffee 884

Coffee 958

Table 12 Item difficulties by MLE

Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12
-2.6	-6.65	-3.1	-4.63	-3.1	-5.65	-1.82	-5.38	13.33	-3.49	13.33	13.33
Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24
-3.49	-3.1	-1.82	13.33	13.33	-4.73	-3.1	-3.49	-1.82	-3.82	-2.6	-2.6

According to the results in Table 12, the easiest features to identify are **fruity**, while the rarest features to identify are green/vegetative, chemical, musty/earthy, burnt, and tobacco.

Table 13 Person abilities by MLE

Person1	Person2	Person3	Person4	Person5	Person6	Person7	Person8	Person9
-5.7	-5.7	-5.22	-4.46	-4.81	-3.56	-5.7	-6.31	-4.46
Person10	Person11	Person12	Person13	Person14	Person15	Person16	Person17	Person18
-4.14	-4.46	-5.22	-5.22	-4.81	-4.46	-3.56	-4.81	-5.22

Since the figures of Table 13 are located in the interval (-7, -3) and no extreme values exist, it means that the number of identified features of all 18 evaluators is quite similar. The median of a person's abilities is -4.81. Therefore, item difficulties below -4.81 can be regarded as the consensus of the evaluators that the coffee bean associates with these features, shown as the figures marked in red in finger 6. These features are fruity, sour/fermented, and fermented.

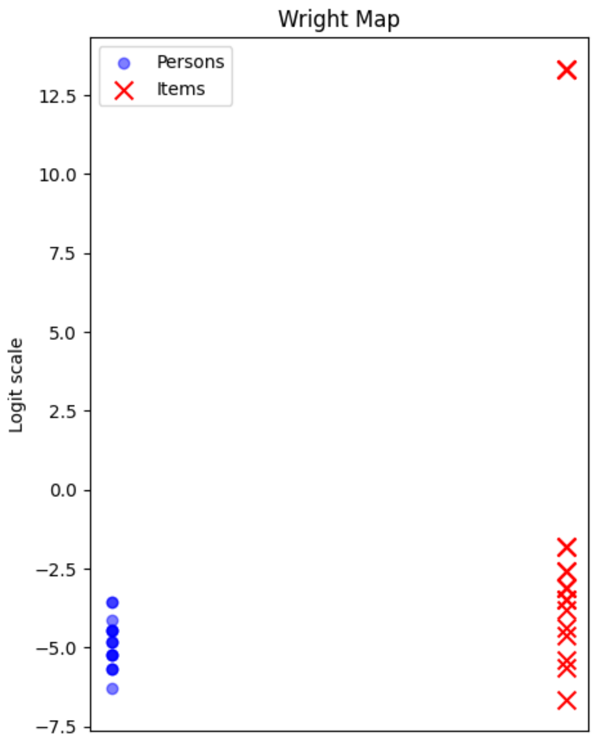

Figure 6 Wright map of coffee 958

Table 13 Person

	102	263	493	731	884	958	Range
PERSON1	-7.18	-4.07	-5.1	-7.2	-4.3	-5.7	3.13
PERSON2	-8.38	-4.45	-6.46	-7.69	-4.3	-5.7	4.08
PERSON3	-8.33	-4.45	-6.46	-6.36	-3.47	-5.22	4.86
PERSON4	-8.33	-5.55	-5.49	-7.2	-3.47	-4.46	4.86
PERSON5	-8.33	-4.07	-7.13	-7.69	-3.85	-4.81	4.48
PERSON6	-5.89	-4.07	-4.74	-5.21	-2.52	-3.56	3.57
PERSON7	-7.71	-4.45	-5.93	-6.76	-3.18	-5.7	4.53
PERSON8	-10.2	-4.45	-6.46	-7.69	-3.85	-6.31	6.35
PERSON9	-6.72	-3.44	-5.49	-5.59	-2.82	-4.46	3.9
PERSON10	-7.71	-4.45	-5.49	-7.2	-3.13	-4.14	4.58
PERSON11	-7.71	-4.45	-5.1	-5.97	-3.13	-4.46	4.58
PERSON12	-9.11	-3.44	-5.1	-7.2	-3.47	-5.22	5.67
PERSON13	-8.33	-4.92	-6.46	-6.76	-4.86	-5.22	3.47
PERSON14	-8.33	-3.73	-5.49	-6.36	-4.3	-4.81	4.6
PERSON15	-6.3	-4.92	-4.74	-5.97	-3.85	-4.46	2.45
PERSON16	-6.3	-3.16	-4.41	-5.21	-3.13	-3.56	3.17
PERSON17	-9.11	-4.92	-7.13	-6.76	-3.13	-4.81	5.98
PERSON18	-7.71	-4.07	-6.46	-5.97	-2.52	-5.22	5.19

Conclusion

This study investigated the applicability of the Rasch Model in evaluating sensory attributes in coffee. To promote objective professional assessment, we need to enhance evaluative methodologies through digital tool integration. Therefore, this research explores the relationship that evaluators utilize the Rasch Model in sensory assessment to establish the evaluation system, offering significant transformative value for both industry standards and competency-based education.

The research aims to discuss the applicability of the Rasch Model on coffee sensory assessment and utilizes the assessment data of Q Grader license renewal conducted in Taiwan on August 26, 27, 2025, as a base. This study analyzes the 18 evaluators' descriptive forms for 6 kinds of coffee samples and demonstrates that the Rasch Model effectively digitizes subjective ordinal feedback into a linear Logit interval scale, thereby significantly enhancing the computational objectivity and scientific rigor of the assessment.

The core findings indicate that the Rasch Model effectively distinguish the evaluators' assessment ability and the difficulty of identifying flavor attributes through Maximum Likelihood Estimation (MLE). It presents the quantitative evaluator competence and the flavor attributes' scientific potential. The evaluators' performance is consistent and with no significant outliers: all evaluators' ability distribution is stable and within a fixed range (e.g., for coffee sample 102 is from –10.2 to -5.89), confirming that this digital measurement approach yields highly reliable performance metrics without significant outliers. The analysis results indicate clearly that fruity is the most consensus flavor attribute and without identify attributes, such as chemical, fermented, and spicy, in the six coffee samples, and this predicts these flavors are not common in the six coffee samples, which was confirmed by the instructor, who stated that these specific flavor profiles were not prepared for the course. These findings are of great significance for professional training and certification systems. The Rasch Model provides a data-driven visual and scientific tool through the Wright Map. These can be used for:

1. Learning analytics enables the quantitative tracking of individual learning trajectories and the extent of competency gains, moving beyond the constraints of traditional pass/fail rubrics, as demonstrated by the alignment of person ability and item difficulty on the Wright Map.
2. Adaptive instructional design enables educators to identify specific cognitive barriers in flavor recognition and to develop tiered, personalized digital training modules accordingly.
3. Global calibration facilitates the digital standardization of evaluators worldwide, providing an empirical foundation for predictive quality engineering and product development.

This study demonstrates the broad utility of the Rasch model in sensory evaluation, establishing a functional framework for more scientifically rigorous and standardized assessment protocols.

Future Research Directions

Ultimately, this research aims to establish a more standardized and technologically robust framework for sensory evaluation, while simultaneously advancing the broader methodological principles of objective measurement within the evaluation discipline.

This study preliminarily verified the feasibility and value of using the Rasch Model for digital coffee evaluation. It can be extended in the following directions with widely and depth in the future:

1. Increase the sample quantity and subject diversity: We suggest incorporating more diverse evaluators, such as the Q Grader from different countries, beginner cupping staff, or general consumers. This will help verify the model's cross-cultural applicability and its stability across varying professional digital literacy and skill levels.
2. Conducting longitudinal tracking research to observe how the abilities of the same evaluators change over time: This can serve as an evidence-based foundation for measuring the longitudinal effectiveness of digital sensory training interventions and for mapping the complex cognitive trajectories within the learning process.
3. Integrate with automated feedback systems: Future research could explore the integration of the Rasch-based framework into AI-driven adaptive learning platforms to provide real-time, calibrated feedback, thereby further human-machine collaboration in professional sensory education .

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