International Journal of Educational Studies
Volume 8, Issue 4, pp. 99-124
2025

Perceived Service Quality and Students' Satisfaction and Recommendation Willingness in Higher Education: Justification of a Formative Measurement Approach Using PLS-SEM

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ABSTRACT: *The aim of this study is to present and test a holistic measure of service quality in higher education (HE), specified as a second-order formative-formative measurement model, challenging the inherent assumption of an underlying reflective measurement model. The study further analyzes the effect of perceived service quality on students' satisfaction and students' willingness to recommend. We empirically tested our model using secondary data collected through the National Student Enquiry (NSE). We selected data for universities in the Netherlands, containing a net sample of 45,149 undergraduate students. PLS-SEM was used to analyze, evaluate, and validate a second-order formative-formative measurement model for HE service quality and its impact on students' satisfaction and willingness to recommend the university. The findings reveal that the antecedent structure of the second-order measurement model for service quality is theoretically and empirically supported. Our results further indicate that service quality is a key driver for both students' satisfaction and their willingness to recommend the university. Research on service quality in HE, specified as a second-order formative-formative measurement model, is scarce. Many higher-order constructs in HE, such as service quality, are specified as reflective measures, where a formative structure might be more appropriate. By analyzing a second-order formative-formative measurement model for perceived service quality in HE, this study contributes to applied quantitative research in higher education. Although we applied our research in the Dutch HE market, our analytical approach is not limited to national borders or the HE market. In many other service contexts (e.g., healthcare, hospitality, automobile repair services, sports clubs, financial services), service quality is often measured reflectively, where a formative structure might be more suitable.*

Key words: *Formative measurement models, higher education, measurement model misspecification, perceived service quality, PLS-SEM, students' satisfaction.*

International Journal of Educational Studies
Vol. 8, No. 4, pp. 99-124
2025
DOI: *10.53935/2641533x.v8i4.458*
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1. Introduction

Perceived service quality (PSQ) in Higher Education (HE) has been researched from several perspectives. From a conceptual perspective there have been attempts to define service quality in higher education (Brochado, 2009; O'Neill and Palmer, 2004; Teeroovengadum *et al.*, 2019). From a content perspective, researchers have examined the number and types of factors composing service quality in higher education (Gupta and Kaushik, 2018; Sultan and Wong, 2012). From a nomological network perspective, the effects of service quality in HE on (aspects of) relationship quality (satisfaction, trust, commitment) and behavioral intentions have been assessed (Chandra *et al.*, 2019; Masserini *et al.*, 2019; Schijns, 2021; Sultan and Wong, 2014; Teeroovengadum *et al.*, 2019). From a measurement perspective, however, there are hardly any studies justifying the measurement mode specification for service quality in higher education. A correctly specified and analyzed perceived service quality (PSQ) construct, however, is a prerequisite since inappropriate modeling may result in incorrect interpretations and biased managerial conclusions (Collier and Bienstock,

2009; Diamantopoulos and Winklhofer, 2001; Jarvis *et al.*, 2003; MacKenzie *et al.*, 2005), leading to unsuccessful services marketing strategies in a highly competitive market for Higher Education (HE).

Misspecification exists when a latent construct, such as perceived service quality (PSQ) in our study, has reflective (formative) measures where formative (reflective) measures are more appropriate (Freeze and Raschke, 2007). Investigating the ability to use formative measurement models in the higher education field is of primary interest since "Many constructs in higher education are best conceptualized and operationalized as formative measures, especially higher-order constructs, such as service quality" (Ghasemy *et al.*, 2020). Service quality, however, has long been conceptualized by using reflective indicators (Brady and Cronin, 2001; Collier and Bienstock, 2009; Gronroos, 1988; Parasuraman *et al.*, 1988) where formative indicators may be more appropriate (Parasuraman *et al.*, 2005; Rossiter, 2002).

Misspecification also exists when researchers apply formative indicators but analyze their model using a reflective approach since the underlying (i.e. default) assumption for SEM analysis (e.g. in CB-SEM) is that the indicators used are reflective in nature. When formative measures are included but analyzed using the reflective approach, the resulting estimates would be invalid. This, however, is "a common and serious mistake often committed by researchers", "leading to serious questions concerning the validity of the results and conclusions" (Chin, 1998).

The shortcomings of existing research, therefore, are twofold. First, academic researchers have been "mechanistic in the application of reflective indicators in model specification" (Collier and Bienstock, 2009), not questioning the directional causality of the measures. That is, "little attention is given during theoretical development as to the formative or reflective nature of these constructs" (Freeze and Raschke, 2007). Second, in most studies, as a default (e.g., in CB-SEM), a reflective approach is applied despite the measures that have been developed as being formative.

From a theoretical perspective, in our study we move beyond the inherent assumption of an underlying reflective measurement model and pay close attention to the directional causality of the measures and constructs to prevent model misspecification.

From a managerial perspective a correctly specified and analyzed PSQ construct, is a prerequisite since inappropriate modeling and/or analyzing may result in incorrect interpretations and biased managerial conclusions (Collier and Bienstock, 2009; Diamantopoulos and Winklhofer, 2001; Jarvis *et al.*, 2003; MacKenzie *et al.*, 2005), leading to unsuccessful services marketing strategies in a highly competitive market for higher education (HE).

The focus of our study, therefore, is to prevent both types of measurement mode misspecification by presenting and empirically testing a holistic measure of service quality in higher education (HE), providing both theoretical reasoning and empirical support for the directional causality of the service quality measures and analyzing the service quality measures accordingly using SEM. During theoretical development of our study, therefore, we pay attention particularly to the formative or reflective specification of the service quality construct in higher education. PSQ is also integrated into a more comprehensive nomological network (conceptual model) as postulating PSQ that sits in a vacuum is of limited value. Our conceptual model is examined in a HE context, using secondary data collected by the Dutch foundation Studiekeuze123 through the National Student Enquiry (NSE).

This paper is structured as follows. First, we elaborate on the constructs included in the NSE data and their interrelations. From this discussion a conceptual model has been developed, and hypotheses are put forward. Second, we explain the methodology of our study elaborating particularly on the measurement mode specification of the perceived service quality construct. Third, we present the results of our empirical study. Next, we present our conclusions and discuss the theoretical and managerial implications of our study. We conclude our paper with the limitations of our study and provide suggestions for further research.

2. Developing the Conceptual Model

In developing the conceptual model, we focus on the constructs captured in the NSE. That is, students' perceptions of service quality (PSQ) in HE, students' overall satisfaction, and students' willingness to recommend the higher education institution (HEI) will be elaborated upon.

Academia Publishing Group

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2.1. Perceived Service Quality (PSQ) in Higher Education (HE)

Despite numerous attempts there is no consensus on how to define PSQ in HE. On behalf of our study, we define perceived service quality in higher education in terms of students' perceptions regarding service performances, delivered by the service provider (i.e., HEI). PSQ, therefore, is "an attitude toward or a global judgement about the superiority or inferiority of a service" (Giovanis *et al.*, 2018). This performance-based approach of service quality (Abdullah, 2006; Cronin and Taylor, 1992; O'Neill and Palmer, 2004; Sultan and Wong, 2012) is suggested to be a better measure of service quality than the disconfirmation approach (Brochado, 2009; Cronin and Taylor, 1994; Dabholkar *et al.*, 2000). Cronin and Taylor (1992) argue that service quality is derived from performance perceptions only. Cronin and Taylor (1994) show that a performance-only measure explains more of the variance in perceived service quality than a measure for disconfirmation. The poor fit for the disconfirmation model results from conceptual, theoretical, and measurement problems associated with the perceptions-minus-expectations service quality model (Teas, 1993; Wong and Sultan, 2021). Further, the definition of perceived service quality takes the students' perspective, since students are suggested to be the primary customers of HEIs (Abdullah, 2006; Annamdevula and Bellamkonda, 2016a; Prakash, 2021; Sultan and Wong, 2014).

Service quality in HE is best conceptualized as a multidimensional construct (Gupta and Kaushik, 2018; Nunkoo *et al.*, 2017; Sultan and Wong, 2012), containing a variety of context specific sub-dimensions (Babakus and Boller, 1992; Lapierre, 1996; Prakash, 2021) covering three broad but critical service areas typically found in higher education: academic, administrative and facilities (Prakash, 2021; Quinn *et al.*, 2009; Sultan and Wong, 2013), and that can be treated as a hierarchical component model (HCM), i.e. second order service quality model (Nunkoo *et al.*, 2017).

Besides a measure for PSQ, the NSE also includes measures for students' satisfaction and students' willingness to recommend their HEI. We, therefore, can embed service quality within a nomological network containing both students' satisfaction and students' willingness to recommend their HEI. In the next sections we develop this more comprehensive model by advancing PSQ as a precursor to students' satisfaction and willingness to recommend.

2.2. Relationship between PSQ and Students' Satisfaction in Higher Education

In this study, students' satisfaction is defined as the feeling resulting from an overall subjective evaluation of a broad spectrum of experiences of university life (Huisman *et al.*, 2022). Students' overall satisfaction, therefore, is seen as a cumulative subjective evaluation of various services provided by the HEI (Elliott and Shin, 2002).

In a HE context empirical studies found service quality to be a key driver for satisfaction (Annamdevula and Bellamkonda, 2016a; Chandra *et al.*, 2019; Masserini *et al.*, 2019; Mwiya *et al.*, 2017; Schijns, 2021; Stankovska *et al.*, 2024; Teeroovengadum *et al.*, 2019; Twum and Peprah, 2020), suggesting that students' satisfaction increases the higher their perceptions of service quality delivered by their HEI. Extensive systematic literature reviews on service quality and students' satisfaction in HE revealed that service quality in HE significantly impacts students' satisfaction (De Oliveira Santini *et al.*, 2017; Dhawan, 2022; Dugenio-Nadela *et al.*, 2023; Onditi and Wechuli, 2017). We, therefore, propose the following hypothesis.

Hypothesis 1: Perceived service quality has a positive effect on students' satisfaction.

2.3. Relationship Between Students' Satisfaction and Students' Willingness to Recommend

Oliver (1997) defines loyalty as "a deeply held commitment to rebuy or repatronize a preferred product or service consistently in the future, despite situational influences and marketing efforts having the potential to cause switching behavior", suggesting loyalty contains an attitudinal as well as a behavioral component (Baldinger and Rubinson, 1996; Khan *et al.*, 2015; Koslowsky, 2000). The willingness to recommend the HEI to others is suggested to be a behavioral intention, reflecting the attitudinal component of customer loyalty (Sultan and Wong, 2013; Sultan and Wong, 2014). Though Masserini *et al.* (2019) define students' loyalty as the "willingness to say positive things about the institution and to inform new candidates about the university", in our study we will refer to the willingness to recommend the HEI to others as an indicator for a student's loyalty to the HEI. Hence, though the behavioral intention 'willingness to recommend the HEI' is closely associated with students' loyalty, it is not regarded as an equivalent of student's loyalty.

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Customer satisfaction is found to be a predictor of behavioral intentions such as the willingness to recommend (Brady and Cronin, 2001; Dabholkar *et al.*, 2000; Olorunniwo *et al.*, 2006). The strong influence of satisfaction on the willingness to recommend is empirically supported in a HE context (Annamdevula and Bellamkonda, 2016a; Chandra *et al.*, 2019; Masserini *et al.*, 2019; Schijns, 2021; Teeroovengadum *et al.*, 2019). We, therefore, expect that students who are satisfied with the services provided by their HEI are willing to say positive words about the HEI and recommend the HEI to others. The following hypothesis, therefore, is postulated.

Hypothesis 2: Students' satisfaction has a positive effect on students' willingness to recommend the HEI.

2.4. Relationship Between PSQ and Willingness to Recommend

Besides customer satisfaction, service quality is also suggested to be a relevant predecessor of customer loyalty (Priyo *et al.*, 2019) and behavioral intentions (Olorunniwo *et al.*, 2006) in a wide range of contexts, e.g. healthcare (Fatima *et al.*, 2018; Giovanis *et al.*, 2018; Lee *et al.*, 2012; Meesala *et al.*, 2018), hotel services (Priyo *et al.*, 2019), automobile repair services (Izogo and Ogba, 2015), sports clubs (Schijns *et al.*, 2016) and financial services (Manimaran, 2010; Siddiqi, 2011). In HE settings the positive effect of perceived service quality on behavioral intentions such as the willingness to recommend the HEI has also been empirically supported (Hennig-Thurau *et al.*, 2001; Twaissi and Al-Kilani, 2015). We, therefore, put forward the following hypothesis.

Hypothesis 3: Perceived service quality has a positive effect on students' willingness to recommend the HEI.

Based on Hypotheses 1 to 3, perceived service quality is suggested to affect students' willingness to recommend both directly and indirectly (through students' satisfaction). Previous studies (Akbar and Parvez, 2009; Annamdevula and Bellamkonda, 2016a; Fatima *et al.*, 2018; Giovanis *et al.*, 2018; Olorunniwo *et al.*, 2006) found empirical evidence for the mediating effect of customer satisfaction on the relationship between perceived service quality and customer loyalty. The impact of perceived service quality on willingness to recommend as a strong indicator for students' loyalty, therefore, is expected to be partly mediated by students' satisfaction. Moreover, Olorunniwo *et al.* (2006) found "that while service quality is an important driver of behavioral intentions, its indirect effect through customer satisfaction is overwhelmingly larger than the direct effect in generating favorable behavioral intentions." Based on this finding, we hypothesize:

Hypothesis 4: The indirect effect of PSQ, i.e., through students' satisfaction, on students' willingness to recommend the HEI is larger than its direct effect.

In sum, the present study integrates service quality in a nomological network including students' satisfaction and willingness to recommend. Perceived service quality is suggested to have a positive impact on both students' satisfaction and students' willingness to recommend. Satisfaction partly mediates the relationship between service quality and willingness to recommend.

Our conceptual model is presented in Figure 1.

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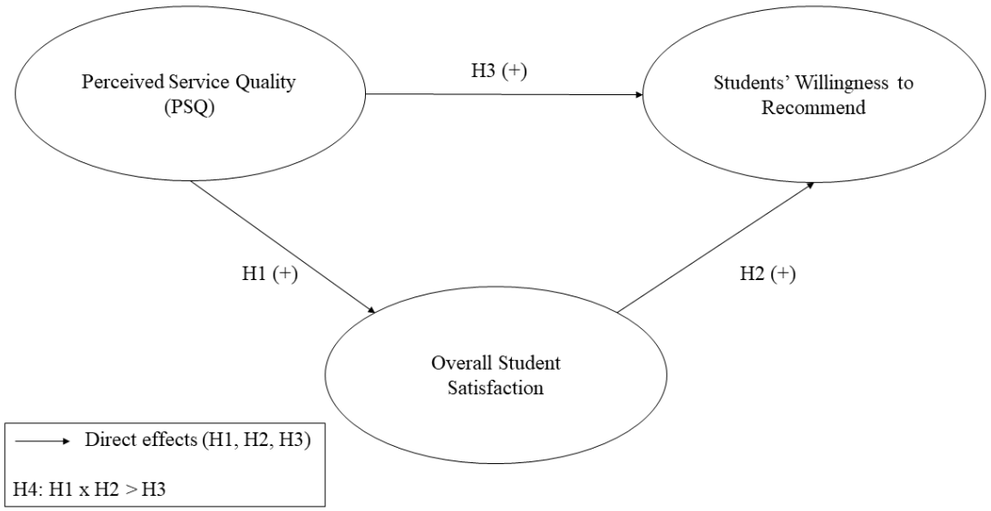

Figure 1. Conceptual model.

3. Methodology

3.1. The Survey Instrument

Starting from 2009 the independent foundation Studiekeuze123 sends out a survey, the NSE (i.e. the National Student Enquiry), an industry-specific service quality instrument developed for the Dutch HE sector. The NSE is a holistic measure comprising a total of 19 service quality factors and attributes from students' perspective, including the three critical service quality aspects academic, administrative and facilities (Quinn *et al.*, 2009; Sultan and Wong, 2010a; Sultan and Wong, 2012; Sultan and Wong, 2013). Both internal and external service quality dimensions as drivers of students' satisfaction are included (Bagur-Femenias *et al.*, 2020). Internal service quality dimensions refer to e.g., classes and curriculum, academic staff and teaching, advising support. External service quality dimensions refer to e.g., skills development, preparation for the future, services and facilities. The NSE therefore contains a comprehensive representation of the concept of service quality.

The NSE is a performance-only measure (Schijns, 2021) which is suggested to be more suitable in the context of higher education as students may not have clear expectations of the services provided by a HEI (Teerovengadum *et al.*, 2016). Sultan and Wong (2010b) also tested a performance-based higher education service quality model with satisfactory results.

The NSE is further validated by Brenders (2013) and Schijns (2021) and, therefore, can be used as a service quality measure in the context of HE.

3.2. Sample Characteristics

The NSE is characterized by a cross-sectional research design measuring service quality perceptions, satisfaction and behavioral intentions after the service has been provided. This research design is adequate and preferred for understanding and testing service quality (Dabholkar *et al.*, 2000). Since we use the NSE-data provided by Studiekeuze123, our conceptual model is empirically tested using secondary data. We selected undergraduates studying according to the on-campus mode at a public university in the Netherlands. This selection resulted in a net sample of 45,149 undergraduates, studying at 17 universities (See Table I). According to the VSNU, the Association of Universities in the Netherlands, all public universities in the Netherlands are therefore included except the Open Universiteit (OUNL). The OUNL is a university for distance learning only (online mode) capturing students almost exclusively studying part-time, while 99.7% of the respondents in our study is to be considered a pure (full-time) student.

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Table 1. Distribution of responding students by HEI.

	University Name	No. of students	%
1	Erasmus University Rotterdam	3,498	7.7
2	Protestant Theological University	23	0.1
3	Radboud University	3,602	8.0
4	Rijksuniversiteit Groningen	5,047	11.2
5	Delft University of Technology	2,704	6.0
6	Eindhoven University of Technology	1,957	4.3
7	Theological University Apeldoorn	14	0.0
8	Theological University of the Reformed Churches	21	0.0
9	Tilburg University	2,280	5.0
10	Leiden University	6,084	13.5
11	Maastricht University	3,226	7.1
12	University of Twente	2,039	4.5
13	University of Utrecht	5,025	11.1
14	University of Amsterdam	4,603	10.2
15	University of Humanistics	85	.2
16	Vrije Universiteit Amsterdam	2,885	6.4
17	Wageningen University & Research	2,056	4.6
	Total	45,149	100.0

Also, a wide range of study programs are included in our study, as can be seen in Table II. Socio-demographic characteristics of the respondents (e.g., gender, age), however, are not provided by Studiekeuze123 for privacy reasons.

Due to our selection 15 (out of 19) service quality constructs are applicable (See Table III). The construct ‘acquired skills for applied research’ for example applies to universities of applied sciences and has not been presented to university students. Since internships are not a standard part of university studies the service quality dimension about internships contained too few observations and, therefore, was not included in our analyses.

Table 2. Distribution of responding students by program

	Study program	No. of students	%
1	Economics	5,416	12.0
2	Behavior and Society	9,368	20.7
3	Health care	5,084	11.3
4	Agriculture and Natural Environment	1,818	4.0
5	Nature	5,110	11.3
6	Education	16	0.0
7	Law	3,504	7.8
8	Cross-sectoral studies	3,581	7.9
9	Language and Culture	5,463	12.1
10	Technology	5,789	12.8
	Total	45,149	100.0

3.3. Measures and questionnaire design

3.3.1. Perceived Service Quality (PSQ)

To reduce the chance of misspecification, we first determine whether PSQ is to be tested as a first-order factor model or as a separate higher-order construct by exploring a sound theoretical base for the assembly of this construct. Second, we determine whether the first-order factors are to be tested as either reflective or formative constructs based on both theoretical considerations and empirical support.

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3.3.1.1. Specifying PSQ as Either First-Order Constructs or a Separate Second-Order Construct

Generally, service quality factors can be specified in two ways, as components or as antecedents (Dabholkar *et al.*, 2000). In the component approach service quality is not viewed as a separate higher-order latent construct, but as a first-order factor model where its components are linked directly to their consequences (Dabholkar *et al.*, 2000). In the component approach, therefore, the individual effects of service quality components on e.g., satisfaction are investigated. The component approach has been applied in several studies. For example, Ali *et al.* (2016), Kashif *et al.* (2016) and Schijns (2021) considered several components of service quality in HE as distinct concepts and analyzed their unique influence on students' satisfaction.

In the antecedent approach service quality is considered as a more abstract concept, constructed as a separate higher-order latent variable with formative dimensions (Wetzels *et al.*, 2009). One of the main benefits of the antecedent approach is that it reduces model complexity (Becker *et al.*, 2012; Hair *et al.*, 2018; Hair *et al.*, 2022; Sarstedt *et al.*, 2019; Van Riel *et al.*, 2017; Wetzels *et al.*, 2009). In contrast to the component approach, however, hardly any studies on service quality in a higher education context have applied the antecedent approach while in some studies service quality was specified as a separate higher-order construct but with reflective dimensions where a formative approach would have been more appropriate. Teeroovengadum *et al.* (2016; 2019), for example, distinguish two service quality components (i.e., functional quality and transformative quality) and consider the functional service quality component as a second-order model. The wording of the items and the labels of the service quality dimensions conceptually suggest the items and dimensions are theoretically distinct, indicating a formative-formative structure of the functional service quality dimension is most appropriate. By using CB-SEM (through AMOS software), however, Teeroovengadum *et al.* (2019) analyze a reflective-reflective specified HCM since for CB-SEM analysis the underlying assumption is that the items are reflective in nature (Chin, 1998). Teeroovengadum *et al.* (2019) recognize this shortcoming and suggest "to consider service quality as a formative higher-order construct given the methodological advantages of formative modeling and using alternative statistical modeling techniques such as partial least squares structural equation modeling."

The 15 PSQ dimensions included in the NSE and considered in our study (See Table III) tap different characteristics of overall service quality in HEIs and, as a result, PSQ is an overall cumulative assessment by students based on their perceptions regarding these 15 facets of service quality. The dimensions represent different characteristics that collectively explain the meaning of service quality in HE, e.g., content and structure of the study, skills development, teachers, counselling, curriculum, study facilities. Removing one dimension would decrease the content validity of PSQ (Jarvis *et al.*, 2003; MacKenzie *et al.*, 2005). The labels of the dimensions conceptually suggest the dimensions are theoretically distinct, and, therefore, the formative measurement mode for the second-order PSQ-construct is appropriate. The formative mode for the second-order PSQ-construct has been empirically validated in several services contexts, e.g. hospital services (Giovanis *et al.*, 2018), health care services (Miranda *et al.*, 2012), hot spring resorts (Liu *et al.*, 2019), and audit services (Pestovic *et al.*, 2021).

Our second-order PSQ-construct, therefore, is formed as a combination of its first-order constructs and the direction of causality is from the first-order constructs to the second-order construct. The formative measurement mode for the second-order PSQ-construct is primarily based on theoretical considerations according to the guidelines provided by Coltman *et al.* (2008), Diamantopoulos and Winklhofer (2001), Hair *et al.* (2022), Jarvis *et al.* (2003) and Rossiter (2002). In the results section we also look for empirical support for the formative mode for our second-order PSQ-construct by investigating both the correlations between the 15 first-order constructs and their VIF-values.

Table 3 gives an overview of the constructs included in our conceptual model and provides the number of items for each measure.

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Table 3. Constructs and number of indicators per construct.

	Construct	# of indicators
1	General Satisfaction	15
2	Perceived Service Quality (PSQ, 2nd order)	71 (Repeated Indicators)
3	Willingness to recommend	1
PSQ Dimensions (1st order)		
1	Content and structure of study	8
2	General skills development	6
3	Scientific skills development	5
4	Connection to professional practice (e.g., preparation for the future)	3
5	Teachers (e.g., academic staff and teaching)	8
6	Guidance/Counselling (e.g., advising support)	3
7	Examination (e.g., tests and assessments)	5
8	Information supply	4
9	Program schedule (e.g., curriculum)	4
10	Study load	4
11	Group/class size	3
12	Study facilities	6
13	Quality care	4
14	Internationalization	4
15	Challenging education	4

3.3.1.2. Specifying First-Order PSQ Constructs as Either Reflective or Formative

Next, the measurement mode of the 15 first-order PSQ components has to be specified, first and for all based on theoretical considerations. According to measurement theory a formative measurement model specification is most suitable when measures are to be identified as distinct drivers of the construct they are assigned to (Diamantopoulos and Winklhofer, 2001; Rossiter, 2002), and when removing indicators would decrease the content validity of the measurement approach (Jarvis *et al.*, 2003; MacKenzie *et al.*, 2005).

The 15 first-order constructs composing PSQ include 71 items in total. Appendix C includes the full list of items. After examining the indicators of each construct, we conclude that the indicators are not to be viewed as a representative sample of the construct (reflective measurement) since individual items are not interchangeable and can't be left out without changing the conceptual meaning of the construct (Ghasemy *et al.*, 2020; Hair *et al.*, 2022; MacKenzie *et al.*, 2005). Instead, each item taps a specific facet of the construct's domain and, together, the items try to fully cover the domain of the construct they are assigned to (Hair *et al.*, 2022; MacKenzie *et al.*, 2005). From a measurement theory perspective, therefore, the first-order constructs are best specified as formative measurement models.

Besides theoretical justification according to the guidelines provided by Coltman *et al.* (2008), Diamantopoulos and Winklhofer (2001), Hair *et al.* (2022), Jarvis *et al.* (2003) and Rossiter (2002), as discussed above, we also look for empirical support for modeling our measurement models formatively in the results section. In the results section, therefore, we apply confirmatory tetrad analysis (CTA) (Ghasemy *et al.*, 2020; Gudergan *et al.*, 2008) and investigate the outer VIF-values to evaluate the measurement mode empirically.

To ensure that the higher-order PSQ construct is identified the repeated indicator approach is applied. That means that the 71 formative indicators are also assigned to the second-order construct PSQ. Though the 15 service quality facets vary in the number of indicators, ranging from a minimum of three to a maximum of eight items (See Table 3), the repeated indicator approach is deemed suitable since there is no support in literature for the assumption of an equal number of indicators (Becker *et al.*, 2016). Both the first-order constructs and the second-order construct, therefore, contain multiple formative items. All items are measured using five-point Likert scales ranging from 1 (=very low/dissatisfied) to 5 (=very high/satisfied).

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3.3.2. Students' Satisfaction

Students' overall satisfaction is measured by 15 five-point Likert scale items capturing perceptions, with endpoints very dissatisfied (1)/very satisfied (5). Each item refers to the respective service quality facet and measures the overall level of satisfaction with that service facet. Students' satisfaction, therefore, is conceptualized as comprising a variety of distinct facets, including e.g., the content of the program, the general and academic skills acquired, the teachers involved, the information provided, etc. (See for the complete list Appendix C). The 15 distinct facets of students' satisfaction together determine students' overall satisfaction. Satisfaction, therefore, is measured as a formative construct.

3.3.3. Students' Willingness to Recommend the Higher Education Institution (HEI)

The willingness to recommend the university to friends and acquaintances is suggested to be a behavioral intention, reflecting the attitudinal component of customer loyalty (Sultan and Wong, 2013; Sultan and Wong, 2014). In our study we, therefore, refer to the willingness to recommend the HEI to others as an indicator for a student's loyalty to the HEI. In the NSE the willingness to recommend the university is measured by a single item on a five-point Likert scale ranging from 1 ("No, absolutely not") to 5 ("Yes, absolutely").

3.4. Data Analysis

Our conceptual model aims at identifying key service quality drivers determining students' satisfaction and behavioral intentions. The path model is relatively complex since it contains more than six constructs while most constructs contain more than four indicators. PLS-SEM, therefore, is an adequate approach analyzing our model (Sarstedt *et al.*, 2021). In addition, PLS-SEM is very flexible in estimating higher-order models (Sarstedt *et al.*, 2019) and is the preferred method when formative measures are involved (Hair *et al.*, 2019). Even when large secondary data sets are involved, as in our study, PLS-SEM offers substantial potential (Hair *et al.*, 2019).

We used IBM-SPSS version 26 for screening and cleaning our data in order to generate a high-quality dataset as input for our advanced analysis in SmartPLS (version 4.1.1.4). In our PLS-SEM analysis we apply the factor weighting scheme instead of the default path weighting scheme, since the factor weighting scheme is suggested "as a compromise solution between the centroid and path weighting schemes when a PLS path model includes one or more HCMs" (Hair *et al.*, 2018).

Since we use a very large sample, we have to be aware of the *p*-value problem associated with large samples (Lin *et al.*, 2013). The problem with the *p*-value is that the *p*-value quickly drops to zero in case of very large samples. We, therefore, do not solely rely on *p*-values but report confidence intervals (CIs) as well, since CIs become narrower and more precise when samples increase (Lin *et al.*, 2013).

4. Results

4.1. Evaluation of the Measurement Models

The measurement models link latent constructs to their respective items. In our study all multi-item measurement models are formatively specified, grounded in measurement theory. We first supplement this formative specification empirically by a Confirmatory Tetra Analysis (CTA-test).

Appendix B contains the results of our CTA-test. Since at least four indicators per latent variable are required (Hair *et al.*, 2018; Hair *et al.*, 2022), three of our measures are excluded from the CTA (i.e., the constructs *Connection to professional practice*, *Group/class size*, and *Guidance/Counselling*; See Table 3 and Appendix A). In short, our CTA shows that for all tested latent variables most tetrads' residual values differ significantly from zero. Our empirical test results, therefore, justify a formative measurement model specification and supplement our theoretical considerations (Hair *et al.*, 2019).

Our evaluation of the measurement models further involves the assessment of both collinearity between indicators, and significance and relevance of outer weights (Chua, 2023; Hair *et al.*, 2019; Hair *et al.*, 2022; Sarstedt *et al.*, 2019; Sarstedt *et al.*, 2021).

Collinearity between the indicators has been assessed using the formative indicator's variance inflation factor (VIF). All outer VIF values are below the more conservative threshold value of 3, ranging from a low 1.006 (indicator *Examination_06*) up to a maximum of 2.838 (indicator *Internationalization_02*). We, therefore, conclude that collinearity among the indicators of our first-order constructs is not an issue.

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International Journal of Educational Studies
Vol. 8, No. 4, pp. 99-124
2025
DOI: *10.53935/2641533x.v8i4.458*
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Besides the collinearity between the formative indicators, we also have to investigate the collinearity between the first-order constructs that form the second-order construct perceived service quality (PSQ) since in our model, these first-order constructs should not be interpreted as independent latent variables, but as formative indicators for the second-order construct PSQ (Ghasemy *et al.*, 2020; Sarstedt *et al.*, 2019). First, we investigate the correlations between the first-order service quality constructs (See Appendix D). Appendix D shows our first-order constructs are not highly correlated. Correlations range from a minimum of 0.26 to a maximum of 0.68, and for 72% correlations are less than 0.50. So, some correlations are high, but most are low, indicating that duplication of measurement has not occurred. Second, we examine the VIF-values which are close to 3 and lower (see Table 4), suggesting that collinearity between the first-order constructs is not at a critical level.

Table 4. VIF-values for the first-order components forming PSQ.

PSQ component	**VIF-value**
Content and structure of study	3.112
General skills development	2.303
Scientific skills development	1.948
Connection to professional practice	1.451
Teachers	2.491
Guidance/Counselling	1.810
Examination	2.120
Information supply	1.949
Program schedule	1.706
Study load	1.794
Group/class size	1.456
Study facilities	1.562
Quality care	2.011
Internationalization	1.360
Challenging education	2.338

Table 5. Paths between LOCs and HOC for Perceived Service Quality (PSQ).

Path	**Weights**	***t* Value**	***p* Value**	**95% Confidence**	**Percentile Interval**
General skills development	0.092	130.677	0.000	[0.091,	0.094]
Teachers	0.110	131.140	0.000	[0.108,	0.112]
Group/class size	0.077	104.272	0.000	[0.076,	0.079]
Information supply	0.085	127.175	0.000	[0.084,	0.086]
Content and structure of study	0.171	190.363	0.000	[0.169,	0.173]
Internationalization	0.063	89.174	0.000	[0.062,	0.065]
Quality care	0.094	129.826	0.000	[0.093,	0.096]
Guidance/Counselling	0.098	127.063	0.000	[0.097,	0.100]
Study facilities	0.074	104.431	0.000	[0.073,	0.076]
Study load	0.089	125.739	0.000	[0.088,	0.090]
Program schedule	0.079	114.599	0.000	[0.077,	0.080]
Examination	0.097	122.086	0.000	[0.095,	0.098]
Challenging education	0.113	148.855	0.000	[0.112,	0.114]
Connection to professional practice	0.079	108.249	0.000	[0.078,	0.081]
Scientific skills development	0.082	115.610	0.000	[0.080,	0.083]

Appendix A includes the formative constructs *outer weights significance testing results*. The significance tests show that all indicator weights are significant. Besides the outer weights of our measurement models, we also have to investigate the significance and relevance of the relationships between the first-order constructs and the second order construct Perceived Service Quality (PSQ) since in our model, these relationships should

International Journal of Educational Studies
Vol. 8, No. 4, pp. 99-124
2025
DOI: *10.53935/2641533x.v8i4.458*
Email: jos.schijns@ou.nl

not be interpreted as structural model relationships but as weights (Ghasemy *et al.*, 2020; Sarstedt *et al.*, 2019). Table 5 shows the relationships between the first-order constructs (LOCs) and the second order construct PSQ, their significance and relevance.

All relationships between the first-order constructs and the second-order construct Perceived Service Quality (PSQ), the weights, are significant at the level of p=0.000. The weights of the first-order constructs on the second-order construct represent actionable drivers of PSQ. *Content and structure of the study* is by far the most relevant driver of PSQ (0.171). *Challenging education* (0.113) and *Teachers* (0.110) complement the top three most relevant drivers for perceived service quality. *Challenging education* and *Teachers* have similar effects on PSQ and, therefore, have equal relevance for forming PSQ.

Within the most relevant driver of PSQ, *Content and structure of the study*, we find the item 'The learning methods used in your study programme' to be the most relevant attribute (Content_07: 0.271), followed by 'The quality of the study materials' (Content_09: 0.225). 'Being challenged or invited to give your very best' is the most relevant attribute within the *Challenging education* dimension (Challenging_01: 0.438). With respect to *Teachers* the attribute 'Quality of feedback your teachers provide' is the most relevant driver (Teachers_06: 0.231). The most relevant service quality components and attributes as mentioned here are highlighted in Appendix A.

In summary, our measurement models show satisfactory results. We, therefore, continue examining our structural model.

4.2. Evaluation of the Structural Model

The structural model connects the latent variables other than the lower-order components (Sarstedt *et al.*, 2019).

First, we check for potential collinearity issues among the constructs PSQ, Willingness to recommend, and Satisfaction. All inner VIF values are below the threshold value of 5 (Hair *et al.*, 2018; Hair *et al.*, 2019; Hair *et al.*, 2022). Collinearity, therefore, is considered not critical.

Next, we assess the significance and relevance of the structural relationships in our model by evaluating their path coefficients. Table 6 shows the path coefficients and their significances. All three structural paths are significant. That is, PSQ has a positive effect on both Satisfaction (*ß*=0.886; p=0.000) and Willingness to recommend (*ß*=0.160; p=0.000). Although the strong effect between PSQ and Satisfaction appears subject to inflation, it is not uncommon in research on the relationship in question. "The students' evaluation of their higher education services experience is best represented by two distinct concepts. Firstly, the perceived 'quality' of the higher education services and secondly the 'satisfaction' with the latter." (Teeroovengadum *et al.*, 2023: p.6). The concepts of quality and satisfaction share common roots but are conceptually distinctive. PSQ in our study refers to the transaction-specific components of the service evaluation, while satisfaction refers to the cumulative experience during the service delivery process. High correlations, therefore, are not exceptional and supported by empirical research. Todea *et al.* (2022), for example, found a significant positive effect of PSQ on Satisfaction (beta = 0.85, p<0.001). Similar results were found by Annamdevula and Bellamkonda (2016b) and Annamdevula (2017) with a standardized beta of minimum 0.84 (p<0.001).

Satisfaction also positively affects Willingness to recommend (*ß*=0.458; p=0.000) and, therefore, partly mediates the relationship between PSQ and Willingness to recommend. The total effect of PSQ on Willingness to recommend is 0.566 (p = 0.000), which is the sum of its direct effect (*ß*=0.160; p=0.000) and total indirect effect through Satisfaction (i.e. *ß*=0.886x0.458=0.406; p=0.000). The total indirect effect of PSQ on Willingness to recommend (0.406), therefore, is larger than its direct effect (0.160).

Table 6.
Structural path coefficients, significances and Confidence Intervals Bias Corrected.

Path	Coefficient	*t* Value	*p* Value	95% Percentile Confidence Interval	
PSQ -> Satisfaction	0.886	739.950	0.000	[0.884,	0.888]
PSQ -> Willingness to recommend	0.160	17.515	0.000	[0.143,	0.177]
Satisfaction -> Willingness to recommend	0.458	48.495	0.000	[0.439,	0.476]

International Journal of Educational Studies
Vol. 8, No. 4, pp. 99-124
2025
DOI: *10.53935/2641533x.v8i4.458*
Email: jos.schijns@ou.nl

We also look at the R^2 values for Satisfaction (R^2=0.785) and Willingness to recommend (R^2=0.365). The R^2 value for Satisfaction can be described as substantial (Ghasemy *et al.*, 2020; Hair *et al.*, 2019). The R^2 value for Willingness to recommend is more likely to be referred to as weak. Our main results are presented in Figure 2.

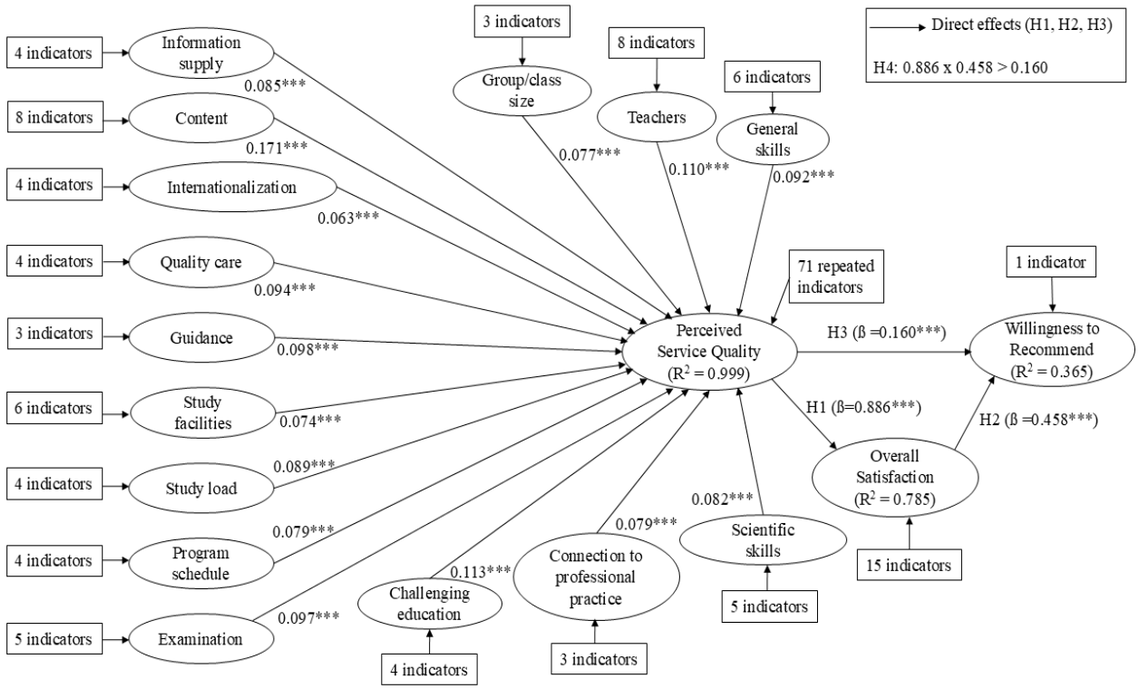

Figure 2. Final estimation of model parameters.

5. Conclusions

Our results provide evidence for the influence of perceived service quality on students' satisfaction (Hypothesis 1). The positive effect of perceived service quality on students' satisfaction has been empirically supported in several studies in a higher education context (Ali *et al.*, 2016; Annamdevula and Bellamkonda, 2016a; Hwang and Choi, 2019; Rafik and Priyono, 2018; Schijns, 2021) and aligns with the outcomes of systematic literature reviews investigating the link between service quality and students' satisfaction (De Oliveira Santini *et al.*, 2017; Dhawan, 2022; Dugenio-Nadela *et al.*, 2023; Onditi and Wechuli, 2017).

Students' satisfaction was found to be an important predecessor of students' willingness to recommend the HEI (Hypothesis 2). The willingness to recommend the HEI to others is suggested to be a behavioral intention, reflecting the attitudinal component of students' loyalty (Sultan and Wong, 2013; Sultan and Wong, 2014). The positive effect of students' satisfaction on students' willingness to recommend has been empirically supported in a HE context (Ali *et al.*, 2016; Hennig-Thurau *et al.*, 2001; Hwang and Choi, 2019; Kashif *et al.*, 2016; Schijns, 2021; Teeroovengadum *et al.*, 2019; Twaissi and Al-Kilani, 2015).

Empirical evidence was also found for the effect of perceived service quality on students' willingness to recommend the HEI (Hypothesis 3). The positive effect of perceived service quality on the willingness to recommend, has been empirically supported in a HE context (Hennig-Thurau *et al.*, 2001; Schijns, 2021; Twaissi and Al-Kilani, 2015).

Satisfaction was found to strongly mediate the effect of perceived service quality on students' willingness to recommend, supporting results revealed in other studies, both inside and outside the HE sector (Akbar and Parvez, 2009; Dabholkar *et al.*, 2000; Fatima *et al.*, 2018; Giovanis *et al.*, 2018; Olorunniwo *et al.*, 2006; Priyo *et al.*, 2019). In accordance with Olorunniwo *et al.* (2006) and Manimaran (2010) we found that service quality is an important driver of behavioral intentions (in our study the willingness to recommend), but its indirect effect through students' satisfaction is overwhelmingly larger. Hypothesis 4, therefore, is also supported.

International Journal of Educational Studies
Vol. 8, No. 4, pp. 99-124
2025
DOI: *10.53935/2641533x.v8i4.458*

Email: jos.schijns@ou.nl

Last but not least, the measurement of service quality in HE through the NSE measure is suggested to be sufficiently comprehensive to capture the HE service quality construct since the measure includes three broad but critical areas of service quality (academic, administrative, and facilities) and captures both the process quality attributes and the outcome quality attributes. Our study found theoretical and empirical support for a second-order, formative-formative HCM of perceived service quality in a HE setting and the model was analyzed accordingly using the formative-formative approach. The formative-formative approach supports "that the various dimensions of service quality are distinct and cannot be simply merged or deleted without changing the meaning of the construct" (Nunkoo *et al.*, 2017: p.2998).

In summary, we conclude that our perceived service quality model, specified as a second-order formative-formative measurement model, is conceptually sound, theoretically founded, and empirically supported and, therefore, considered a valid measure. Perceived service quality in HE is suggested to have a positive impact on both students' satisfaction and students' willingness to recommend. Satisfaction partly mediates the relationship between service quality and willingness to recommend.

6. Theoretical implications

The main aim of our study was to present and empirically test a holistic measure of service quality in higher education (HE) specified as a second-order formative-formative measurement model and analyze the model accordingly since research on service quality in HE, conceptualized as a second-order HCM, is scarce. By providing both theoretical reasoning and empirical support, we paid close attention to the directional causality of the measures and constructs and analyzed the model accordingly to prevent model misspecification. This paper, therefore, provides a holistic second-order formative-formative measurement model for service quality, integrated in a nomological network as postulating service quality that sits in a vacuum is of limited value.

We found theoretical and empirical support for a second-order, formative-formative HCM of service quality in a HE setting. Our study, therefore, contributes to the scarce amount of literature investigating the usefulness and applicability of the formative-formative type hierarchical component model since the formative-formative type model is less likely used in empirical research (Ghasemy *et al.*, 2020; Jarvis *et al.*, 2003; Ringle *et al.*, 2012), as academic researchers "have been so mechanistic in the application of reflective indicators in model specification" (Collier and Bienstock, 2009: p.292). In most studies, as a default (e.g., in CB-SEM), a reflective approach is applied and "little attention is given during theoretical development as to the formative or reflective nature of these constructs" (Freeze and Raschke, 2007: p.1). By analyzing a second-order formative-formative hierarchical component model for perceived service quality in HE we moved beyond the inherent assumption of an underlying reflective measurement model (Van Amelsvoort *et al.*, 2020) and contribute to higher education's applied quantitative research (Ghasemy *et al.*, 2020).

We also contribute to theory by embedding PSQ in a nomological network. First, as Nunkoo *et al.* (2017: p.2981) suggest, "a second-order service quality model leads to a theoretically robust and more parsimonious structural model". Second, because "Service quality and related marketing concepts such as customer satisfaction and loyalty have been rarely used in the higher education sector in the past" (Teeroovengadum *et al.*, 2019: p.427). Analyzing PSQ that is grounded in the antecedent model approach (Dabholkar *et al.*, 2000), therefore, is found to be a promising progression in understanding students' perceptions of service quality, how these perceptions came about, and how they affect students' satisfaction and behavioral intentions.

7. Managerial Implications

The results of this study indicate that high quality services provided by the HEI positively affect both students' satisfaction and willingness to recommend the HEI to others (e.g., prospective students). It is, therefore, important that managers of HEIs constantly monitor the quality of their services delivered to their main stakeholder, the student. A correctly specified and analyzed PSQ construct, however, is a prerequisite since inappropriate modeling may result in incorrect interpretations and biased conclusions (Jarvis *et al.*, 2003), leading to unsuccessful services marketing strategies in a highly competitive market for Higher Education (HE). In accordance with Podsakoff *et al.* (2006: p.197), who suggested that "… many important strategy constructs are more appropriately modeled as having formative indicators than as having reflective indicators", we conceptualized service quality in HE as a second-order formative-formative measurement model and found theoretical and empirical support for this antecedent model approach.

International Journal of Educational Studies
Vol. 8, No. 4, pp. 99-124
2025
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Email: jos.schijns@ou.nl

We further integrated PSQ in a nomological network including students' satisfaction and willingness to recommend. By integrating service quality in a nomological network managers can assess its impact on students' satisfaction and willingness to recommend. And, since the weights of the lower-order service quality dimensions on the higher-order service quality construct represent actionable key drivers of service quality, managers find support to better design service delivery and improve students' perceptions of service quality (Becker *et al.*, 2016). By also examining the weights of the indicators on the lower-order service quality dimensions managers obtain even more concrete suggestions for service improvements.

In our study the service quality components *Content and structure of the study*, *Challenging education*, and *Teachers*, in that order, turned out to be the top three most relevant (categories of) service quality drivers. When investigating service quality attributes on (formative) item level, management is provided with even more concrete suggestions to improve service quality and increase satisfaction and behavioral intentions. Implementing an Importance-Performance Map Analysis (IPMA) both on latent variable level and on indicator level supports HE managers further in identifying the weakest service quality aspects and subsequently taking appropriate improvement decisions. An IPMA, however, is more likely to be applied on the level of an individual HEI and its faculties and, therefore, is beyond the scope of our study.

For monitoring PSQ on a regular or frequent basis, the main benefit of using the antecedents model is that managers can simply measure the overall evaluation (i.e. the second-order construct). For diagnostic purposes, however, policymakers need to examine the service quality components (i.e., first-order constructs) and their respective indicators (Dabholkar *et al.*, 2000) to understand and eliminate barriers to students' satisfaction and behavioral intentions (Prakash, 2021).

8. Limitations and Research Avenues

In our study perceived service quality (PSQ) is embedded within a limited nomological network and put forward as a predecessor for student satisfaction and willingness to recommend. Evaluating PSQ in HE as a HCM simplifies the analysis of more comprehensive models since the number of relationships in the nomological network decreases compared to a network in which each single PSQ dimension is related to other constructs in the network. As a result, more comprehensive models can be explored without sacrificing robustness and parsimoniousness. We, therefore, suggest extending the nomological network as shown in our study with antecedents of customer satisfaction and willingness to recommend since exploring the antecedents of both constructs increases our understanding of developing and building sustainable relationships between students and their HEIs. Including, for example, perceived institutional image as possible predictor of students' satisfaction and willingness to recommend is a promising research avenue, since "image has now become one of the main determinants for choosing where to enrol and can be effective for attracting the best students and teachers" (Masserini *et al.*, 2019: p.96). Institutional image refers to the impressions stakeholders (e.g. students) have of a university (Arpan *et al.*, 2003) and is suggested to have positive effects on both students' satisfaction and students' behavioral intentions (Chandra *et al.*, 2019). Also, students' trust and commitment are suggested to be possible mediators between service quality, satisfaction, and behavioral intentions (Masserini *et al.*, 2019).

Besides enriching our conceptual model with variables as causes or mediators also moderators can increase our insights and understandings of forming satisfaction and behavioral intentions as relevant outcomes. Wong and Sultan (2021), for example, put forward individual-level variables (e.g., age, gender, level of education) as possible demographic moderators that affect student's perceptions of service quality. "Perception of service quality is subjective and is believed to vary with the demographic characteristics of students" (Min and Khoon, 2014: p.90). Also, system-level variables (e.g., public or private HEI, online mode or on-campus mode, universities or colleges, federal or provincial) can provide a better understanding of differences in service quality perceptions (Prakash, 2021; Wong and Sultan, 2021).

Although we applied our research in the Dutch HE market, our analytical approach isn't limited to national borders. We, therefore, invite other researchers to apply the analytical approach put forward in this paper to HE-data in other countries. Data collections comparable to the NSE are, for example, the National Student Survey (NSS) in the United Kingdom (UK) and the Student Experience Survey (SES) in Australia and seem suitable for the type of research presented in this study.

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International Journal of Educational Studies
Vol. 8, No. 4, pp. 99-124
2025
DOI: *10.53935/2641533x.v8i4.458*
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Acknowledgments:

We would like to thank Studiekeuze123.nl for providing the data for this study.

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Vol. 8, No. 4, pp. 99-124
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Vol. 8, No. 4, pp. 99-124
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Appendix A. Formative constructs outer weights significance testing results.

Formative Constructs	Formative Indicators*	Outer Weights	*t* Value	*p* Value	95% Percentile Confidence Interval	
General satisfaction	… 02	0.184	43.283	0.000	[0.176;	0.193]
	…_03	0.105	27.355	0.000	[0.097;	0.113]
	… _04	0.070	18.988	0.000	[0.063;	0.077]
	… _06	0.124	32.157	0.000	[0.117;	0.132]
	… 07	0.097	26.189	0.000	[0.090;	0.104]
	… _08	0.074	21.308	0.000	[0.067;	0.081]
	… _09	0.133	34.329	0.000	[0.126;	0.140]
	… _10	0.064	18.365	0.000	[0.057;	0.071]
	… _11	0.118	32.615	0.000	[0.111;	0.125]
	… _12	0.127	32.785	0.000	[0.119;	0.135]
	… _15	0.130	35.346	0.000	[0.123;	0.137]
	… _16	0.114	32.947	0.000	[0.107;	0.120]
	… _17	0.085	24.134	0.000	[0.079;	0.092]
	… _18	0.153	38.934	0.000	[0.145;	0.160]
	… _19	0.067	20.063	0.000	[0.061;	0.073]
Connection to professional practice	… _01	0.459	42.719	0.000	[0.438;	0.480]
	… _02	0.270	23.963	0.000	[0.246;	0.291]
	… _04	0.408	42.383	0.000	[0.391;	0.428]
Group/class size	… _01	0.363	41.878	0.000	[0.345;	0.378]
	… _02	0.306	33.011	0.000	[0.288;	0.323]
	… _03	0.517	55.886	0.000	[0.500;	0.536]
Internationalization	… _01	0.124	8.630	0.000	[0.096;	0.152]
	… _02	0.311	21.625	0.000	[0.282;	0.339]
	… _03	0.339	25.911	0.000	[0.315;	0.364]
	… _04	0.391	30.730	0.000	[0.367;	0.417]
Program schedule	… _01	0.153	17.357	0.000	[0.136;	0.169]
	… _02	0.305	33.320	0.000	[0.287;	0.323]
	… _03	0.287	31.861	0.000	[0.267;	0.302]
	… _04	0.531	68.244	0.000	[0.517;	0.546]
General skills development	… _01	0.251	36.627	0.000	[0.237;	0.264]
	… _03	0.306	47.409	0.000	[0.294;	0.319]
	… _04	0.232	33.293	0.000	[0.218;	0.245]
	… _05	0.132	20.331	0.000	[0.120;	0.145]
	… _06	0.286	43.725	0.000	[0.272;	0.298]
	… _07	0.187	26.962	0.000	[0.173;	0.200]
Teachers	… _01	0.151	27.545	0.000	[0.140;	0.161]
	… _02	0.124	21.954	0.000	[0.114;	0.136]
	… _03	0.138	23.592	0.000	[0.127;	0.149]
	… _04	0.150	22.934	0.000	[0.137;	0.163]
	… _05	0.197	28.368	0.000	[0.183;	0.210]
	… _06	0.231	40.821	0.000	[0.221;	0.242]
	… _07	0.151	25.754	0.000	[0.140;	0.163]
	… _08	0.203	40.050	0.000	[0.193;	0.213]
Information supply	… _02	0.369	52.293	0.000	[0.354;	0.381]
	… _03	0.264	36.256	0.000	[0.250;	0.279]
	… _04	0.315	47.290	0.000	[0.301;	0.328]
	… _05	0.384	62.790	0.000	[0.372;	0.396]
Content and structure	… _01	0.175	39.737	0.000	[0.165;	0.183]

International Journal of Educational Studies
Vol. 8, No. 4, pp. 99-124
2025
DOI: *10.53935/2641533x.v8i4.458*
Email: jos.schijns@ou.nl

of study	… 02	0.120	26.148	0.000	[0.111;	0.130]
	… 03	0.141	36.269	0.000	[0.133;	0.149]
	… 04	0.197	42.756	0.000	[0.188;	0.205]
	… 05	0.145	37.904	0.000	[0.138;	0.153]
	… 06	0.158	37.657	0.000	[0.150;	0.167]
	… 07	0.271	63.118	0.000	[0.263;	0.280]
	… 09	0.225	50.428	0.000	[0.215;	0.233]
Quality care	… 01	0.432	67.874	0.000	[0.419;	0.444]
	… 02	0.107	15.458	0.000	[0.093;	0.120]
	… 03	0.215	26.189	0.000	[0.200;	0.231]
	… 04	0.448	66.277	0.000	[0.435;	0.462]
Guidance/ Counselling	… 04	0.379	45.625	0.000	[0.364;	0.396]
	… 05	0.326	39.661	0.000	[0.309;	0.342]
	… 06	0.434	55.447	0.000	[0.418;	0.449]
Study facilities	… 01	0.466	51.606	0.000	[0.449;	0.484]
	… 02	0.032	2.939	0.003	[0.011;	0.053]
	… 03	0.086	8.598	0.000	[0.066;	0.105]
	… 05	0.145	14.648	0.000	[0.126;	0.164]
	… 06	0.133	12.192	0.000	[0.111;	0.156]
	… 07	0.425	48.669	0.000	[0.409;	0.443]
Study load	… 01	0.299	36.675	0.000	[0.283;	0.314]
	… 02	0.294	36.327	0.000	[0.279;	0.310]
	… 04	0.345	46.524	0.000	[0.330;	0.361]
	… 05	0.345	47.977	0.000	[0.331;	0.359]
Examination	… 01	0.345	55.370	0.000	[0.333;	0.356]
	… 02	0.277	38.750	0.000	[0.263;	0.291]
	… 04	0.234	31.785	0.000	[0.219;	0.247]
	… 05	0.360	55.380	0.000	[0.346;	0.372]
	… 06	-0.021	3.882	0.000	[-0.031;	-0.010]
Challenging education	… 01	0.438	75.378	0.000	[0.427;	0.450]
	… 02	0.299	53.059	0.000	[0.288;	0.310]
	… 03	0.235	38.105	0.000	[0.223;	0.247]
	… 04	0.264	46.507	0.000	[0.253;	0.275]
Scientific skills development	… 01	0.557	79.899	0.000	[0.544;	0.571]
	… 02	0.191	21.467	0.000	[0.174;	0.208]
	… 04	0.102	11.994	0.000	[0.085;	0.118]
	… 05	0.178	19.532	0.000	[0.161;	0.195]
	… 07	0.250	27.971	0.000	[0.234;	0.268]

***Note:** the NSE questionnaire has been adapted since its introduction in 1991. Items have been changed or removed and so has their numbering. Numbering, therefore, is non-consecutive.

International Journal of Educational Studies
Vol. 8, No. 4, pp. 99-124
2025
DOI: *10.53935/2641533x.v8i4.458*
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Appendix B. CTA results

Construct	Tetrad	Tetrad Value	*t* Value	*p* Value	95% Confidence Interval	Percentile Interval
General skills development	01	0.024	13.980	0.000	[0.019,	0.019]
	02	0.018	10.495	0.000	[0.013,	0.013]
	04	-0.012	7.227	0.000	[-0.016,	-0.016]
	06	0.021	13.429	0.000	[0.017,	0.017]
	07	0.041	24.468	0.000	[0.037,	0.037]
	10	0.118	43.438	0.000	[0.111,	0.111]
	16	0.066	33.623	0.000	[0.061,	0.061]
	22	0.031	15.522	0.000	[0.026,	0.026]
	26	0.046	24.993	0.000	[0.041,	0.041]
Internationalization	01	0.081	23.627	0.000	[0.073,	0.089]
	02	-0.188	32.280	0.000	[-0.201,	-0.175]
Program schedule	01	0.150	42.487	0.000	[0.142,	0.158]
	02	0.147	39.824	0.000	[0.139,	0.155]
Information supply	01	0.054	20.397	0.000	[0.048,	0.060]
	02	0.037	12.892	0.000	[0.030,	0.043]
Quality care	01	0.052	21.642	0.000	[0.047,	0.058]
	02	0.011	4.070	0.000	[0.005,	0.018]
Study facilities	01	0.110	33.337	0.000	[0.101,	0.120]
	02	0.100	26.896	0.000	[0.090,	0.110]
	04	0.051	18.591	0.000	[0.043,	0.058]
	06	-0.016	6.016	0.000	[-0.023,	-0.008]
	07	0.044	16.985	0.000	[0.037,	0.051]
	10	0.128	39.587	0.000	[0.119,	0.137]
	16	0.150	47.967	0.000	[0.141,	0.158]
	22	0.060	23.632	0.000	[0.053,	0.067]
	26	0.094	30.184	0.000	[0.085,	0.102]
Study load	01	0.052	19.662	0.000	[0.046,	0.058]
	02	0.033	11.640	0.000	[0.027,	0.040]
Examination	01	0.068	35.502	0.000	[0.063,	0.073]
	02	0.056	27.106	0.000	[0.050,	0.061]
	04	-0.001	0.948	0.344	[-0.003,	0.001]
	06	0.003	3.178	0.002	[0.001,	0.006]
	10	0.001	0.821	0.412	[-0.001,	0.003]
Challenging education	01	0.015	6.204	0.000	[0.010,	0.021]
	02	-0.050	16.563	0.000	[-0.057,	-0.043]
Scientific skills development	01	0.071	35.536	0.000	[0.066,	0.076]
	02	0.048	21.920	0.000	[0.043,	0.054]
	04	0.072	35.603	0.000	[0.067,	0.078]
	06	-0.030	17.695	0.000	[-0.035,	-0.026]
	10	0.043	19.255	0.000	[0.037,	0.048]
Teachers	01	0.094	45.133	0.000	[0.088,	0.101]
	02	0.099	47.374	0.000	[0.092,	0.105]

International Journal of Educational Studies
Vol. 8, No. 4, pp. 99-124
2025
DOI: *10.53935/2641533x.v8i4.458*
Email: jos.schijns@ou.nl

	04	0.052	30.343	0.000	[0.047,	0.057]
	06	0.005	4.604	0.000	[0.002,	0.009]
	07	0.039	23.472	0.000	[0.034,	0.045]
	10	0.015	9.136	0.000	[0.010,	0.020]
	13	0.008	6.022	0.000	[0.004,	0.012]
	17	0.084	44.445	0.000	[0.079,	0.090]
	23	0.031	17.690	0.000	[0.026,	0.036]
	26	-0.012	7.119	0.000	[-0.017,	-0.007]
	30	0.004	3.690	0.000	[0.001,	0.007]
	33	-0.007	5.699	0.000	[-0.011,	-0.004]
	42	-0.031	22.463	0.000	[-0.036,	-0.027]
	73	0.021	13.421	0.000	[0.016,	0.026]
	85	0.004	2.753	0.006	[0.000,	0.009]
	97	0.006	5.557	0.000	[0.003,	0.009]
	100	0.020	14.649	0.000	[0.016,	0.024]
	110	-0.052	24.287	0.000	[-0.059,	-0.046]
	121	0.003	2.099	0.036	[-0.002,	0.008]
	156	-0.045	24.323	0.000	[-0.050,	-0.039]
Content and structure of study	01	0.012	8.568	0.000	[0.008,	0.016]
	02	-0.012	7.981	0.000	[-0.016,	-0.007]
	04	0.009	6.351	0.000	[0.005,	0.013]
	06	-0.012	8.969	0.000	[-0.016,	-0.008]
	07	0.006	4.394	0.000	[0.002,	0.010]
	10	0.014	10.637	0.000	[0.010,	0.018]
	13	0.011	8.874	0.000	[0.007,	0.014]
	17	0.023	15.603	0.000	[0.019,	0.028]
	23	0.007	5.233	0.000	[0.003,	0.011]
	26	-0.004	2.990	0.003	[-0.008,	0.000]
	30	0.000	0.171	0.865	[-0.003,	0.003]
	33	-0.005	4.442	0.000	[-0.009,	-0.002]
	42	-0.014	12.999	0.000	[-0.017,	-0.010]
	73	0.020	15.791	0.000	[0.016,	0.024]
	85	0.033	22.231	0.000	[0.029,	0.038]
	97	0.004	3.736	0.000	[0.001,	0.007]
	100	0.016	12.766	0.000	[0.012,	0.019]
	110	0.011	7.721	0.000	[0.007,	0.015]
	121	0.020	12.451	0.000	[0.015,	0.025]
	156	-0.015	10.358	0.000	[-0.019,	-0.010]

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Appendix C. Full list of items

Construct	**Item #***	**Statement** *Please rate your satisfaction with …:* *<1 to 5; 1 = very dissatisfied, 5 = very satisfied>*
General satisfaction	…_02	The content of the programme
	…_03	The general skills you acquire in your programme
	…_04	The academic skills you acquire in your programme
	…_06	The teachers involved in your study programme
	…_07	The information provided by your study programme
	…_08	The learning facilities offered by your study programme
	…_09	Examinations and assessment (e.g. assessment criteria and forms of examinations)
	…_10	Programme schedules
	…_11	Your study load
	…_12	Academic guidance/counselling
	…_15	The opportunities made available to you to help improve your programme
	…_16	How well you are prepared for a professional career
	…_17	Group/class size
	…_18	The way your study programme challenges you in a positive way
	…_19	The attention for internationalisation (in the curriculum, studying abroad, etc.)
Connection to professional practice	…_01	Acquiring skills for professional practice
	…_02	The focus of your programme on professional practice
	…_04	The link to professional practice (e.g. work placements/internships, guest speakers, assignments for external organisations)
Group/class size	…_01	Tutorial group size (project groups)
	…_02	Lecture group size (classes)
	…_03	Your study programme's ratio of large-group learning versus small-group learning
Internationalization	…_01	Encouragement to study abroad
	…_02	Encouragement to learn about other cultures
	…_03	Focus of your programme on international subjects
	…_04	Opportunities offered to you to study abroad or complete a work placement abroad
Program schedule	…_01	The timely publication of study programme schedules
	…_02	The timely notification of schedule changes
	…_03	Practicality of study programme schedules (with regards to factors like times and locations)
	…_04	The number of teaching hours planned
General skills development	…_01	Critical thinking
	…_03	Problem solving
	…_04	Justifying your conclusions
	…_05	Communication skills (e.g. oral presentations, conversation)
	…_06	Teamwork
	…_07	Debating/reasoning skills
Teachers	…_01	Your teachers' subject expertise

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	…_02	Your teachers' teaching skills
	…_03	Your teachers' availability outside contact hours
	…_04	Your teachers' sense of interaction with their students
	…_05	Quality of guidance your teachers provide
	…_06	Quality of feedback your teachers provide
	…_07	The way your teachers inspire you
	…_08	Your teachers' understanding of professional practice in their field
Information supply	…_02	Information about your academic progress
	…_03	Information about rules and procedures
	…_04	Information about the organisation of your study programme (such as majors, minors, studying abroad)
	…_05	Timely publication of examination and assessment results
Content and structure of study	… 01	The level of your study programme
	…_02	How well the content of your study programme meets your expectations
	…_03	The match between your prior education and your programme
	…_04	How motivating you find your programme to be
	…_05	The match between the content of your programme and current professional/academic developments
	…_06	The connection between the various components of your programme
	…_07	The learning methods used in your study programme
	…_09	The quality of the study materials
Quality care	…_01	Evaluation of education and learning based on student feedback
	…_02	Information about evaluation outcomes
	…_03	The way your study programme uses evaluation outcomes
	…_04	The way your study programme deals with complaints and issues
Guidance/ Counselling	…_04	Opportunities for receiving guidance/counselling
	…_05	Quality of guidance/counselling provided
	…_06	The initiative your study programme shows in providing you with support or guidance
Study facilities	…_01	Suitability of classrooms
	…_02	Suitability of workstations (e.g. quality of computers and study rooms)
	…_03	The availability of workstations (e.g. sufficient number of workstations)
	…_05	The library/resource centre
	…_06	IT facilities
	…_07	The digital learning environment
Study load	…_01	The distribution of the study load across the academic year
	…_02	The feasibility of deadlines
	…_04	The ability to take the preferred courses without encountering a study delay
	…_05	How much credits (ECs) correspond to the actual study load
Examination	…_01	The transparency of the criteria used to assess your academic work and progress
	…_02	The suitability of examinations and assessment to the content of the programme

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	…_04	Quality of examination on knowledge
	…_05	Quality of practical examinations
	…_06	The number of assessments in your programme
Challenging education	…_01	Being challenged or invited to give your very best
	…_02	Being given opportunities to pursue your own interests
	…_03	Being encouraged to explore deeper into the curriculum material
	…_04	Students challenging and inspiring each other to perform to a higher level
Scientific skills development	…_01	Analytical thinking
	…_02	Critical assessment of scientific work
	…_04	Writing scientific papers
	…_05	Research methods and techniques
	…_07	Conducting research
Willingness to recommend		Would you recommend your study programme to friends, family or colleagues? *<1 to 5; 1 = No, absolutely not, 5 = Yes, absolutely>*

*Note: the NSE questionnaire has been adapted since its introduction in 1991. Items have been changed or removed and so has their numbering. Numbering, therefore, is non-consecutive.

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Appendix D.

Correlations of the formative (first-order) constructs.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	General skills development	1.00														
2	Teachers	0.53														
3	Group/class size	0.42	0.46													
4	Information supply	0.42	0.53	0.36												
5	Content and structure of study	0.63	0.68	0.47	0.53											
6	Internationalization	0.36	0.37	0.27	0.42	0.37										
7	Quality care	0.46	0.59	0.39	0.53	0.56	0.37									
8	Guidance/ Counselling	0.44	0.59	0.37	0.50	0.53	0.36	0.53								
9	Study facilities	0.37	0.45	0.40	0.47	0.46	0.32	0.48	0.41							
10	Study load	0.37	0.49	0.37	0.49	0.53	0.32	0.47	0.42	0.40						
11	Program schedule	0.35	0.46	0.37	0.51	0.48	0.30	0.44	0.39	0.44	0.54					
12	Examination	0.50	0.59	0.39	0.53	0.64	0.31	0.54	0.47	0.41	0.54	0.47				
13	Challenging education	0.59	0.61	0.42	0.48	0.68	0.43	0.54	0.50	0.40	0.45	0.39	0.55			
14	Connection to professional practice	0.43	0.42	0.28	0.37	0.49	0.27	0.42	0.40	0.33	0.30	0.26	0.37	0.45		
15	Scientific skills development	0.65	0.49	0.34	0.41	0.57	0.31	0.43	0.40	0.34	0.35	0.34	0.48	0.52	0.33	1.00

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