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Assessing teaching quality in nutrition education: A study of two programs in the Netherlands and Australia

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ABSTRACT

The quality with which teachers deliver school-based nutrition programs may impact program effectiveness. The current study examined teaching quality of two programs, Taste Lessons (n = 15 Grade 6 and 7 teachers) and CUPS (n = 3 Year 3 and 4 teachers) via lesson observation using the Quality Teaching Model (QTM). Taste Lessons is a well-established Dutch program on healthy eating and CUPS is a novel Australian program that contains lessons in which nutritional content is integrated with mathematical concepts. The QTM evaluates three dimensions of teaching (Intellectual Quality, Quality Learning Environment and Significance), each containing six elements of classroom practice. Each element was coded using a 1–5 scale (1 – 'not evident' to 5 - 'highly evident') to describe the degree to which the lesson exhibits high levels of the element. Both programs were of moderate to high teaching quality and lowest scores were observed for *Metalanguage, Student direction, Cultural knowledge* and the use of *Narrative*. The QTM can be an effective tool to assess the teaching quality of nutrition education programs by examining classroom practice.

1. Introduction

Schools are considered an ideal ground for providing early nutrition interventions to improve children's nutrition knowledge, eating habits and to prevent obesity (Dudley, Cotton & Peralta, 2015; Graziose et al., 2017). As such, numerous nutrition programs have been implemented in schools and subsequently evaluated for their effect on children's health-related outcomes (Evans et al., 2012; Micha et al., 2018). Nutrition education programs in schools have demonstrated moderate effectiveness for increasing nutrition knowledge (Cotton et al., 2020; Dudley et al., 2015), improving fruit and vegetable intake (Evans et al., 2012; Silveira et al., 2011), and reducing total energy intake (Cotton et al., 2020).

Primary school teachers play a key role in providing nutrition education. Effective nutrition education depends heavily not only on program quality, but also on the delivery by the teachers in charge of implementing these programs. Previous research found that the quality of classroom practice was positively associated with students' scores for academic tests (Gore et al., 2021; Ladwig et al., 2007), highlighting the importance of assessing teaching quality. Investigating the quality of teaching may help explain the variability in impact of nutrition education on children's nutrition related outcomes, their learning experiences and benefits, but also can be used to evaluate practices or content that need improving and to identify educational gaps. Several models have been designed to evaluate teaching quality, each with varying strengths of statistical relationships with improved student learning (Kane & Staiger, 2012). One such model that has been used over time in research to identify positive student outcomes is the Quality Teaching Model (QTM) (Gore et al., 2021; NSW Department of Education & Training, 2006). This comprehensive pedagogical framework was designed to guide evaluation of classroom practices and can be used to understand, support, or (re)design lessons and activities. The QTM,

Abbreviations: QTM, Quality Teaching Model; CUPS, Cross-curricular Unit on Portion Size; AGHE, Australian Guide to Healthy Eating; NSW, New South Wales; PDHPE, Personal Development, Health and Physical Education.

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Table 1
Program description.

	Taste Lessons	Cross-curricular Unit on Portion Size (CUPS)
Lesson duration	50 min	40 min
Age category	9–11 years old	8–10 years old
Component	Non-integrative/traditional	Integrative learning (nutrition and mathematics)
Topic	Organic and conventional food production	Healthy eating, food groups, portion/serve sizes, volume measurements
Learning goals	The students: • Learn about organic farming • Can describe a few characteristics of organic farming, for example not using synthetic chemical fertilizers but green manure, or not using herbicides or pesticides • Have an opinion about organic farming • Recognize different logos for organic farming, such as the Australian Certified Organic logo; the National Association for Sustainable Agriculture Australia logo and the Demeter (Bio-dynamic) logo	Students learn to: • Identify food groups, serve sizes, the number of recommended daily serves, nutritional label information, volume of sugar in foods • Estimate, measure and compare quantities of food and serve sizes, and revise a portion • Be able to use cubes and food models to compare and estimate serve sizes • Understand that a portion size "cube" can be measured in a formal unit and convert cubes to cups and back • Identify a serve size of a particular food and estimate what that is in cups • Create lunch boxes that have positive food choices in relation to food serve sizes and explain reasoning
Materials	Lesson description, worksheets, cucumbers	Food models, mathematics cubes, a set of measuring cups, AGHE posters and brochures, plastic containers, lesson plans, presentation slides and worksheets
Description	A lesson about differences between organic and conventional food production. Children discussed different arguments and applied their learned knowledge in a debate activity, followed by a fun tasting activity with regular and organic cucumbers	Lessons involved learning about the AGHE and how to measure the standard serve size recommendations using mathematics cubes. Children were taught about sugar content of foods and how to read nutrition labels on food products. The final lesson required the children to create their own healthy lunchbox in line with the healthy eating guidelines
Delivered by	Teacher	Teacher
Training/support	No training	Half-day professional development workshop
Country	The Netherlands	Australia

developed in 2003 in New South Wales (Australia), has three dimensions (Intellectual Quality, Quality Learning Environment and Significance) and 18 elements (explained in the method section below, see Table 2). To the best of our knowledge, the quality of lessons taught as part of nutrition education programs has not been evaluated.

Defining and measuring teaching quality is complex with lack of an internationally accepted measures, resulting in different and often sub-optimal results (Coe et al., 2014; Rowan et al., 2015). However, research on existing tools or measures used to assess quality teaching, including the QTM, seems to agree that classroom observations are valuable and reliable (Kane & Staiger, 2012). In the current study we investigate teaching quality of two nutrition education programs using classroom observations as measurement method. The QTM was deemed most appropriate given its robust and evidence-based approach. Additionally, Collin (2017) described the QTM as 'the lens with which we can evaluate the quality of teaching practice across our school settings, stages and subject areas', indicating the model is applicable across settings and school subjects (Collin, 2017). This is particularly useful as we are interested in whether nutrition programs that differ in their educational approach (traditional versus integrative), cultural background, context and content address different elements of the QTM. Hereon, two programs that vary in approach were purposively selected.

Taste Lessons is a proven successful nutrition education program. Previous studies on its effectiveness found a significant increase in nutrition knowledge in primary school children who participated in the program (Battjes-Fries et al., 2015; Verdonschot et al., 2020). Although the success of the program is based on research evidence, implementing nutrition education comes with several challenges. Teachers indicate a lack of time as the main barrier for teaching nutrition, and a lack of resources and long-term sustainability as additional reasons for not being able to implement nutrition education (M. C. Battjes-Fries et al., 2016; de Vlieger et al., 2019).

The Cross-curricular Unit on Portion Size (CUPS) program is a novel program that integrates mathematics content into nutrition lessons. Findings from a pilot cluster randomised controlled trial have demonstrated program effectiveness for student nutrition knowledge, but not for portion size estimation skills (B. M. Follong et al., 2021). Integrative teaching strategies were used as previous literature suggested that integration, particularly with core curricular subjects (e.g., mathematics), could potentially reduce time barriers that teachers experience in teaching nutrition (B. M. Follong et al., 2021; Jones & Zidenberg-Cherr, 2015; Love et al., 2020; Perera et al., 2015).

To gain insight into the teaching quality of nutrition education programs, the current study examined the quality of delivery for the two aforementioned primary school-based nutrition education programs). This paper attempts to answer the following two research questions 1) *What is the teaching quality of the two nutrition education programs according to the Quality Teaching Model*? and 2) *How can the Quality Teaching Model be used to improve nutrition education programs in schools?* To answer these questions, the QTM has been used to unpack the quality of classroom teaching of the two programs using observation of the lessons that were delivered by the teachers.

2. Methods

2.1. Study design and programs

An observational study design was used to assess teaching quality of the two nutrition programs (see Table 1 for program descriptions).

The program Taste Lessons was developed in 2006 in the Netherlands and consists of five lessons for each grade, discussing various topics in relation to five themes: 'taste', 'nutrition and health', 'cooking', 'food production' and 'consumer skills', including several activities such as tasting and cooking experiments (Steunpunt Smaaklessen & EU-Schoolfruit September, 2020). In the period from January 2017 to June 2020, 5000 out of the total 7000 Dutch primary schools implemented lessons from the Taste Lessons program, which showed to be successful in improving children's nutrition knowledge (Battjes-Fries et al., 2015; Verdonschot et al., 2020). For the current study only one lesson, the Cucumber debate, out of the total five lessons was chosen for teaching quality observation. This lesson was selected as a previous evaluation study found that it was most frequently implemented in the classroom by teachers who were provided with all five program lessons (Verdonschot et al., 2020). During this lesson, children learn about the differences between conventional and organic food production, taste regular and organic cucumbers and substantiate and defend their point of view in a debate. Materials include a booklet including the lesson description, cucumbers for the taste activity (organic and conventional)

and two worksheets for each student. One worksheet was for the taste activity to note the differences between conventional and organic cucumbers looking at price, way of production and their senses, and the second worksheet includes guidelines and discussing points on organic and conventional food production that can be used for the debate activity. In total 15 observations of this lesson were conducted amongst different teachers and classes in the Netherlands.

For the CUPS program, lesson observations were embedded within a pilot cluster randomised controlled trial which was shown to be effective in increasing children's nutrition knowledge, but with no significant improvements in portion size estimation skills (B. M. Follong et al., 2021). The program included multiple cross-curricular lessons on mathematics and portion size estimation. Six lessons were designed to teach primary school children about healthy eating, food groups, portion and serve sizes, and volume measurements. Furthermore, content was aligned with the New South Wales (NSW) K-10 syllabus for mathematics and Personal Development, Health and Physical Education (PDHPE). Resources and education materials included mathematics cubes, measuring cups, food models (e.g., food model of an apple) and the Australian Guide to Healthy Eating (AGHE) (National Health & Medical Research Council., 2017). The recent protocol paper describes the methodologies used, and outlines the lesson content, sequence, and learning outcomes in more detail (Follong et al., 2020). Since the CUPS observations were part of a larger RCT, the methodology differs slightly from Taste Lessons. For example, the observations of the current study include several CUPS lessons delivered by only three teachers whereas only one lesson of Taste Lessons was delivered by 15 teachers. The CUPS program was implemented in two schools in a regional metropolitan area in Australia by three teachers who delivered six lessons each as part of the program. Quality teaching data was collected for at least five lessons per teacher, resulting in a total of 16 classroom observations. It needs to be acknowledged that the two programs cannot be directly compared due the different content, setting and level of development (e.g., nutrition content only in the Netherlands implemented since 2006 versus nutrition integrated with mathematics content in Australia developed in 2019). However, it is chosen to present and discuss the two programs together to enhance readability, to provide insight in differences between the two programs and how these can be measured using the QTM.

2.2. Study sample and procedure

The current study included primary school teachers (in the Netherlands: Grade 6 and 7, in Australia: Year 3 and/or 4) and their students (aged 8–11 years). In the Netherlands, schools were invited to participate in the study through advertisement of the study on social media, in the Taste Lessons newsletter and website (in Dutch: smaaklessen.nl) (Steunpunt Smaaklessen & EU-Schoolfruit September, 2020). Interested teachers were requested to send an email to the research team. The observations were conducted in the period of 2019–2021, which was a longer period than originally anticipated because planned visits were cancelled or postponed due to COVID-19-restrictions.

In Australia, schools were contacted by phone or email. Out of five consenting teachers, three teachers and their students were randomly allocated to the CUPS intervention group. Consent was sought from the principals, teachers, and students. The quality teaching observations for this group took place during the entire program period (October till December 2019).

For both programs, researchers visited participating schools to observe the lessons, on a day and time suggested by the teachers. The research team consisted of MSc and PhD students with a degree in nutrition and public health (n = 5 and n = 2, respectively) from either Wageningen University & Research (The Netherlands) or University of Newcastle (Australia). All researchers were trained through University of Newcastle by an experienced team on the use of the QTM for observing and evaluating teaching quality. This training involved 14 h of activities including watching, coding and discussing several pre-recorded videos, discussion of allocated scores, and rating agreement with statements on a scale from one to five for each of the 18 elements of teaching quality evaluated by the QTM.

The Dutch study on Taste Lessons was approved by the Social Science Ethical Committee (SSEC) from Wageningen University and Research (CoC nr: 09,215,846) and the Australian study on CUPS obtained ethics approval from the University of Newcastle (H-2018–0492) and the Catholic Diocese of Newcastle-Maitland in NSW, Australia.

2.3. Measures and outcome variables

The teaching quality of the two programs has been assessed by means of classroom observations based on the QTM, an evidence-based pedagogical framework that focuses on the improvement of student learning (Ladwig & King, 2003; Newmann, 1996). The QTM has already been widely implemented in Australia and has been found to be an appropriate model to discuss teaching practices across subjects and student levels (Gore & Rosser, 2020; Gore et al., 2017). Findings from a recent statewide study found improved student outcomes when the model was combined with a professional development program called Quality Teaching Rounds (Gore et al., 2021).

The QTM differentiates the following three dimensions: 1) Intellectual Quality, 2) Quality Learning Environment, and 3) Significance, with each dimension consisting of six elements, resulting in a total of 18 elements (see Table 2). Elements within the *Intellectual Quality* dimension focus on generating deep understanding of important, substantive concepts, skills, and ideas during the lessons. The *Quality Learning Environment* dimension focuses on creating productive environments in classrooms, with each element clearly targeting student learning (NSW Department of Education & Training, 2006). The third dimension, *Significance,* refers to pedagogy that supports meaningful learning for students by drawing connections between prior knowledge of the students and contexts outside the classroom (NSW Department of Education & Training, 2006).

Further information on the QTM can be found in NSW Department of Education and Training (2006, 2020) and Gore (2007) (Gore, 2007; NSW Department of Education & Training, 2006; NSW Department of Education & Training, 2020). A 1–5 coding scale was used for each element, with a score of '5' indicating the element is highly evident and a score of '1' meaning there is little to no evidence for the element in classroom practice. For each element, a coding scale was provided that includes a descriptor for each score distinguishing the relative presence of the element. The descriptor states observable aspects of the classroom practices such as the number of students (none, some, most, all) and the duration (none of the time, through to all of the time) (NSW Department of Education & Training, 2020).

For the Taste Lesson program, all lessons were observed by a single research assistant. In contrast, the CUPS lessons were observed by a team of three researchers with both individual and joint observations, with the maximum of two observers. Whenever possible based on availability of the research team, joint observations were conducted to enhance objectivity of the outcome measures. Nine joint observations involved lessons being coded by each observer individually, with final coding negotiated until agreement was reached for each of the elements. Subsequently, inter-rater reliability for the scores of the joint observations were calculated for the CUPS teaching quality only.

The data on the mean quality score of the Taste Lessons observations was divided into quartiles. The four observations of the lowest quartile were further investigated by describing the elements that scored lower than average (mean for all observations of that element) to get more insight into the elements that need improvements and enhance overall teaching quality.

As the CUPS program contains several lessons delivered by three teachers, observations represented a range of different lessons per

Table 2
The dimensions and elements of the Quality Teaching Model (Quality Teaching Academy, 2021).

Dimensions	Elements	Explanation
Intellectual Quality	Deep knowledge	To what extent is the knowledge being addressed focused on a small number of key concepts and the relationships between and amongst concepts?
	Deep understanding	To what extent do students demonstrate a profound and meaningful understanding of central ideas and the relationships between and amongst those central ideas?
	Problematic knowledge	To what extent are students encouraged to address multiple perspectives? To what extent are students able to recognise knowledge as constructed and therefore open to question?
	Higher-order thinking	To what extent are students regularly engaged in thinking that requires them to organise, reorganise, apply, analyse, synthesise and evaluate knowledge and information?
	Metalanguage	To what extent do lessons explicitly name and analyse how language functions? To what extent do lessons provide frequent commentary on language and its use in varying contexts?
	Substantive communication	To what extent are students regularly engaged in sustained conversations (in oral, written or artistic forms) about the ideas and concepts they are encountering?
Quality Learning Environment	Explicit quality criteria	To what extent are students provided with explicit criteria for the quality of work they are to produce? To what extent are those criteria a regular reference point for the development and assessment of student work?
	Engagement	To what extent are most students, most of the time, seriously engaged in the lesson? To what extent do students display sustained interest and attention?
	High expectations	To what extent are high expectations of all students communicated? To what extent is conceptual risk-taking encouraged and rewarded?
	Social support	To what extent is there strong positive support for learning and mutual respect amongst teachers and students and others assisting students' learning? To what extent is the classroom free of negative personal comment or put-downs?
	Students' self-regulation	To what extent do students demonstrate autonomy and initiative so that minimal attention to the disciplining and regulation of student behaviour is required?
	Student direction	To what extent do students exercise some direction over the selection of activities related to their learning and the means and manner by which these activities will be done?
Significance	Background knowledge	To what extent do lessons regularly and explicitly build from students' background knowledge, in terms of prior school knowledge, as well as other aspects of their personal lives?
	Cultural knowledge	To what extent do lessons regularly incorporate the cultural knowledge of diverse social groupings?
	Knowledge integration	To what extent do lessons regularly demonstrate links between and within subjects and key learning areas?
	Inclusivity	To what extent do lessons include and publicly value the participation of all students across the social and cultural backgrounds represented in the classroom?
	Connectedness	To what extent do lesson activities rely on the application of school knowledge in real-life contexts or problems? To what extent do lesson activities provide opportunities for students to share their work with audiences beyond the classroom and school?
	Narrative	To what extent do lessons employ narrative to enrich student understanding?

teacher, rather than one lesson delivered per teacher. Therefore, analysing quartiles was not possible for this program.

For the Taste Lessons program, characteristics of the participating schools and teachers were collected using a questionnaire for the teacher which was administered after the program. Questionnaire items included school type (religious/public), teaching experience (in years) and sex. CUPS baseline characteristics were collected through student questionnaires and teacher interviews.

3. Results

3.1. Demographic characteristics

The characteristics of the participating schools, teachers and children are summarised in Table 3. In the Netherlands, a total of 15 teachers implemented the Cucumber debate lesson from the Taste Lessons program. The majority of teachers was female (60%) with a mean teaching experience of 12.6 years. In total, 322 children participated with more boys (54%) than girls, and with a mean class size of 21.5 children. Of the Dutch schools, most followed a religious principle (10 out of 15), were of medium size with 150–400 students (7 out of 15) and located in a town (7 out of 15). CUPS was implemented by three teachers employed at two different Catholic schools. All participating teachers were female and had a mean experience of nine years in teaching several primary school levels. In total 79 consenting children participated in the CUPS program. Less than half of these children (49%) identified themselves as girls.

3.2. Teaching quality of the two nutrition programs

The mean scores for the dimensions and elements of the QTM are listed below for each program (see Table 4). High inter-rater reliability was found for the separate scores of the observers (ICC 0.93, 95% CI 0.91–0.95).

Table 3
Descriptive statistics of the schools, teachers, and children.

	Taste Lessons	CUPS
Schools (n = 17)	15	2
Sector, n		
Public	5	0
Religious	10	2
Location, n		
City (>100.000 citizens)	4	2
Small city (10.000–100.000 citizens)	4	0
Town (<10.000 citizens)	7	0
Teachers (n = 18)	15	3
Male, n (%)	6 (40)	0 (0)
Teacher experience (years), mean (SD)	12.6 (8.6)	9 (8.7)
Children (n = 401)	322	79
Boys, n (%)	174 (54)	40 (51)
Class size, mean (SD)	21.5 (4.6)	26.3 (2.3)

3.2.1. Intellectual Quality

Regarding Intellectual Quality, Taste Lessons scored a mean of 3.9 (SD: 0.7), and had scores ranging from 2.8 (SD: 0.7) for *Metalanguage* to 4.8 (SD: 0.4) for *Deep knowledge*.

CUPS scored a mean of 2.9 (SD: 0.9) with scores ranging from 1.5 (SD: 0.5) for *Problematic knowledge* to 3.8 (SD: 1.0) for *Deep knowledge*. The mean score of 1.6 for *Metalanguage* indicates that the lessons involved little to no discussion about words, symbols, images and how text works (NSW Department of Education & Training, 2006). When *Problematic knowledge* is scored low, knowledge is not treated as a body of information that is open to question and is not subject to cultural,

Table 4
Observation scores for the dimensions and elements per program.

Dimension/ Element		
Intellectual Quality	Taste Lessons, Mean (±SD) (15 observations)	CUPS, Mean (±SD) (16 observations)
Deep knowledge	4.8 ± 0.4	3.8 ± 1.0
Deep understanding	3.5 ± 0.7	3.3 ± 0.8
Problematic knowledge	4.2 ± 1.0	1.5 ± 0.5
Higher-order thinking	3.5 ± 0.6	3.4 ± 0.8
Metalanguage	2.8 ± 0.7	1.6 ± 0.7
Substantive communication	4.7 ± 0.6	3.6 ± 1.0
Total	**3.9 ± 0.7**	**2.9 ± 0.9**
Quality Learning Environment		
Explicit quality criteria	2.9 ± 1.2	2.4 ± 0.8
Engagement	3.9 ± 0.8	3.5 ± 0.7
High expectations	3.8 ± 0.8	3.6 ± 1.1
Social support	4.3 ± 0.8	3.9 ± 0.8
Students' self-regulation	3.5 ± 0.7	2.8 ± 0.7
Student direction	1.1 ± 0.3	1.1 ± 0.2
Total	**3.3 ± 1.1**	**2.9 ± 0.9**
Significance		
Background knowledge	4.2 ± 0.9	3.1 ± 1.1
Cultural knowledge	1.0 ± 0.0	1.1 ± 0.3
Knowledge integration	2.3 ± 0.5	2.7 ± 0.9
Inclusivity	4.8 ± 0.4	4.8 ± 0.6
Connectedness	4.3 ± 0.8	3.1 ± 0.9
Narrative	2.1 ± 0.7	1.1 ± 0.3
Total	**3.1 ± 1.4**	**2.6 ± 1.3**
All elements	**3.42 ± 1.1**	**2.79 ± 0.6**

social and political influences (NSW Department of Education & Training, 2006).

3.2.2. Quality Learning Environment

The mean score of Taste Lessons was 3.3 (SD: 1.1) and ranged from a 1.1 (SD: 0.3) for *Student direction* to a 4.3 (SD: 0.8) for *Social support*.

CUPS scored a mean of 2.9 (SD: 0.9), with a lowest score of 1.1 (SD: 0.2) for *Student direction* and the highest score for *Social support* with a 3.9 (SD: 0.8). When *Student direction* is scored low, students exercise no control over class activities and the teacher decides what the students do for how long and when (NSW Department of Education & Training, 2006).

3.2.3. Significance

Taste Lessons resulted in a mean score of 3.1 (SD: 1.4) and ranged from a 1.0 (SD: 0) for *Cultural knowledge* to a 4.8 (SD: 0.4) for *Inclusivity*.

CUPS scored a mean of 2.6 (SD: 1.3), ranging from a 1.1 for both *Narrative* and *Cultural knowledge* (SD: 0.3 for both) to a 4.8 (SD: 0.6) for *Inclusivity*. Low scores for *Cultural knowledge* mean that teachers and students only discussed the lesson content through the scope of the dominant culture. In addition, low scores for *Narrative* indicate that the CUPS lessons did not include a narrative or the narratives were disconnected from the content of the lessons (NSW Department of Education & Training, 2006).

3.3. Differences within Taste Lessons observations

When looking at Taste Lessons only, the median score of all observations and all the 18 elements of the QTM was high, namely 3.95 with an inter quartile range of 3.63–4.23. The elements that scored lowest (compared to mean scores from all observations) from observations in the lowest quartile ($n = 4$) included: *Deep understanding* (mean: 3.3, compared to a mean of 3.5 including all observations), *Higher-order thinking* (mean: 3.3, compared to a 3.5), *Social support* (mean: 3.8, compared to a 4.3), *Students' self-regulation* (mean: 3.0, compared to a 3.5), and *Background knowledge* (mean: 3.8, compared to a mean of 4.2 based on all observations).

4. Discussion

4.1. Main results

The aim of the current study was to explore the teaching quality of two different nutrition education programs with the QTM. Results indicated that Taste Lessons and CUPS had quality teaching scores that were moderate to high for the observations as a whole and for all three dimensions individually (Intellectual Quality, Quality Learning Environment, Significance).

Earlier studies using the QTM to observe core school subjects (e.g., English, mathematics) in Year 3 and 4 classrooms found a lower mean score than the current study (mean previous research: 2.62, mean Taste Lesson: 3.42, mean CUPS: 2.79) (Gore et al., 2017). As classroom teaching involved core curricular subjects, these lessons were not as novel for the teachers and children compared to the nutrition lessons taught in the current study. The fact that the teachers who participated in the current study on nutrition education participated voluntary, they may have had greater interest and enthusiasm about implementing the lesson. This may explain why results of the current study are higher than previous studies using the QTM framework. This latter is potentially also the case for the children, as they are not used to receiving lessons on nutrition and may have been more excited and interested in the lesson compared to the lessons of core curriculum subjects.

Differences in findings for Taste Lessons compared to CUPS may be explained by several factors. Firstly, Taste Lessons was developed in 2006 with evidence already confirming it is an effective program for increasing nutrition knowledge in primary school children. The program has been implemented by 5000 out of the total 7000 Dutch primary schools and can be considered as a best practice. It is therefore expected that this lesson would have been refined over time as result of previous research and implementation enhancements by the program developers and users (Battjes-Fries et al., 2015; M. C. Battjes-Fries et al., 2016; Steunpunt Smaaklessen & EU-Schoolfruit September, 2020). In contrast, CUPS was a novel program that was first implemented in 2019. No enhancements have been made yet due to research outcomes only recently been evaluated. The fact that Taste Lessons scored higher was therefore not surprising. Future research on the CUPS is needed to further develop the program and improve teaching quality.

Additionally, Taste Lessons' main focus was on increasing knowledge about food production through a lesson on organic and conventional cultivation. High scores for *Deep knowledge* were therefore expected. CUPS scored (slightly) higher on *Knowledge integration* than Taste Lessons as expected, which can be explained by the cross-curricular teaching strategies used.

Nevertheless, it should be noted that the programs used a different approach, content, and were implemented in two different countries. It is therefore important to note that the results of these two programs cannot be directly compared as the setting was likely to have influenced results. Future research is therefore recommended to further explore the cultural impact on teaching quality of the programs, by implementing the same programs in the two countries and comparing results. This is likely to be feasible in the future (post-COVID-19 restrictions).

Due to the limited ability to compare the programs, the following sections (4.2–4.4) discuss the two lowest elements per dimension for both programs and provide suggestions to improve the quality teaching scores.

4.2. Intellectual Quality

Considering the Intellectual Quality, Taste Lessons scored lowest on *Metalanguage, Deep understanding* and *Higher-order thinking*, with the latter two elements having the same score. The teacher presented logos for organic food production in class, but *Metalanguage* could become more evident if for example symbolic features of these logos and related definitions were identified and clarified with students (NSW Department of

Education & Training, 2006). Regarding *Deep understanding* and *Higher-order thinking*, mixed results were observed where some students understood a substantial portion of the lesson and students performed some *Higher-order thinking* during the debate activity. The QTM suggests planning sufficient time within a lesson or across a sequence of lessons for students to demonstrate *Deep understanding* and extend student thinking beyond recall by using follow-up questions such as: 'Why would you say that?', 'How does this compare with previous comments?' and 'What might be the result if we change the context?' (NSW Department of Education & Training, 2006).

Within the CUPS program, the lowest mean score was observed for the element on *Problematic knowledge.* All lessons used an integrative approach that included both mathematical and nutrition concepts. Mathematics content confers less flexibility in terms of discussing principles from multiple, contrasting or conflicting, perspectives. As the nutrition content was based on the AGHE, students were taught how to interpret and use the healthy eating guidelines (National Health & Medical Research Council., 2017). The guidelines provide information on the amount of food recommended per age group and gender. These recommendations are fixed and leave little room for discussion. Although teachers could have discussed the fact that these recommendations are a guide only and differ based on personal characteristics, they may have not felt comfortable discussing this due to their limited nutrition background knowledge. The above could therefore explain the low scores for *Problematic knowledge* within the CUPS program. Particularly for the nutrition content, improvement should be made regarding the inclusion of nutrition information that supports teachers to open up discussions on multiple perspectives and solutions. Similar to Taste Lessons, CUPS scored low on *Metalanguage*. Attention could have been drawn to the symbols within the AGHE or the difference in meaning between serve and portion size in order to improve the score for *Metalanguage*.

4.3. Quality Learning Environment

Within the Quality Learning Environment dimension, both programs scored lowest on *Student direction* and *Explicit quality criteria*. Low *Student direction* can be explained by the fact that the teachers delivered the lessons as described in the lesson guidelines that were provided by the researchers. Lesson guidelines and activities did not allow for students to control many aspects (e.g., timing, pace, assessment criteria or choice of activities) of the lessons. *Student direction* could become more evident in classrooms by incorporating scaffolded choices within activities, for example tiered activities with multiply entry and exit points so students can determine what challenges they can meet (NSW Department of Education & Training, 2006). For Taste Lessons, the results for *Explicit quality criteria* were probably not as high, as the teacher followed the lesson description, where it was not explicitly listed to address detailed criteria regarding the quality of work. Teachers who implement the Cucumber debate lesson could score higher on this element by providing students with clear criteria that explicitly describes the quality of work expected (NSW Department of Education & Training, 2006). The CUPS lesson plans included success criteria for the teachers to assess their students' progression and achievements. Although the teachers may have used these criteria to check their students' work, they might have not discussed these with their students. Providing students with explicit criteria at the start and throughout the lesson and for students to check their work might contribute to the scoring of *Explicit quality criteria*.

4.4. Significance

Taste Lessons scored lowest on *Cultural knowledge* and *Narrative.* The fact that *Cultural knowledge* was not evident in the lesson implies that the lesson does not include any cultural content of diverse social groups. Teachers could incorporate *Cultural knowledge* into this lesson by considering how these types of food production reflect and value diversity and including the practices of social groups (NSW Department of Education & Training, 2006). It is also recommended that lesson plans to support teachers be amended with the inclusion of appropriate cultural substance. The low score for *Narrative* means teachers did not include many stories that were written, told, read, viewed or listened to help illustrate knowledge on food production in the classroom, which could move the evidence of *Narrative* to a higher level (NSW Department of Education & Training, 2006).

Similarly, CUPS produced low scores for both elements on *Narrative* and *Cultural knowledge. Narrative* could easily be incorporated by linking the nutrition content to personal experiences and stories that bring the substance alive. Teachers could prepare stories in advance or plan several opportunities for students to construct their own (NSW Department of Education & Training, 2006). Moreover, teachers were provided with the AGHE for Aboriginal and Torres Strait Islander people but may have not used these resources to explore differences in cultures and social groups. Lesson plans therefore need to explicitly refer to these cultural guides in order to enhance the reflection on and value of diversity within the CUPS activities.

4.5. Differences within Taste Lessons observations

The quartile division of the Taste Lessons resulted in different elements with lower scores than found in results of all observations. This may be explained by several factors. When reporting the mean teaching quality for all observations, findings describe the overall score for the lesson and take into account variation between observations. In contrast, findings on the lowest elements for the lower quartile lessons may highlight quality teaching scores that were low for particular teachers. The lesson description can be seen as a constant factor as all teachers received the same lesson description. It is therefore understandable that one element related to the lesson description is coded low on all observations. For example, the element *Cultural knowledge* scored for all observations a ''1", as it was not included in the lesson description, whereas the element *Social support* is not a particular part of the lesson description but is more dependant of teaching style and atmosphere within the classroom. In addition, the observations were all with different teachers ($n = 15$), meaning the differences within the lessons may be influenced by the teacher. Firstly, even while teachers may understand the importance of nutrition education, teachers may not feel prepared to deliver nutrition-related instructions (Blom-Hoffman et al., 2004; Cho & Nadow, 2004). Notably, research found that teachers without nutrition background or skills deliver nutrition information less often compared to teachers who do have a nutrition background (Cho & Nadow, 2004; Prelip et al., 2012).

In the current study, only one out of five lessons of the Taste Lessons program was selected. Lower scores in one lesson may be balanced by higher scores in the remaining lessons and vice versa. For example, the debate activity in the lesson may result in higher scores for *Substantive communication*, compared to another lesson of Taste Lessons which includes a cooking activity in class. Future studies on teaching quality of Taste Lessons should therefore include results of all the lessons to draw conclusions on the program as a whole, instead of just one lessons like the current study.

4.6. Strengths and limitations

Strengths of the current study were the fact that it was innovative to assess the teaching quality of nutrition programs with the QTM and observations to explore practice delivery. The QTM is a synthesis of reliable research that empirically links qualities of pedagogy to improve student learning (NSW Department of Education & Training, 2006). This model has been widely implemented in Australia within both research and classroom settings. Furthermore, observational data assessing quality of delivery is considered to be more accurate due to higher objectivity, than data collected through self-reported questionnaires (Dusenbury et al.,

2003). While the two programs were observed by a different team of researchers (Dutch versus Australian), all researchers followed identical training sessions on the QTM prior to data collection. Furthermore, joint observations of the CUPS lessons involving both independent evaluation and joint discussions of two researchers improved objectivity. Besides, high inter-rater reliability (ICC 0.93, 95% CI 0.91–0.95) indicated high similarity between results of the two observers.

There are several limitations that need to be acknowledged. First, the total 31 observations across two different programs cannot be compared due to different methodologies (i.e., number of lesson observations per teacher), meaning conclusions are only based on 15 (Dutch) or 16 (Australian) observations. Secondly, it is likely that only a selective group of highly motivated teachers participated in this study, as nutrition education is not mandatory in schools in both countries and the teachers participated on a voluntary base. This may have reduced external validity of the current study due to low generalizability. Teachers with less familiarity with- and interest in nutrition may score lower on quality teaching due possibly to lower background knowledge. Future studies with a larger and more representative sample are therefore recommended. Contrary to the CUPS observations, teaching quality for the Taste Lessons program should be assessed using joint observations in order to promote objective examination. Nevertheless, the observation notes of the lesson of Taste Lessons from the observer were coded separately by a second researcher and scores were discussed to obtain an agreed code. The fact that the CUPS program involved multiple lessons as part of a coherent teaching unit, scores vary across these lessons and may therefore limit the ability to draw strong conclusions on the overall teaching quality. In addition, previous studies on the QTM framework included student learning (e.g., academic test results) as an outcome to assess the effect of the quality of the practical delivery (Gore, 2018; Gore et al., 2017). The current study did not include student outcomes due to lack of time and resources, and its aim being to initially explore the program delivery. However, it may still be of interest to include student outcomes in the future to draw firmer conclusions on teaching quality of nutrition programs for student outcomes. Future research on the effect of nutrition education on student learning with the QTM is therefore recommended.

5. Conclusion and recommendations for future research and practice

The current study was the first study that examined teaching quality of nutrition programs using the QTM. It can be concluded that the QTM can be used as a tool to assess teaching quality within different countries. Even though the results of both programs are not directly comparable due to differences in program content, setting, country and methodologies, the results for each program individually are still valuable. The findings show how different scores for teaching quality can be explained by differences in programs and methodologies and how each program needs its own strategy for improvement. This highlights the versatile use of the QTM within the unexplored research field of nutrition education. Based on the observations, both the Taste Lessons and CUPS program demonstrated a good teaching quality. However, there is room for improvement, particularly for the elements on *Metalanguage, Student direction, Cultural knowledge* and *Narrative*. It is recommended that teachers and nutrition program implementers; 1) identify language or symbolic features that are essential for developing deep understanding of the key concepts of the lesson, 2) incorporate choices within the learning activities so that the students are provided with opportunities to exercise control, 3) provide opportunities, where appropriate, for students to explore different social groups and value diversity, and 4) include narrative as a powerful tool, such as stories written, told, read, viewed or listened to, to help the students understanding the concept of the lesson (NSW Department of Education & Training, 2006). These practical recommendations are based on the generally lower scores on *Metalanguage, Student direction, Cultural knowledge*, and *Narrative* observed in the observed programs. While the findings show that these two nutrition education programs are of moderate to high teaching quality, more research is needed to further confirm these conclusions. Especially on the novel CUPS program as this was based on a sample of three teachers across two primary schools. To investigate the teaching quality of the Taste Lessons, it is essential to conduct observations for all the five lessons of the program rather than one. Moreover, future studies evaluating programs are recommended to use the same methodology to be able to compare results and draw strong conclusions. Enhancing teaching quality may benefit student learning, with future trials being paramount to support this claim. Researchers are encouraged to use this QTM and the observational approach, and to examine student learning as this may result in firmer conclusions on program quality (Gore, 2018; Gore et al., 2017).

Data availability statement

The data presented in this study are not publicly available due to privacy and ethical restrictions.

Author contributions

A.V. and B.M.F. formulated the research questions, designed the study, collected, and analysed the data and wrote the article. E.d.V. and A.H.-N assisted with designing the study in the Netherlands and C.E.C., E.P, A.M. and T.B. assisted with designing the study in Australia. All authors assisted in writing the article and have read and agreed to the published version of the manuscript.

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Declaration of Competing Interest

The authors declare no conflict of interest.

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