



Beyond Visualization Literacy: Predicting Correct Interpretation through User Characteristics, Item Difficulty and Rasch-Based Measurement

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DESCRIPTION

Visualizations have become an essential means of communicating quantitative information in science, education, business, healthcare, journalism and public policy. Charts and graphs can present complex relationships more efficiently than lengthy numerical descriptions, but the presence of a visualization does not guarantee that viewers will interpret it correctly. People with similar levels of general visualization literacy may arrive at different conclusions when presented with the same graphic. Interpretation accuracy can depend on individual characteristics, the complexity of the visual task and the interaction between the viewer and the information being presented. A more comprehensive approach to visualization comprehension therefore considers several dimensions simultaneously. Instead of treating correctness as a simple consequence of whether a person possesses adequate literacy skills, predictive models can incorporate user traits, characteristics of individual visualization questions and quantitative measures of item difficulty [1-3].

Rasch-based scoring provides a useful framework for representing these dimensions because it separates the ability of a respondent from the difficulty of an assessment item. This creates an opportunity to understand why some people interpret particular visualizations correctly while struggling with others. User traits can include demographic characteristics, educational background, previous exposure to charts, familiarity with numerical concepts, confidence in interpreting data and general cognitive or analytical tendencies. Experience with statistical graphics may make certain visual encodings easier to understand, while unfamiliar chart formats may require additional mental effort. Confidence can also influence performance, although confidence and actual correctness do not necessarily develop together. A person may feel comfortable interpreting a graph while overlooking an important scale, comparison or contextual detail [4-6].

The characteristics of the visualization task itself are equally important. Simple questions may require identifying a single maximum or minimum value, whereas more difficult questions can involve comparisons across multiple categories, trends over time, ratios, intersections or interactions between variables. The visual encoding also affects interpretation. Bar charts, line graphs, scatterplots, heat maps and more specialized displays place different demands on the viewer. Color, scale, labelling, spatial arrangement and visual density can either facilitate understanding or introduce additional obstacles. Item difficulty provides a particularly useful way to describe these differences. Two questions presented using the same chart may require substantially different reasoning. A straightforward question asking which category has the largest value may be easier than one requiring the viewer to compare several values and infer a relationship. By assigning difficulty characteristics to individual items, predictive models can distinguish problems caused by task complexity from differences in individual ability [7-9].

The measurement offers a mathematical framework for making this distinction. In a simplified form, the probability that a person answers an item correctly depends on the difference between the person's estimated ability and the item's difficulty. A respondent with greater visualization interpretation ability should have a higher probability of answering difficult items correctly, while an item with greater difficulty should reduce the probability of a correct response across respondents. This common measurement scale allows people and items to be considered within the same analytical structure. The resulting Rasch scores can provide more informative measures than raw percentages alone. A person who answers eight out of ten questions correctly on very difficult items may demonstrate a different level of ability from someone who achieves the same percentage on relatively simple questions. Similarly, an item that only a small proportion of respondents answer correctly may not necessarily indicate poor literacy; it may simply require more complicated reasoning. Rasch-based analysis helps account for this distinction [10].

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CONCLUSION

Predictive modelling can then combine Rasch-derived measures with user characteristics and item-level information. Machine-learning algorithms may identify nonlinear relationships between these variables and interpretation correctness. For example, previous experience with statistical graphics might be especially beneficial for complex visualizations but have little effect on simple comparison tasks. Likewise, educational background may interact with item difficulty rather than functioning as an independent predictor across every type of visualization. Predictive accuracy alone, however, should not determine how such systems are used. User characteristics may contain sensitive information and models can reproduce biases present in their training data. A prediction that a particular person is likely to misunderstand a visualization should therefore be treated as an indication for supportive intervention rather than a fixed judgment about ability. Transparent model development, appropriate validation and careful interpretation are important when applying predictive methods to human performance.

REFERENCES

1. Pesudovs K, Burr JM, Harley C, Elliott DB. The development, assessment, and selection of questionnaires. *Optom Vis Sci.* 2007;84(8):663-674.
2. Khadka J, McAlinden C, Pesudovs K. Quality assessment of ophthalmic questionnaires: Review and recommendations. *Optom Vis Sci.* 2013;90(8):720-744.
3. Massof RW. The measurement of vision disability. *Optom Vis Sci.* 2002;79(8):516-552.
4. Tennant A, Kūçūkdıvecı AA. Application of the Rasch measurement model in rehabilitation research and practice: Early developments, current practice, and future challenges. *Front Rehabil Sci.* 2023;4:1208670.
5. Leung YY, Png ME, Conaghan P, Tennant A. A systematic literature review on the application of Rasch analysis in musculoskeletal disease—a special interest group report of OMERACT 11. *J Rheumatol.* 2014;41(1):159-164.
6. McAlinden C, Pesudovs K, Moore JE. The development of an instrument to measure quality of vision: The Quality of Vision (QoV) questionnaire. *Investig Ophthalmol Vis Sci.* 2010;51(11):5537-5545.
7. Cacho-Martínez P, Cantó-Cerdán M, Lara-Lacárcel F, García-Muñoz Á. Validation of the Symptom Questionnaire For Visual Dysfunctions (SQVD): A questionnaire to evaluate symptoms of any type of visual dysfunctions. *Transl Vis Sci Technol.* 2022;11(2):7.
8. Cappelleri JC, Lundy JJ, Hays RD. Overview of classical test theory and item response theory for the quantitative assessment of items in developing patient-reported outcomes measures. *Clin Ther.* 2014;36(5):648-662.
9. Tennant A, Conaghan PG. The Rasch measurement model in rheumatology: What is it and why use it? When should it be applied, and what should one look for in a Rasch paper? *Arthritis Rheum.* 2007;57(8):1358-1362.
10. Schiffman RM, Christianson MD, Jacobsen G, Hirsch JD, Reis BL. Reliability and validity of the ocular surface disease index. *Arch Ophthalmol.* 2000;118(5):615-621.