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Assessment of competences in sustainability management. Analyses to the construct dimensionality

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Assessment of Competences in Sustainability Management: Analyses to the Construct Dimensionality

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Abstract

The paper discusses an examination of the dimensions of a competence model for sustainability management. A central assumption is that the dimensions of the competence model differ according to knowledge representation (i.e., declarative vs. schematic and strategic knowledge) and content area (i.e., business administration and sustainability from a societal perspective, as well as sustainability management). Study participants included 850 students from 16 universities in Germany, and the analyses were conducted on the basis of structural equation modeling. The results reveal an expectation-compliant finding whereby the types of knowledge addressed by different assessment formats and content requirements can be presented in two disjunct dimensions. On the one hand, the model analyses indicate a better fit to the multidimensional model, which distinguishes between declarative knowledge in the field of business administration and sustainability from a social perspective, while on the other hand, the analyses suggest a better fit to sustainability management.

Key words: competence model in sustainability management, competence structure, competence diagnostics, business simulation, simulation-based assessment, corporate social responsibility

Abstract deutsch

Dieser Beitrag thematisiert die Messung von Kompetenzen für das Nachhaltigkeitsmanagement. Eine zentrale Annahme des zugrunde gelegten Kompetenzmodells ist, dass sich die Dimensionen nach der Wissensrepräsentation (deklaratives vs. schematisches und strategisches Wissen) und nach inhaltlichen Bereichen (Betriebswirtschaft, Nachhaltigkeit aus gesellschaftlicher Perspektive und Nachhaltigkeitsmanagement) unterscheiden. An der Studie nahmen 850 Studierende aus 16 deutschen Universitäten wirtschaftswissenschaftlicher Studiengänge teil. Die Analysen wurden auf der Grundlage von Strukturgleichungsmodellierungen durchgeführt. Die Ergebnisse zeigen einen erwartungskonformen Befund dahingehend, dass die über unterschiedliche Assessmentformate und inhaltliche Anforderungen adressierten Wissensarten zwei disjunkte Dimensionen darstellen. Die Modellanalysen zeigen eine bessere Passung zum mehrdimensionalen Modell, bei dem zwischen deklarativem Wissen im Bereich der Betriebswirtschaftslehre und der Nachhaltigkeit aus gesellschaftlicher Perspektive einerseits und dem Nachhaltigkeitsmanagement andererseits unterschieden wird.

Schlüsselbegriffe: Kompetenzstrukturmodell für das Nachhaltigkeitsmanagement, Kompetenzdiagnostik, Unternehmenssimulation, simulationsbasierte Messung, Corporate Social Responsibility

1 Introduction

In higher education, there is a growing awareness with regard to education for sustainable development (Barth, Michelsen, Rieckmann & Thomas, 2015). The key objective of these efforts is to integrate the concept of sustainable development as a guiding principle in the curricula of higher education. Furthermore, several indicators related to the education of sustainable development have been implemented to generate control-relevant information for education policy (Michelsen et al., 2011). Despite all of these efforts in sustainability-oriented higher education, fundamental challenges remain. These challenges refer especially to valid instruments to measure learning outcomes of sustainable development (Adomßent et al., 2014). Until now, most approaches focus on general behavioral characteristics and reflect generic skills and key competences (e.g., the concept of Gestaltungskompetenz, de Haan, 2008), whereas domain-specific competences in sustainable development are less frequently considered. This applies in particular to the field of business administration. Existing instruments to measure competences in this field are based on economic concepts from the shareholder perspective and thus assume the maximization of the market value. Sustainability management, however, requires an integrative perspective of the economic, ecological and social implications of business decisions. Existing tests to measure competences in business administration, e.g., the Major Field Achievement Test in Business (ETS, 2011) and the tests developed in the context of the ILLEV and WiWiKOM I-II projects (cf. Zlatkin-Troitschanskaia et al., 2016), are resulting in the identification of business competence structures and their determinants. The specific facet of sustainability management, which has become a growing concern in higher education in recent years, has not been included in these previous studies and tests.

The study of business administration falls under two perspectives. First, students in German universities find the study programs in business administration to be interesting with such classes having the highest number of first semester students during the winter term of 2017/18, specifically, 38,294 out of 437,737 (Statistisches Bundesamt, 2018). Second, entrepreneurial activities play a decisive role in sustainable development. Companies are both, important starting points for sustainability problems and key players in solving the problems.

Therefore, this study[1] aims to develop and test a competence model to assess learning outcomes in the field of sustainability management in higher education business administration study programs. In this paper, the development of the assessment framework, the underlying competence model and the first empirical results regarding the competence structure are discussed.

2 Theoretical Framework

The most widely accepted definition of sustainability is derived from the Brundtlandt Report of the United Nations World Commission on Environment and Development, which defines sustainable development as the endeavor to satisfy the needs of the present generation without risking the fundamentals of life for the next generation (WCED, 1987). Sustainable development can only be realized if economical, ecological and social issues are considered together and if their interdependencies are also taken into account. This definition is understood as a guiding principle for policy, political decision-making and actions in various societal areas primarily because it does not pit ecological, economic and social perspectives against each other. For the definition and operationalization of sustainability-related learning goals and the measurement of learning outcomes, however, it is necessary to identify domain-specific concepts, definitions and competence models.

Competence in sustainability management is defined as the complex ability to identify and consider the stakeholders' somewhat aligned/somewhat conflicting economic, environmental and social goals in the target system of a company. This means, in particular, to take into account the short-, medium- and long-term interactions of the stakeholders' different goals and the consequences for the company as well as for the company's surrounding area. Accordingly, sustainability management means to manage a company in such a way that it exists in the long term and contributes positively to the sustainable development of society and the natural conditions of the environment (based on Seeber, Hartig, Dierkes & Schumann, 2016). With respect to corporate decision making for sustainability management, it is assumed that the different sustainable goals are partly interchangeable, which is, consistent with corporate management practice, a realistic and,

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hence, a plausible assumption. Moreover, a constant weighting of the economic, environmental and social goals in all corporate decision-making processes is not presumed because the weighting depends on the sustainability relevant issue. Thus, the degree of consideration of the economic, environmental and social goals in management practice varies between a classic triple-bottom-line approach (Elkington, 1999) and an economic triple-bottom-line approach. This definition is based on an understanding of sustainability management that is oriented toward realistic market mechanisms and the requirements of various stakeholders. However, the balanced preservation of the resource base and the efficient use of the resources cannot (always) be achieved. Hence, the great challenge is to legitimize the trade-offs that arise (Müller-Christ, 2011).

The above definition of competence in sustainability management also clearly emphasizes that from a content perspective, this construct is located between sustainability from a more general societal perspective and the fundamental aspects of business administration. The implementation of sustainability in companies requires the incorporation of normative ideas and principles into the decision-making process, the development of models for identifying and evaluating alternative courses of action, and the integration of these courses of action into existing structures, processes and information instruments in companies. Thus, coping with sustainability relevant corporate decision-making situations requires a fundamental knowledge of the sustainability concept, on the one hand, and of the adequate possibilities for operationalization in business management, on the other.

Previous studies in the field of vocational education and training (VET) have examined the multidimensionality of domain-related competence structures with two subdimensions, namely, declarative expertise knowledge regarding sustainability and the ability to apply this knowledge in variable problem-solving situations (Michaelis, 2017; Seeber & Michaelis, 2014). While the domain-specific knowledge and understanding about theories and concepts is primarily composed of declarative knowledge, the ability to apply this knowledge in operational management situations, which are decision-making situations, requires the integration of different types of knowledge. Management decision making requires the integration of procedural and declarative knowledge, the development of mental models and the application of domain-specific heuristics, which are described by the term's schematic and strategic knowledge (schematic [why] and strategic [when, where, how]

knowledge). For example, the development of a sustainability-oriented logistic system requires, on the one hand, declarative knowledge about the environmental impact of logistics with respect to different types of transport modes, system transports, life cycle assessments, etc. and, on the other hand, declarative and procedural knowledge of the business administrative domain, particularly with respect to cost-benefit analysis. Furthermore, to make a decision, the specific situation of the company, such as its objectives, strategies, interests of stakeholders, etc., as well as the local and regional infrastructure conditions must be considered. In other words, "strategic knowledge is rarely ever directly measured. Rather, it is implicated when other types of knowledge are accessed" (Shavelson, Ruiz-Primo & Wiley, 2005, 415).

Therefore, in this study, a multidimensional competence model for sustainability management based on the findings from the VET research is assumed. First, the dimensions differ according to knowledge representation, i.e., declarative, procedural, schematic and strategic knowledge (Shavelson & Ruiz-Primo, 1999), and second, according to content differentiations, i.e., (1) sustainability from a societal perspective, (2) business and administration, and (3) sustainability management.

For the preliminary competence model, a four-dimensional structure derived from economic, ecological, and social considerations is assumed: (1) declarative **k**nowledge about **s**ustainable **d**evelopment from a societal perspective (KSD), (2) declarative **k**nowledge of **b**usiness **a**dministration (KBA), (3) declarative **k**nowledge of **s**ustainability **m**anagement (KSM), and (4) the ability to generate strategies and justifications for specific options in terms of sustainability management (SSKSM, **s**chematic and **s**trategic **k**nowledge in **s**ustainability **m**anagement), .

It is not assumed that these four dimensions are independent from each other. Instead, a substantial correlation between KBA and KSM as well as between these two dimensions and the ability to apply this knowledge in managerial situations (SSKSM) is expected. Furthermore, we assume a substantial correlation between KSD and KSM as well as between both constructs and SSKSM.

The competence model for sustainability management is underpinned by a business model linking a system-based perspective with a process-based perspective. In this model, enterprises are complex systems embedded in specific changing environments that interact with different stakeholder groups. Considering the state of research, however, sustainability

decisions in an entrepreneurial context are not based solely on declarative knowledge factors, but rather, they are closely linked to the individual value system (Michaelis, 2017). Therefore, it can be assumed that the application of schematic and strategical knowledge elements in sustainability management is supported by sustainability related attitudes and motives. This aspect, however, cannot be covered in depth in this article, and therefore is declared as a research outlook at this point.

Figure 1: Competency structure model “Sustainability Management” (based on Seeber, Hartig, Dierkes & Schumann, 2016)

Insert figure 1 here

3 Test Development

Due to the research gap in competence measurement for sustainability management, there are no published and valid test instruments for this domain. Consequently, test instruments have been developed. Taking into account the central facets of the competence model (see Figure 1), the assessment must focus on a cognitive perspective of the different types of knowledge to be addressed. While declarative knowledge can be measured with selected tasks from the domain in form of multiple-choice-items and short answer items, the ability to apply this knowledge and to make strategic managerial decisions requires a more complex test-setting that allows for the transferability of knowledge and the integration of different types of knowledge to authentic entrepreneurial decision-making situations with incomplete and multilayered information. For this reason, a computer-based assessment design was chosen.

The test for the measurement of declarative knowledge about sustainability from a societal perspective is based on previous work in the area of VET (Michaelis 2017, Seeber & Michaelis 2014). Figure 2 presents a sample item.

Figure 2: Example of an Item on the KSD test.

Insert figure 2 here

New instruments had to be developed for the dimensions of KBA, KSM and SSKSM.

The KBA test was developed on the basis of accepted and widespread textbooks of business administration (Thuis & Stuive, 2014). The KSM and the SSKSM tests are based primarily on current research on sustainability management that focuses on the alignment of the company with the target dimensions of sustainability (Schaltegger & Wagner, 2006). In the interest of active sustainability management, the ecological and social impacts are not only considered on the basis of external requirements, e.g., legal requirements but also systematically along the entire value chain. For the development of the items, we divided the company's activities into primary and secondary value chain components, as discussed in previous literature. Figure 3 presents an example of the fundamental questions on corporate sustainability management from the KSM test.

Figure 3: Example of an item for the KSM test.

Insert figure 3 here

To measure the ability to apply business knowledge and knowledge about sustainability in complex situations (SSKSM), a simulation was developed in which the students must empathize with the various management situations of a bicycle manufacturer. Accordingly, 13 different situation based stories along the entire value chain of this virtual company were developed. As exemplified in Figure 4, the students are introduced to the situation via a video. To make and justify a decision regarding further action, the students gain access to mail traffic, transport routes, cost statements and other documents. The subsequent items for this situation contribute to the continuation the story.

Figure 4: Example of an item from the SSKSM test.

Insert figure 4 here

This instrument is more consistent with a performance assessment. Consequently, this instrument measures primary schematic and strategic knowledge. Table 1 provides an overview of the core field of content of the test instruments.

Table 1: Core field of content of test instruments

Insert table 1 here

The final test instruments include 80 items for KBA, 53 for KSD and 51 for KSM. The SSKSM test consists of 73 items and 13 complex situations. The situations of the SSKSM test are presented in a balanced booklet design such that students had to respond to only three or four situations. The cognitive requirements of the tasks for all test components have been varied systematically. We used a modified version of the cognitive taxonomy of Anderson and Krathwohl (2001) as well as aspects of functional modeling and complexity to vary the cognitive requirements of the tasks. Additionally, the booklets were designed so the average response time was approximately 45 minutes, according to a pilot study. The results of the confirmatory factor analysis (see section 5.3) for the SSKSM dimension indicate that each booklet loads, on average, between .31 and .54 on the SSKSM dimension, which we interpret as comparable factor loadings.

Furthermore, a questionnaire has been developed to measure interests, learning opportunities and attitudes toward sustainability (see figure 1).

4 Research Questions

This study aims at the empirical testing of the dimensionality of the competence model. Regarding the internal structure of the response data, we assume unidimensional structures for each of the achievement tests, and we also assume that the response data from all tests can be adequately described by a four-dimensional structure with separate factors for each test. The following hypotheses are tested as follows:

H1: The response data within each test fits a unidimensional structure.

H2: The response data from all achievement tests have a multidimensional structure with separable dimensions for KSD, KBA, KSM and SSKSM. Furthermore, there is an interest in the strength of the relationships between the dimensions of the competence model. The correlation analysis is presented in the following hypothesis:

H3: We assume, according to previous research in the field of competence measurement, that all correlations between the four dimensions are positive.

In principle, it is assumed that KSD and KBA are considered as the reference dimensions for KSM and SSKSM. Regardless of general normative sustainability considerations, sustainability decisions in corporate contexts always require a substantial business administration rationality. The time for and degree of the additional consideration of environmental and social impacts of the company depend greatly on the stakeholders' interests and the market conditions. Therefore, the following hypothesis is presented.

H4: The correlation between KBA and KSM is stronger than the correlation between KSD and KSM.

In addition to Hypothesis 4, it is assumed in Hypothesis 5 that the application of knowledge toward sustainability management is most strongly associated with the content-related test component of declarative and procedural knowledge about sustainability management:

H5: The correlation between KSM and SSKSM is stronger than both the correlation between KBA and SSKSM and the correlation between KSD and SSKSM.

5 Method

5.1 Sample and Test Administration

Table 2 shows the composition of the data collected at 16 universities.

Table 2: Sample size and composition

Insert table 2 here

To ensure a representative sample, the majority of students were interviewed directly in lectures and tutorial sessions. Participation was voluntary in accordance with the legal requirements, but all participants received a voucher for cinema or online shopping. The test was restricted to 90 minutes. Students were provided with tablet computers, calculators and headphones.

The first three test modules (KSD, KBA, KSM) were restricted to ten minutes each, and students were informed about the time remaining. During this time, it was not possible for participants to answer all questions. Therefore, the items were displayed randomly, and the

users were forwarded directly to the next unit after 10 minutes. On average, students answered 24.27 (median = 23) KSD items, 24.2 (median = 21) KBA items and 22.02 (median = 20) KSM items. After completing the three declarative tests, they continued with the business simulation (SSKSM).

Items that were presented to students but were skipped, i.e., left unanswered and then continued to the next item, thus resulting in a missing response, were coded as incorrect. Items not presented within the time limit of 10 minutes, i.e., not reached, were coded as missing.

5.2 Analysis

To assess the dimensionality of the KBA, KSM, KSD and SSKSM tests, we performed confirmatory factor analysis in Mplus (Version 7.31, Muthén & Muthén, 1998-2013) using the WLSMV estimator for ordinal data and theta parameterization. For the evaluation of model fit, we report χ^2 values with corresponding degrees of freedom, as well as CFI, TLI and RMSEA fit indices. According to Hu and Bentler (1999), we consider values close to .95 for CFI / TLI and .06 for RMSEA as indicators of good model-data fit. First, one factor models with the factor variance set to 1 and the factor mean set to 0 (basic model) were performed, thus all factor loadings were estimated freely. In a second step, items with negative or nonsignificant factor loadings (Model 2) were excluded. Subsequently, residual correlations between the observed variables were checked. In a last step, models that estimated residual variances between sets of items with modification indices greater than four (Model 3) were specified. Due to the testlet design for the situational judgment test, where each test taker was presented with only 17 to 27 out of 72 items, the covariance coverage was low, and contingency tables for some of the graded items contained empty cells. To overcome estimation problems, item scores within one situation were aggregated to total scores for every situation, and these situation scores were used to specify the basic model as described above. As this issue results in continuous indicators, the MLR estimator for the analysis of the SSKSM test was used.

Unidimensional 2PL models using the package TAM (Robitzsch, Kiefer & Wu, 2018) in R (R Core Team, 2017) to report the EAP reliability for each of the tests were estimated. As it is not possible to model local dependencies in TAM, these statistics were reported only for the first two steps (basic model and Model 2). They were not reported for Model 3.

Hypothesis 2 was tested by evaluating the global fit of the four-dimensional model and by comparing the theoretically assumed four-dimensional model to a one-dimensional model using the MLR estimator. Difference testing was performed by calculating a scaled chi-square difference test (Satorra & Bentler, 2010). Due to the large number of items compared to the test-taking time for the declarative test modules and the testlet design for the simulative test module, we controlled contingency tables with empty cells. To overcome estimation problems, item parcels were used. Three parcels per test as indicators of the latent constructs were built (Little et al., 2002) by taking item difficulties and factor loadings into account. The estimation of the four-dimensional model also provides the latent correlations between the scales (hypothesis 3). Hypotheses 4 and 5 were assessed by conducting significance tests of the differences of the correlations.

6 Results

Table 3 presents the different factor models for each of the tests with corresponding fit indices. The RMSEA indices show good model fit for every model and for every test, whereas each of the basic models show neither good model fit according to the CFI and TLI nor satisfactory reliability for the unidimensional models. After excluding items with negative or nonsignificant factor loadings in Model 2, the scales indicate better but still not satisfactory model fit. In all of Model 2, we find considerable residual variances between the observed variables. After allowing the biggest residual correlations of observed variables to correlate, Model 3 shows good model fit to unidimensional models for the response data of the KSD, KSM and SSKSM tests. For the KBA test, although the CFI and TLI indices improve from the basic model to Model 3, they still remain below a value of .95. Except for the SSKSM test (*rel* = .70), the reliabilities for the tests do not reach acceptable levels and marginally decline in the second model.

The four-dimensional factor solution for the overall model indicates good model fit (χ^2 = 53.134; df = 48; p = .28; RMSEA = .011 90 % CI [.000 - .026]; CFI = .99; TLI = .99). The scaled chi-square difference test reveals that the less restrictive four-dimensional model fits the data better than the one-dimensional model ($\bar{T}_d$ = 35.629; df = 6; p < .001), thus supporting hypothesis 2.

The correlations between the dimensions, as presented in Table 4, are all positive and differ significantly from zero (p < .001), which supports hypothesis 3. However, in

hypothesis 4, the significance test of difference for the correlations between KBA and KSM and between KSD and KSM indicates that the correlations do not differ significantly from zero (p = .90). The significance test of difference also contradicts hypothesis 5 as the correlation between KSM and SSKSM is neither larger than the correlation between KBA and SSKSM (p = .23) nor larger than the correlation between KSD and SSKSM (p = .19).

Table 3: Fit indices for the basic models and modified models for each of the tests

Insert table 3 here

Table 4: Correlations among the latent constructs with bootstrapped confidence intervals based on 500 replications

Insert table 4 here

7 Discussion

7.1 Dimensionality of the newly developed tests

The findings suggest that the tests are not strictly unidimensional, contrary to hypothesis 1. According to the selected fit indices, an acceptable model fit for unidimensional models is only reached by excluding items with nonsignificant or negative factor loadings and including local item dependencies for each test. To begin, the model estimation process for hypothesis 1 will be discussed as will the steps undertaken for Model 2 and Model 3.

For all of Model 2, items with nonsignificant or negative factor loadings were excluded. As item exclusion is based on statistical criteria, it is important to note that the theoretically assumed constructs are still represented by the remaining items.

As CFI and TLI did not reach acceptable values after estimating Model 2, local dependencies for Model 3 were subsequently estimated. Nevertheless, it should be noted that CFI and TLI are close to the cutoff value .95 for the KSD and SSKSM tests.

For all of Model 3, local dependencies between items or situations were included, respectively. We propose two strategies for dealing with these local dependencies in further research. If item pairs with local dependencies cannot be explained by content, excluding items with high local dependencies could be considered, providing the remaining items still cover the assumed constructs. This strategy is more suitable for the declarative tests because items for these tests were constructed independently of each other (in contrast to the items for the SSKSM test) and were designed to cover a variety of topics within their constructs, e.g., production, logistics, corporate management, and human resource management for the KBA test. Therefore, explaining local item dependencies based on item content seems unlikely.

On the other hand, a content-based examination of dependencies between the situations could be helpful for the SSKSM test. Hence, the thirteen situations are depicted in different business units. Considering the business processes model, the business units can be located in either production, corporate management or support process. The clustering into business processes could account for local dependencies between some of the situations on the SSKSM test. To assess this hypothesis, more complex models could be considered that account for the clustering of situations into different business domains. These models would require a larger sample than that available in our present study.

Regarding hypothesis 2, the analysis confirms the assumed multidimensional competence model. Thus, the results confirm the findings of previous research on the separation of knowledge representation (Michaelis, 2017; Seeber & Michaelis, 2014). However, previous studies have neglected the interaction with the theoretically assumed basic discipline of business administration for sustainability management.

7.2 Relations between the Dimensions in the Model

With respect to the relationships between and among the dimensions, all dimensions have positive correlations, thus confirming hypothesis 3, but the assumed differences in strengths between the dimensions, i.e., hypotheses 4 and 5) are rejected. Both the KBA and KSM indicate a significant proportion of shared variance with the SSKSM dimension. Indeed, the correlations show that the stronger the proportion of business administration in the respective test component, the lower the relationship with the situational test component. The weaker relationship between the KBA and SSKSM could be traced to a thematic

background. Moreover, this can be partially explained by the dependence of sustainable decisions on the particular situation of the decision maker, in which general knowledge of sustainability has a stronger influence on the decision than does classical knowledge about business administration. However, there is conflicting ideas regarding the weighting of the sustainability dimensions to each other (Elkington, 1999). For example, on the one hand, competitive advantages can be achieved by observing sustainability relevant aspects. On the other hand, sustainability commitment is also associated with operating expenses. From a more neoclassical perspective of business administration, increasing marginal returns in favor of economic success is only realistic to a certain level of environmental protection or social commitment (Schaltegger & Synnestvedt, 2002). Moreover, the reactions of the different stakeholders regarding a more sustainable management are difficult to assess, especially for the capital holders. Thus, taking into account the results, it can hypothetically be assumed that a high level of knowledge about business and administration and an attitude toward a neoclassical perspective on business administration can inhibit performance on the SSKSM. However, differentiated structure equation models with an examination of the influence of affective and motivational dispositions (especially attitudes) are necessary for such a hypothesis test.

Nevertheless, the results clarified that the promotion of declarative knowledge regarding sustainability from a general societal perspective is important when making business decisions from a sustainable development perspective. However, previous competency models of sustainability management considered more domain-specific sustainability management knowledge elements than the general sustainability perspective (e.g., Hesselbarth & Schaltegger, 2014). This approach is particularly important with regard to the future design of a range of courses at universities with respect to the promotion of competences toward sustainability management.

7.3 Methodological issues

One major technical limitation of our study is the sample size. Although the total number of participants is large, the number of responses per item is low, and the covariance coverage in the current sample is particularly low due to the incomplete assessment design. The analysis of the dimensionality of both the individual achievement test and the whole model should be replicated with a larger sample size. For the SSKSM test, the covariance coverage was too low to analyze dimensionality at the item level. Therefore, item parcels for the

analysis of the dimensionality of the SSKSM test and for the estimation of the overall four-dimensional model were used. Parceling is a methodological technique often criticized for possibly covering model misspecifications. While we are convinced that parceling is adequate to analyze the multidimensional model across all tests, a closer examination of the dimensionality of the SSKSM test with a larger sample size and higher covariance coverage remains desirable.

A second technical limitation is that we cannot control for effects of different response formats of the declarative test components and the situational test component. The response format can affect the correlations between the situational test items and the declarative ones and in consequence the dimensional structure across the four tests. Nevertheless, we contend that the response format affects the size of the absolute correlation but not the direction of the correlation (hypothesis 3). If the response format affects relations between the tests, all correlations between the declarative test components and the situational test will probably be affected in the same way. Accordingly, the relative differences in the correlations in which we are interested will not be impacted (see hypothesis 4 and 5).

One noticeable detail in the results is the low reliability of the declarative tests (see Table 3). Given that the aim of the study was to cover a broad field of content within a limited testing time, the low reliabilities can be attributed to a relatively low number of item responses per person. If the testing time were extended, e.g., from 10 to 30 minutes, reliabilities of .50 could potentially be increased to .75.

8 Conclusion

The findings of this study confirm the assumed multidimensional structure of competences in sustainability management. The unidimensionality of the tests assessing the four dimensions, however, are ambiguous. This issue should be addressed by either revisions of the test instruments or by a more fine-grained analysis of the dimensional structure using more complex models, a strategy that will require larger sample sizes. The findings also indicate that the pattern of relations between the four dimensions is not consistent with our original assumptions and that the declarative knowledge about sustainability has the strongest relation to performance when making business decisions that take sustainable development into account. This finding may imply that the promotion of knowledge about sustainable development from a societal perspective should be given

greater weight in business administration and economics degree programs. Hence, future research should consider two challenges. One is the investigation of the role of interests, attitudes and internalized ethical norms regarding business decisions related to sustainability. The second is the examination of the learning opportunities that promote the development of competences in sustainability management with respect to both individual and institutional contexts.

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Tables

Table 1: Core field of content of test instruments

Competences in sustainable development from a societal perspective (KSD)	**Competences in business administration (KBA)**
- Theoretical and widespread normative concepts, facts and their significance - Sustainability strategies - Currently discussed sustainability examples, such as certificates	- Finance & accounting - Procurement, material management, logistics and production - Marketing, corporate communications, channel management, human resources management - Corporate governance, strategic planning, management accounting
Knowledge of sustainability management (KSM) and schematic and strategic knowledge of sustainability management (SSKSM)	
- Sustainability in strategy and process planning, marketing and human resource management, product development and materials management, supply chain management and logistics - Innovation management, company life-cycle assessment - Legal framework conditions for corporate sustainability management - Sustainability reporting, sustainability indicators, environmental cost accounting	

Table 2: Sample size and composition

Total sample size	**Course of Studies**			**Bachelor ratio**	**Age** (median / standard deviation)	**General matriculation standard**	**Native language: German**
	Business administration	**Economics**	**Business education**				
850 (357 female, 191 miss.)	218	193	177	68.3 %	23 / 3.03	92.4 %	92.2 %
		197 miss.		194 miss.	212 miss.	191 miss.	191 miss.

Note: miss. = missing responses.

Table 3: Fit indices for the basic models and modified models for each test

		Basic model	Model 2	Model 3
KBA	**Modification**	-	**20 items excl.**	**9 dependencies**
	χ^2 (df)	3168.920 (3080)	1800.918 (1710)	1750.702 (1701)
	RMSEA	.006	.008	.006
	90 % CI	[.000 - .009]	[.000 - .012]	[.000 - .010]
	CFI	.81	.85	.92
	TLI	.81	.84	.91
	EAP.rel	.57	.56	-
KSM	**Modification**	-	**18 items excl.**	**13 dependencies**
	χ^2 (df)	1314.624 (1224)	562.386 (495)	489.195 (482)
	RMSEA	.010	.014	.004
	90 % CI	[.003; .014]	[.006; .019]	[.000; .013]
	CFI	.79	.87	.99
	TLI	.78	.86	.99
	EAP.rel	.53	.51	-
KSD	**Modification**	-	**13 items excl.**	**14 dependencies**
	χ^2 (df)	1373.735 (1325)	789.184 (740)	704.128 (726)
	RMSEA	.007	.009	.000
	90 % CI	[.000; .012]	[.000; .015]	[.000; .009]
	CFI	.92	.94	1.00
	TLI	.92	.93	1.00
	EAP.rel	.60	.60	-
SSKSM	**Modification**	-	**1 situation excl.**	**5 sit. dependencies**
	χ^2 (df)	73.694 (59)	61.694 (51)	39.74 (46)
	RMSEA	.018	.016	.000
		[.000; .030]	[.000; .030]	[.000; .018]
	CFI	.92	.94	1.00
	TLI	.90	.92	1.00
	EAP.rel[a]	.70	.69	-

Note: Basic model: 1-factor model, factor variance = 1, mean = 0. Model 2: items removed with nonsignificant or negative factor loadings (.1 level, 1-sided hypothesis testing). Model 3: Correlated residuals for item pairs with mod. indices > 4 are estimated

Table 4: Correlations among the latent constructs with bootstrapped confidence intervals based on 500 replications

	KBA		KSM		KSD	
		(SE) [90 % CI]		(SE) [90 % CI]		(SE) [90 % CI]
KBA						
KSM	**.76**	(.095) [.58, .98]				
KSD	**.59**	(.087) [.43, .74]	**.75**	(.087) [.58, .93]		
SSKSM	**.47**	(.097) [.31, .65]	**.64**	(.104) [.46, .83]	**.81**	(.086) [.64, .98]

Note. N = 847 students. Bold numbers represent significant correlations ($p < .001$).

Abbildungen

Figure 1: competency structure model “sustainability management” (based on Seeber, Hartig, Dierkes & Schumann, 2016)

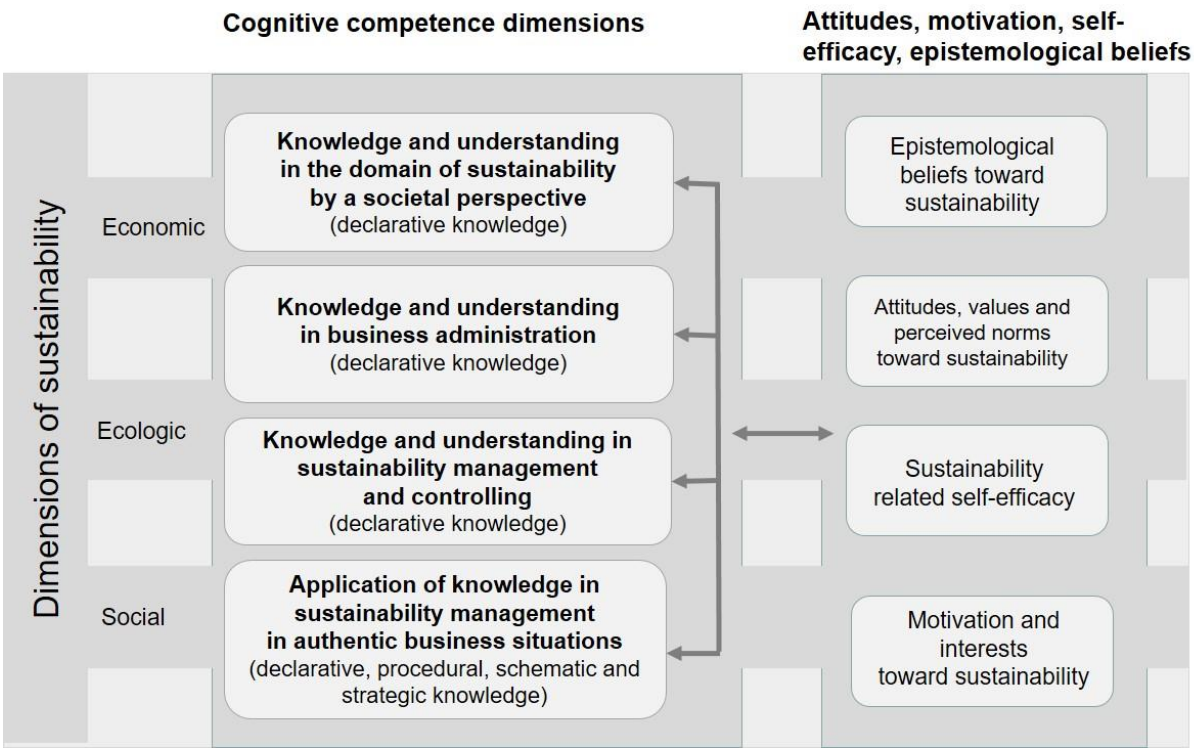

Figure 2: Example of an item for the KSD-test

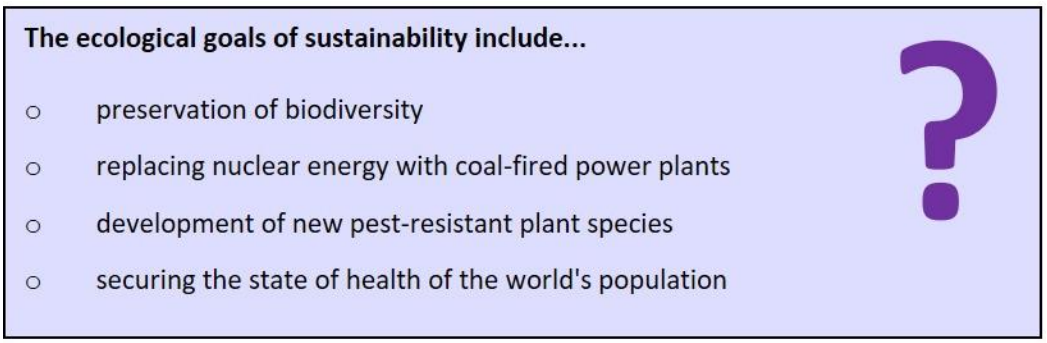

Figure 3: Example of an item for the KSM-test.

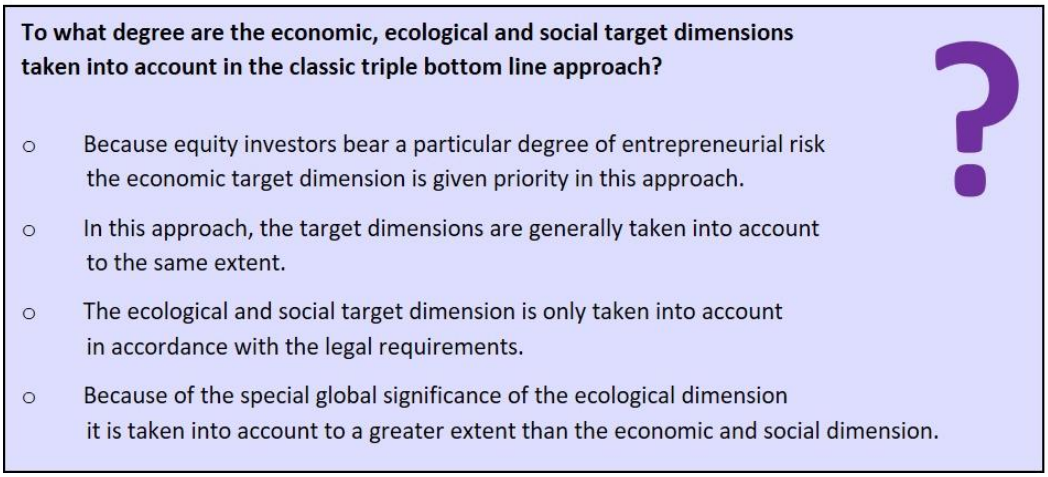

Figure 4: Example of an item for the SSKSM-test.