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The development, psychometric properties and refinement of a food literacy scale for specific and general application

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ABSTRACT

Food literacy continues to be a developing concept, and the need for a universal definition with agreed sub-constructs and validated measuring instruments continues to be a priority. The concept describes the knowledge, skills and behaviours needed to meet daily challenges in the face of growing global non-communicable diseases associated with incorrect food behaviour. This research aims to develop, refine and validate a Food Literacy Scale for context-specific and general applications. Food literacy definitions and subconstruct formulations reported elsewhere were used to guide the development of a pool of items ($N = 204$). This research reports on a process of refinement and validation based on a combination of CTT and Rasch modelling, using results from a middle-income database (population $N = 1657$, sample $n = 862$). The application of Rasch analysis provided credible evidence for the quality of the psychometric properties of the instrument. Pragmatic decisions were made about which items to keep or delete, based on qualitative considerations as well as comparison and contrasting of indicators derived from each statistical framework. The final instrument consisted of 95 dichotomous items grouped in six subscales, namely Procurement (11 items), Economics (9 items), Consumption (21 items), Nutrition (24 items), Food safety (17 items), and Socio-cultural aspects (13 items). The large item pool offers scope for further refinement upon implementation in different contexts. The final scale is modular, meaning that one or more subscales can be removed or replaced before implementation. Based on its excellent psychometric properties, the SAFLS^{TM} (South African Food Literacy Scale) is suitable to measure the food literacy of middle-income consumers across many contexts.

1. Introduction

Food Literacy has been defined by Vidgen and Gallegos (2014) (p 54) as "the scaffolding that empowers individuals, households, communities or nations to protect diet quality through change and strengthen dietary resilience over time. It is composed of a collection of inter-related knowledge, skills and behaviours required to plan, manage, select, prepare and eat food to meet needs and determine intake". This definition, one of the most cited and regularly applied definitions, is just one of many definitions currently utilised in this field of research. Food Literacy has been suggested as a basic competency that consumers need in order to make sensible decisions regarding the foods they consume to maintain good health. It is understood to be "a set of cognitive and social skills associated with the ability to acquire and understand information about food and nutrition to make appropriate nutritional decisions" (Zwierczyk et al., 2022) (p 9710). It is informed by everyday actions associated with food choices and eating behaviour which are complex activities that are influenced by many physiological and sociological factors. High levels of Food Literacy have been shown to provide humans with a set of knowledge, skills and abilities to handle complicated food-related decisions and behaviour that can have positive short-term and long-term consequences (Gianni et al., 2023). The Food Literacy construct, first conceptualised in the USA in 1998, was in fact initially formulated to respond to modern consumers' deteriorating health as a consequence of their diminished ability to make good food choices and exhibit cautious eating behaviour. Food literacy has close links with health literacy and nutrition literacy (Krause et al., 2018), and many food literacy development works considered Nutbeam's tripartite health literacy model (Krause et al., 2018; Nutbeam 2000; Nutbeam 2008).

Even though social class stratification is not decisive in terms of healthy eating behaviour (Hupkens et al., 2000) the global emerging middle-income social class is often adversely affected by inadequate Food Literacy levels. The Atlas of African Health Statistics

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(World-Health-Organization, 2022) reports that 27 % of South Africans suffer from hypertension, that non-communicable diseases have become the main cause of death in Sub-Saharan Africa (37 % of people under the age of 70), that a 50 % reduction in overweight levels by 2025 will not be possible (cross-analysis clearly shows that obesity is still rising the fastest in emerging economies), and it is predicted that 700 million people can expect to live with diabetes by 2045 (Saeedi et al., 2019). Many of these statistics are consequences of the middle-income social class lifestyle. The middle-income social stratum as a group often has long working hours, hence their inability to prepare food from scratch at home; they often report refined processed take-out and convenience foods as more affordable than cooking with raw ingredients from scratch at home, and they most often have economic aspirations and therefore desire all the lifestyle conveniences, such as regular eating out of the home. The reasons for deteriorating Food Literacy levels are manifold and include aspects such as diminished cooking education at school (culinary de-skilling) (Slater, 2017), declining transfer of skills between generations, and many others. In South Africa, where the middle-income social stratum is reported to struggle greatly with their food behavioural health (Manafe et al., 2022), this group could also benefit from increased Food Literacy through their higher education levels, economic viability and others.

In this paper, the authors describe the development of a diagnostic instrument for measuring Food Literacy in a South African context, with universal components suitable for an international consumer, as well as context-specific components suitable for the South African middle-income stratum. We offer a scale with subconstructs, each with a set of universal core items. The core items are furthermore complemented by a few additional items formulated specifically for South African middle-income consumers. These supportive items could be amended and altered for different contexts. The core items will allow comparison across contexts while the context-relevant items can inform tailored actions at the local level.

2. Background and problem statement

The need for modern humans to exhibit good levels of Food Literacy in order to live healthily through their food acquisition and consumption behaviour is paramount. Information derived from the accurate assessment of consumer Food Literacy levels can be utilised in many applications, from designing appropriate health and nutrition intervention programs to amending culinary programs, informing the recruitment of specialised workers, and many more. There is a keen interest in this topic as indicated by a recent scoping review of papers published over a 21-year period that contain the Food Literacy concept, where 429 of 549 peer-reviewed articles were original research (Thompson et al., 2021). Even though a great deal of research is conducted in this field, there seems to be no international consensus on the definition and essential subconstructs for Food Literacy. In order to advance this field, it would therefore appear that a global definition for Food Literacy, with a mutually agreed set of subconstructs that is endorsed by a prominent international agency, is urgently required as the "full breadth, reach and scope of the term 'Food Literacy' has yet to be explored" (Thompson et al., 2021) (p 2).

New definition formulations have proliferated since the inception of the concept in 1998 with 38 novel definitions reported for Food Literacy by Truman, Lane and Elliott (2017) and 51 more novel definitions identified by Thompson et al. (2021). The proposed composition of subconstructs within the Food Literacy construct varies greatly in the literature, resulting in many differences and inconsistencies, which further hamper the development of measuring instruments.

Even though many researchers today favour one of the original Food Literacy definitions by Vidgen and Gallegos (2014) (Fingland et al., 2021; Thompson et al., 2021; Thompson et al., 2022), Jo et al. (2021) concurred that there is currently no consensus on the definition of Food Literacy. Most development in the field appears to be context-specific, to the extent that not a single of the four most frequently cited definitions for Food Literacy included all the accessible subconstructs (or dimensions) such as skills/behaviours; food/health choices; culture; knowledge; emotions, and food systems (Thompson et al., 2021). Other research expands the Food Literacy definition to comprise 11 subconstructs under four main domains, namely planning and management; selection; preparation and finally eating (Fingland et al., 2021; Thompson et al., 2022). Authors Jo et al. (2021) indicate that of the 31 validated reliable Food Literacy measurement instruments they investigated, most were developed for a specific target population, such as for young children from Melbourne (Wijayaratne et al., 2022), Australian adults (Thompson et al., 2022), 10–12-year-old overweight Tehrani school children (Doustmohammadian et al., 2022), Spanish university students (Luque et al., 2022), and others. Many Food Literacy scales are furthermore adapted from existing instruments, such as a cultural adaptation into Polish of the Short Food Literacy Questionnaire (SFLQ) (Zwierczyk et al., 2022), the use of the SFLQ in Turkey (Durmus et al., 2019), Brazil (Zeminian, Corona, Batista, da Silva & da Cunha, 2022), for German office workers (Meyn et al., 2022) and a Chinese version of the Food Literacy Evaluation Questionnaire (FLEQ) (Qian et al., 2022). These scales were developed with different measuring items which reflect the specific populations and their cultures for which the scales were developed (Fingland et al., 2021). As a result, the need for a *comprehensive* reliable and validated Food Literacy measurement instrument remains unaddressed (Park et al., 2020). Such a comprehensive Food Literacy instrument has many applications, and could, amongst others, be applied to guide intervention programs to address current world citizens' disconnection and consequent inability to feed themselves adequately, and the ever-increasing global health crisis caused by it.

The first step towards the development of such a universal Food Literacy scale is to reach agreement on a construct definition that is universally accepted along with its essential subconstructs. The essential subconstructs must then be operationalised in a manner that is general, but also context and culture specific. While most humans consume food as a means of survival, their social, environmental, and economic circumstances influence and direct their choices and behaviours regarding what and how they consume food. It is, therefore, to be expected that a global Food Literacy definition and measurement instrument with broad international application would be operationalised with universal (generic) and context-specific measuring items to account for cultural and socio-demographic specifics.

The fraternity of Food Literacy specialists needs to furthermore reach consensus on whether only food specialists and professionals in the food industry or also the broader public should be consulted on definition and subconstruct development. Even though Thompson et al. (2022) consider the practice of involving the general public in Food Literacy measurement development positively, it would appear that most developments are done through the inclusion of expert and public opinions, even if only for certain phases of the development. In most recent Food Literacy measurement developments, generation was done through either extensive literature reviews, or utilising existing scale items followed by expert content relevance ratings and validations using a sample of the particular targeted population (Fingland et al., 2021; Malarat & Chongmontri, 2023; Park et al., 2020; Stjernqvist et al., 2021). In developed societies that are more homogeneous, it may be possible to obtain input for measurement development from the general public only, but in developing societies the opinions of food experts should carry more weight due to their knowledge and experience. Due to the heterogeneity of the South African population, we followed a combined approach for this research, where the definition, subconstructs and item generation were done in consultation with experts, but item reduction and validation were done utilising an appropriate sample of the middle-income population.

A further criterion for scale development is that items should not discriminate against the test-taker. Items should be accessible across

test-takers' socio-economic status. In the case of the middle-income social stratum, it is assumed that most consumers would display fairly homogeneous economic abilities and behaviour, which implies that it socio-economic status is expected to function as a determinant of food intake independent of food literacy (Fingland et al., 2021).

Instrument development and refinement require both qualitative and quantitative approaches; qualitative methods are typically used for construct elicitation and the operationalization of the construct, but quantitative approaches are required for instrument refinement and assessment of its psychometric properties. Traditionally, classical test theory (CTT) was used exclusively for instrument refinement, but more sophisticated models with improved sensitivity have been developed (Rusch et al., 2017). IRT models are increasingly being employed for scale development in education, psychology and health sciences, as well as marketing and social sciences, because of their superior properties. Recently, two separate studies reported on the development, refinement and validation of measurement instruments for food literacy (Thompson et al., 2022) and nutrition literacy (McNamara et al., 2022), respectively, using IRT models. The advantages derived from statistical analysis based on IRT models include "continuous, interval-level scoring, item-level parameters that facilitate the development of valid measures, precise scoring and reliability estimates, and valid comparisons of respondents who took more, fewer, or different items" (Kean & Reilly, 2014 and references cited therein). The reader is referred to any of the numerous monographs and research articles where the properties and implementation of IRT models are described, for example in Tennant and Conaghan (2007).

3. Methodology

3.1. Development of a food literacy definition and subscales

This research reports on the refinement and validation of the South African Food Literacy Scale (SAFLS^{TM}) for the middle-income socio-economic stratum that was informed by the Food Literacy definition of Fisher et al. (2019). Their definition states that food literacy "refers to an individual's knowledge, skills and behaviour as demonstrated through sourcing and consumption, as well as the nutritional, economic, safety and social aspects of food" (p 11). The grounded research conducted to synthesise a definition and subconstructs through consensus corresponded with the leading definitions of Vidgen and Gallegos (2014). Because of South Africa's heterogeneous societal composition, it was necessary to develop a new definition for the Food Literacy concept that showed remarkable retrospective similarities to the work of Vidgen and Gallegos. The Delphi methodology followed in developing the definition was not primed by items in an existing scale, but rather informed by local food-related experts to enrich the definition with their local knowledge and expertise. It is for this reason also that an existing scale, such as the SFLQ, was not adapted. The process provided a richer definition to ground the scale development process that followed. The detailed process followed for construct elucidation and item formulation was reported separately (Fisher et al., 2019), but is briefly summarised below. Subconstruct and item development involved an extensive process of consultation and negotiation to arrive at an acceptable level of consensus on subconstruct and item formulation before psychometric validation and item reduction was undertaken using Rasch modelling.

The SAFLS^{TM} was developed during a three-round Normative Delphi process which targeted 305 food industry experts from a diverse range of fields (food journalists, food magazine editors, food magazine publishers, food guide editors, cookbook authors, retail promoters, product developers, responsible sourcing advocates, recipe developers, food scientists, food technologists and other individuals working in research and development, government representatives, lecturers, cookery school teachers, school teachers, academics, dieticians, human nutritionists, chefs, restaurateurs, cooks, caterers, and food service managers). During the first scoping round, 76 respondents provided their self-constructed definitions of Food Literacy that were thematically analysed to identify the relevant prominent constructs and extrapolated for inclusion in the final definition. During the second distillation round, 71 respondents' opinion convergence (retention rate of 93.4%) was calculated through a quantitative rating of statistical parameters of the constructs contained in the proposed definition. The statistical analysis aimed to calculate collective judgement consensus by way of frequencies, means, standard deviations (SD), One-way ANOVA and a post hoc Bonferroni Test (Fisher et al., 2019). The mean level of agreement with the stated definition was Mean 8.43 (Max = 10; SD 1.54), while the agreement with the relevance of the subconstructs and their domains (Max = 4) were: Procurement (sourcing): Mean 3.63 (SD 0.59), Economics (or Financial ability): Mean 3.41 (SD 0.73), Consumption: Mean 3.54 (SD 0.61), Nutrition: Mean 3.57 (SD 0.70), Food safety: Mean 3.61 (SD 0.67), and Socio-cultural aspects: Mean 3.37 (SD 0.81) (Fisher et al., 2020). The six subscales were understood as follows:

- **Procurement (Pr)**: consumers' competence in sourcing and acquiring (obtaining, buying) food wisely from available accessible sources;
- **Financial (Fi)**: the economic ability that represents consumers' competence in acquiring (buying) available and accessible food wisely within their financial ability without wastage;
- **Consumption (Co):** consumers' competence to make informed choices when planning, preparing and eating food and meals. This ability furthermore assumes competence in the use of appropriate equipment, storing and cooking food, as well as interpreting and adapting recipes;
- **Nutrition (Nu)**: the ability of consumers to competently address health and wellbeing by way of their selection, preparation and consumption of health-promoting foods;
- **Food Safety (FS):** the ability to competently handle, prepare and store food safely in a manner that will prevent food-borne illnesses;
- **Social-cultural aspects (So)**: consumers' competency to consider their culture, ethnicity, food fashions or trends, entertainment and status within their food and eating behaviour.

3.2. Item pool

The next step was the development of an initial pool of items (N = 204) covering all six of the specified subconstructs, by faculty members and willing academics who contributed items to populate an initial battery of scale items that would represent the various dimensions of the Food Literacy construct. The scale items reflect behaviour that middle-income people may display in everyday interactions to feed themselves. The scale and particularly the items represent conduct (knowledge, skills and behaviour) towards various aspects of food interactions, such as being aware of the cost of food, how to traverse food safety issues and nutritional self-care, to name a few. In the initial development of the scale items, the aim was to have a good distribution of items across most food groups that middle-income consumers would interact with in their day-to-day food behaviour, while comprising items which test knowledge, skills and abilities.

Particular South African food literature was consulted to incorporate the ethnicity of the sample group taking part in this investigation. This included Eat Ting (Tshukudu & Trapido, 2016); South African Indigenous Foods (Basemzansi & Moroka, 2004); Indian Delights (Mayat, 2007); Curry: Stories & Recipes Across South Africa (Govender-Ypma, 2017); The South African Cookbook (Cheifitz, 1994), The South African Encyclopedia of Food and Cookery (Smit & Fulton, 1986); Leipoldt's Cape Cookery (Leipoldt, 1989); Traditional Cookery of the Cape Malays (Gerber, 1978); Culinary Fundamentals (Moriarty, 2006); The Green Food Bible (Wills, 2008); and Contemporary Nutrition (Wardlaw & Smith, 2018). These sources were supplemented with existing food-related scales such as Measuring Food Literacy (O'Sullivan, 2015); Spanish Nutrition Literacy Scale (Coffman & La-Rocque, 2012); General

Nutrition Knowledge Questionnaire for adults (Parmenter & Wardle, 1999); Nutrition Literacy Indicators for College Students in Taiwan (Liao & Lai, 2017); the Green Food and Beverage Literacy Scale (Wang, 2016); Salt Knowledge Questionnaire (Sarmugam et al., 2014); the Food Disgust Scale (Hartmann & Siegrist, 2018); The Short Food Literacy Questionnaire (SFLQ) for adults (Krause et al., 2018); and A Scale to Measure Tourist Motivation to Consume Local Food (Kim & Eves, 2012). Scale items could therefore be made more specific for the middle-income South African population by adding commonly consumed foods to the specification of the food group items (Vellema et al., 2016).

In the final Delphi round three, participating respondents (n = 28) were requested to aid in the generation, refinement and credibility check of the pool of items which would represent each of the subconstructs, particularly in their fields of expertise. Experts were requested to categorise the 204 proposed scale items on a 3-point Likert-type scale: 1 meant include; 2 uncertain; and 3 exclude, and to rephrase scale items where necessary, or comment on readability and credibility. This round furthermore offered experts the opportunity to provide alternative or new scale items that might fully cover dimensions and themes that they had already been informed about (David et al., 2018; Mallinckrodt et al., 2016) all the while taking the latent variable, Food Literacy, into account. At the end of this exercise, the item bank consisted of 151 true-false items probing proficiency in 6 subscales: Procurement (19), Economics (13), Consumption (31), Nutrition (36), Food Safety (27) and Socio-cultural aspects (25). Although the advantages and/or disadvantages of dichotomous scales continue to be debated, in this work we based our decision to only use dichotomous scale items on the strength of their ease of use, content clarity and elimination of the guessing factor found in 3-parameter models (Martin-de-Las-Heras & Tafur, 2011).

3.3. Sample alignment

An independent consumer research firm, Consulta (Pty) Ltd, was contracted to compile a questionnaire comprising the resultant item pool of 151 items, which they distributed electronically to their extensive South African database. The questionnaire was completed by 1657 respondents with a demographic distribution as reported in Table 1. This sample is skewed towards white respondents presumably because of access to technology and differences in cultural response patterns. The component of white respondents in the sample was subsequently reduced to a random selection of 400 records which retained an adequate sample size but improved alignment with the racial demographics of the South African middle-income group (Schotte et al., 2017). The descriptive statistics reported in Table 2 indicate that the performance distribution of the sample was comparable to that of the population.

The demographic characteristics of the sample for attributes other than ethnicity are reported in Table 3. The sample had a good balance of age and gender and displayed typical middle-income characteristics; while 78% of respondents pursued or acquired post-secondary qualifications, the monthly food budget of at least 55% of the sample was below USD300.

Table 1
Demographics of the sample as compared to the South African middle-income (Schotte et al., 2017).

Ethnicity	Number of respondents in population (N = 1657)	Number of records in sample (n = 862) [% of sample]	Demographics of South African middle-income
Black	226	226 (26.2%)	50.6%
Coloured	61	61 (7.1%)	14.6%
White	1195	400 (46.4%)	28.1%
Indian	130	130 (15.1%)	6.7%
Asian	13	13 (1.5%)	
Undisclosed	27	27 (3.1%)	
Other	5	5 (0.6%)	
TOTAL	1657	862	

Table 2
Descriptive statistics for the data set and subset.

	Population (N = 1657)	Sample (n = 862)
Mean total score (max 151) [SD]	109.8 [8.8]	108.1 [10.5]
Median	111	109
Range	Min = 61; Max 139	Min = 68; Max 134

Table 3
Demographic characteristics of participants in the sample.

Category	Category descriptions	Frequencies (n = 862)
Age	>40 years	383
	≤40 years	479
Gender	Male	373
	Female	489
Level of education	Completed high school (Grade 12)	191
	Undergraduate student	164
	Graduate (Bachelor's degree or diploma)	345
	Honours degree	113
	Master's degree	39
	PhD	9
Monthly food budget	Less than USD110 (R2000)	70
	Between USD110 and USD275 (R2 000 to R5 000)	404
	Between USD330 and USD550 (R6 000 to R10 000)	134
	More than USD550 (R10 000)	32

3.4. Instrument refinement

Instrument refinement was subsequently conducted in a stepwise manner using both classical statistical methods and Rasch item analysis. Pragmatic decisions were made about items to keep or delete based on qualitative considerations as well as comparison and contrasting of indicators derived from each statistical framework. The data set (151 items, 862 respondents) had no missing responses. Rudimentary item analysis was conducted in Xcel to determine item difficulty (% correct) and item discrimination using the *extreme group method* (Cappelleri et al., 2014) based on the top and bottom 23% of responses. Rasch analysis of the data was performed using RUMM2030 software (Andrich et al., 2002) which was set up for the analysis of dichotomous data. The results of the Rasch analysis are reported here according to the guidelines provided by Tennant and Conaghan (2007).

In the first round, all items with a zero or negative discrimination index were deleted (21 items). Next, all items flagged for gross misfit by Rasch analysis were investigated and those with high fit residuals (large discrepancy between scores observed and scores predicted by the Rasch model), as well as poor item characteristics (low difficulty and/or poor discrimination), were deleted (13 of 26 items). The data did not fit the Rasch model well, so rounds 3 to 5 involved more rigorous scrutiny of items based on considerations of item difficulty, discrimination and item fit, resulting in the deletion of another 22 items. The final version of the instrument comprised 95 items after removing a total of 56 items. The 95 dichotomous items were grouped in six subscales, namely Procurement (11 items), Economics (9 items), Consumption (21 items), Nutrition (24 items), Food safety (17 items), and Socio-cultural aspects (13 items). The scale is modular, which means that one or more subscales can be removed or replaced before implementation.

The initial bank of items was developed to test knowledge, skills and behaviour within each of the six subconstructs. However, the three categories were not differentiated during the refinement process; items that did not show good characteristics were removed regardless of how their removal could affect balanced distribution between the three

categories. It was therefore important to develop subconstructs containing items from the three different categories, but an equal number of questions from each of the categories within each subconstruct could not be assured.

4. Results

In this section we discuss the validity and reliability of the scale and report on psychometric aspects that are fundamental to the Rasch approach, namely the fit of items and persons to the model, a test of the assumption of local independence of items, differential item functioning, and the targeting of the scale (Tennant and Conaghan, 2007).

The construct validity and content relevance of the instrument was ensured by a systematic process of construct, subconstruct and item development based on expert opinion which was reported elsewhere (Fisher et al., 2019) and was summarised above. The instrument showed excellent internal consistency as indicated by the relevant statistics, Cronbach's alpha 0.85 as determined by the CTT analysis, and a person separation index of 0.84 estimated by Rasch analysis, which is a reliability metric closely related to Cronbach's alpha. The data showed no response dependence, which indicates that each of the 95 items provided unique, independent information about the latent trait, food literacy. This was confirmed by the absence of residual correlations between pairs of items (none higher than 0.21) and principal components analysis which indicated that the principal factor accounted for only 3.57% of the variance. There was also no undesired differential item functioning by age or gender, which means that respondents from these demographic subgroups had similar response patterns for all items; they were not (dis)advantaged by the content or formulation of any items. A small number of items showed differences between response patterns according to ethnicity, level of education and food budget, as could be expected.

An important advantage of Rasch analysis is the visual representation of item and person measures on the same interval scale in a so-called person-item or Wright map (Fig. 1). The mean item measure is set at 0.0 logits with person measures presented on the left and item measures on the right of the vertical axis with item difficulties and person ability increasing from the bottom upwards. Persons with an ability matching the difficulty of a specific item have a 50% probability of answering the item correctly, while persons with an ability measure 1.0 logit higher have a 75% likelihood to provide the correct answer. In our case, the distribution of person measures was approximately symmetric, but the items were not well targeted for the sample population as evidenced by the mean raw score total (69.8, max 95) and the mean person measure (1.32 logits). The person-item map shows a lack of items matching upper ability levels which can be expected to introduce measurement error and influence fit statistics. There is an oversupply of items between −2 and +0.5 logits which provides scope for item elimination to shorten the questionnaire.

The data still did not fit the model perfectly, as evidenced by the overall fit statistics (Total-item chi-square 1800.87, df 855, χ^2 prob 0.0000). Possible causes for misfit in our case include item misfit, targeting of the instrument to the population and, to a lesser extent, person misfit. The observed responses for a small number of people (30 persons, 3.5% of the sample) were erratic, but this was deemed small enough to be accommodated during instrument refinement. Eight items were still flagged for misfit, seven were over-discriminating and one under-discriminating. However, it should be noted that the increased sensitivity of Rasch analysis is expected to flag issues that otherwise would go undetected.

Based on its promising psychometric properties – excellent internal consistency and absence of undesired differential item functioning and response dependence – the instrument is considered suitable for assessing the Food Literacy of the South African middle class and designing interventions for improvement. The next step would be to target a more representative sample of the South African middle class that also includes respondents not reached by online surveys, as well as implementation in contexts outside South Africa so that informed decisions can be made about item removal for further refinement.

5. Discussion

This work aimed to propose a validated Food Literacy Measurement Instrument (SAFLS^{TM}) that may be used in a wide range of contexts. The full scale with 95 items offered in Table 4 (Appendix A) has been carefully crafted through meticulous item reduction strategies. The scale is divided into six sub-scales (Procurement, Economics or Financial ability, Consumption, Nutrition, Food Safety and Socio-cultural aspects), which aims to assess most of the relevant competencies that an average middle-income person living in an advanced or developing economy of the world would require to negotiate the complexities of everyday food behaviour in the 21st century.

The scale was specifically developed to measure Food Literacy within the middle-income subgroup, as this social stratum has been reported to suffer from the effects of nutritional deficiencies. The fact that middle-income subgroups are expected to display similar behaviour irrespective of context as a result of urbanisation, Westernisation or globalisation, implies that they display similar characteristics in terms of financial abilities, desires for Western comforts and also often display changes towards Western diets. Because these traits are often independent of cultural background, middle-income people in New Delhi would show similar degrading eating behaviour as middle-income people in Johannesburg.

It is important to note that the scale can therefore potentially be used in any global middle-income population group displaying economic aspirational behaviour that may lead to nutrition-transition

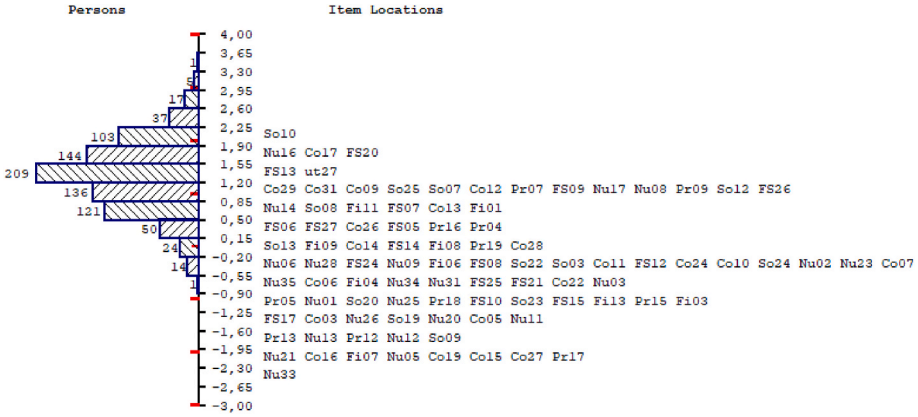

Fig. 1. Wright Map illustrating item parameters and person estimates.

characteristics. The SAFLS^{TM} however, includes seven items that would only be appropriate to a South African middle-income audience (see items in Table 4 in greyscale). These are Co24: South African recipes indicate oven temperatures in degrees Fahrenheit, So03: Mabela is made from sorghum, So09: Biltong is made from beef and game, So19: Atchar is made from green mangoes, So22: Bunny chow is made with brown bread, So23: Yellow rice is served with bobotie and So24: Amasi can be used in baking. The metric system is used in South Africa, and if a potential user wants to include Co24, the wording could be changed to match the system that is used in their country. The remaining six items are all from the socio-cultural aspect sub-construct and reflect specific food items particular to a South African audience. These could potentially be amended or replaced with appropriate examples of the culture or country where the scale will be applied. Alternatively, the socio-cultural subscale can be removed altogether. The scale is also not well aligned with the competencies of the sample that was surveyed where the majority of respondents found the questions quite easy to answer correctly. This is a consequence of the constraints imposed by online data collection. Consequently, the sample did not fully represent the component of the South African middle-income population with limited access to computers or limited experience of online surveys. Another method of administering future surveys to middle-income may be considered. We anticipate that better targeting will be evident from a more representative sample of the population.

6. Final remarks

Seen against global statistics of worsening health resulting from poor food choices and eating behaviour, a standardised tool to equitably measure Food Literacy levels across nationalities is urgently needed. There is considerable value and consequently potential gain to be generated through the development of a universal scale that could be applied across cultural boundaries to measure Food Literacy. As the nutritional needs of the ever-increasing global middle-income social group are undeniable, such a scale will have many applications. It could be used, for example, to inform consumer training programmes or be applied for specialist applications, such as competence assessment in the food and hospitality industries.

Unfortunately, the development of an internationally or cross-culturally useable scale to measure Food Literacy is currently hampered by the fact that there is no commonly accepted Food Literacy definition, nor commonly accepted sub-constructs from which to develop a measuring instrument. There is a proliferation of instruments developed for target groups that have only niche applications, and there is no agreement on who should inform the development of a measuring instrument – the sample themselves (the public), or industry experts.

Based on its excellent psychometric properties we assert that the SAFLS^{TM} is suitable for *general* application across many contexts to measure the level of a sample's Food Literacy. The application of Rasch analysis provided credible evidence for the quality of the psychometric properties of the instrument. However, further refinement must be undertaken before accurate and objective measurement of *individual* respondents can be claimed. For this purpose, the fairly large item pool of 95 items was intentionally kept for implementation in different contexts.

Our instrument is unique in the following aspects:

- the constructs were developed by a consensus process involving a wide range of food experts from academia, health professions, industry, business and the public sector;
- the scale targets a cross-section of the middle-income stratum of general public across all demographic groups;
- the scale consists of both general and context-specific items and is modular so that it is suitable for general application in different contexts.

The SAFLS^{TM} was developed for middle-income South Africans, but it can easily be adapted for application internationally by rephrasing a small number of items or by removing the last subscale in totality. The development of this scale represents an important step towards achieving a truly universal scale, for the following reasons: It is based on definitions and constituent subconstructs that were derived with deliberate methodology from expert opinions and it consists of a bank of items to operationalise those subconstructs which was rigorously validated both quantitatively and qualitatively. Furthermore, the bulk of the items are generic for middle-income application in multiple diverse contexts, and it provides examples of context-specific items which can be replaced depending on the context of use.

Ethical statement

The study adhered to, and approval received, from the Ethics Committee of the Faculty of Natural and Agricultural Sciences of the University of Pretoria with the reference number: 160318-009.

Implications for gastronomy

Being able to correctly ascertain the level of a person's level of food literacy has far-reaching applications in the world of gastronomy. Examples where the correct measurement of a person's level of food literacy is of paramount importance include intervention applications in the world of nutrition, such as those involved in aiding people who struggle with their health as a consequence of their day-to-day interaction with their food behaviour. It could also apply to the screening of applicants who may study in food-related fields, such as professional cooking, gastronomy, food management, nutrition, dietetics, general health and well-being; and determining the competency levels of workers wishing to enter food and hospitality related employment on various levels. The hospitality industry may also want to determine the level of food literacy of a particular segment of their clientele to validate their offerings against customer expectations; the food retail industry may use food literacy levels when determining packaging information; the food safety environment may similarly use specific levels of food literacy to determine how cognisant consumers are of food safety dangers; government, and food-aid organisations and others may use specific food literacy levels when promoting the transformation of food systems toward healthy and sustainable diets.

Credit author statement

Hennie Fisher: Conceptualization, Methodology, Data curation, Resources, Writing- Original draft preparation, Writing- Reviewing and Editing. Marietjie Potgieter: Conceptualization, Methodology, Software, Formal analysis, Instrument Validation, Writing- Original draft preparation, Writing- Reviewing and Editing, Visualization.

Declaration of competing interest

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report. The authors certify that the submission is original work and is not under review at any other publication. Both authors hereby declare equal contributed to the entire manuscript.

The authors wish to acknowledge the contributions of Prof Alet Erasmus and Annemarie Viljoen through their participation in the development of the definition, subconstructs and the generation of the initial pool of items. The authors would also like to thank Mr AB Heyns for his assistance with extensive language editing and proof reading.

Data availability

Data will be made available on request.

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Appendix A

Table 4
South African Food Literacy Scale™

	Item code	Item statement
Procurement	Pr04	Spirit vinegar contains alcohol. (N)
	Pr05	Imported food is an excellent choice. (N)
	Pr07	Whole spices can be stored indefinitely. (N)
	Pr09	Fresh fish can be refrigerated for one week. (N)
	Pr12	Meat with bones improves the flavour of soup and stews. (Y)
	Pr13	Over-fishing is a global problem. (Y)
	Pr15	Margarine and butter give the same quality baked goods. (N)
	Pr16	All chocolate contains sugar. (N)
	Pr17	The quality of red meat is indicated with a grading system. (Y)
	Pr18	Coconut milk is a dairy product. (N)
	Pr19	Brown eggs keep longer than white eggs. (N)
Financial	Fi01	All high-quality food is expensive. (N)
	Fi03	No-name brand food is low quality. (N)
	Fi04	Sugar beans are an affordable protein substitute. (Y)
	Fi06	Spinach stems can be used to make a dish. (Y)
	Fi07	Brown lentils can be added to mince to increase the volume of the dish. (Y)
	Fi08	Ready-to-eat food is economical. (N)
	Fi09	A drum of frying oil costs less per litre. (Y)
	Fi11	Fresh milk is always cheaper than long-life milk. (N)
	Fi13	Canned vegetables are better value for money than fresh vegetables. (N)
Consumption	Co03	It is better to use a serrated knife to cut fresh bread. (Y)
	Co05	Eggs at room temperature are better for baking. (Y)
	Co06	The cooking time in a microwave oven depends on the amount of food. (Y)
	Co07	Vegetables should be cooked with their skins on. (Y)
	Co09	Creamed eggs and sugar can be stirred into a hot mixture. (N)
	Co10	Lamb shanks are ideal for deep-frying. (N)
	Co11	Salt is only added to pasta after boiling. (N)
	Co12	Bread dough should be kneaded lightly. (N)
	Co13	Jelly powder should first be mixed with some cold water. (N)
	Co14	Melted ice cream can be successfully refrozen. (N)
	Co15	Cut avocado discolours. (Y)
	Co16	Mayonnaise contains oil. (Y)
	Co17	All types of rice should be washed before cooking. (N)
	Co19	Before frying eggs, the pan should be heated. (Y)
	Co22	The same amount of cake batter can be poured into any cake tin. (N)
	Co24	South African recipes indicate oven temperatures in degrees Fahrenheit. (N)
	Co26	All vegetables should be boiled with the lid on. (N)
	Co27	Popcorn can be made in the microwave oven. (Y)
	Co28	Height above sea level affects baking. (Y)
	Co29	A cake should be baked on the bottom shelf of a standard oven. (N)
	Co31	Cornflour can be mixed with boiling water. (N)
Nutrition	Nu01	The fibre in whole-wheat bread makes you fat. (N)
	Nu02	Vegetables should be cooked just before serving. (Y)
	Nu03	Brown rice releases energy slowly. (Y)
	Nu05	One could become overweight if one eats the incorrect foods. (Y)
	Nu06	All fruit juices are good for you. (N)
	Nu08	The body breaks down all vegetable fibres. (N)
	Nu09	Sunshine is needed for healthy bones. (Y)
	Nu11	All carbohydrates are bad. (N)
	Nu12	Oats porridge is more nutritious than corn flakes. (Y)
	Nu13	Peanuts are a source of protein. (Y)
	Nu14	All added food colours are bad. (N)
	Nu16	Salt is harmful. (N)
	Nu17	Brown sugar is healthy. (N)
	Nu20	It is recommended to drink more than 6 glasses of water per day. (Y)
	Nu21	Use oil sparingly when cooking. (Y)
	Nu23	When deep-frying, the oil temperature has health consequences. (Y)
	Nu25	It is recommended to eat five fruits and vegetables every day. (Y)
	Nu26	Root vegetables are unhealthy. (N)
	Nu27	Cooking vegetables in the microwave oven destroys the nutrients. (N)
	Nu28	Egg yolks are unhealthy. (N)
	Nu31	Chicken is sometimes plumped up with salt water. (Y)
	Nu33	It is important to eat a variety of foods daily. (Y)
	Nu34	Coffee creamer is a healthy milk substitute. (N)
	Nu35	No additional fat is needed when cooking regular mince. (Y)

(*continued on next page*)

Table 4 (*continued*)

	Item code	Item statement
Food Safety	FS05	Long life milk needs no refrigeration at all. (N)
	FS06	Adding spices to a stew will improve its storage life. (N)
	FS07	Food can be eaten after the sell-by date. (Y)
	FS08	Fish and chicken can be deep-fried in the same oil. (N)
	FS09	One should not stand in front of a microwave oven that is on. (N)
	FS10	Cool hot food in the fridge. (N)
	FS12	The same cutting board can be used to for cutting vegetables and chicken. (N)
	FS13	It is recommended to slowly warm up leftover stew in the warming drawer. (N)
	FS14	Use the lid of a pot to extinguish the flames of a burning pot of oil. (Y)
	FS15	Chips should be dried before deep-frying. (Y)
	FS17	Food can be defrosted in the microwave oven. (Y)
	FS20	Defrost chicken in lukewarm water. (N)
	FS21	Opened tinned food can be refrigerated in the tin. (N)
	FS24	Salting is a way to keep food longer. (Y)
	FS25	It is acceptable to taste and stir food with the same spoon. (N)
	FS26	Cooking kills all bacteria. (N)
	FS27	Meat can be kept outside the fridge for a day. (N)
Socio-cultural aspect	So03	Mabela is made from sorghum. (Y)
	So07	Vegetarians eat only fruits and vegetables. (N)
	So08	All Halaal foods are Kosher. (N)
	So09	Biltong is made from beef and game. (Y)
	So10	Curry powder is also called Garam Masala. (N)
	So12	All sushi is made with raw fish. (N)
	So13	A pita is a small pizza. (N)
	So19	Atchar is made from green mangoes. (Y)
	So20	Briyani is made with pasta. (N)
	So22	Bunny chow is made with brown bread. (N)
	So23	Yellow rice is served with bobotie. (Y)
	So24	Amasi can be used in baking. (Y)
	So25	Marshmallows can be eaten by people who do not eat animal products. (N)

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