EFFECTS OF LIFE SATISFACTION ON STUDENTS' ATTITUDES TOWARDS STATISTICS AND TECHNOLOGY AND THEIR INTERRELATIONSHIPS

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Abstract

In a society in which technology and changes are increasingly fast, the role of Statistics has become increasingly important. The students' attitudes towards Statistics, according to the literature review, are very interrelated with the affective and cognitive components and with the value attributed to this discipline in terms of its importance and usefulness in their personal and professional life. The psychological well-being of students, in addition to all other related components, as well as their attitudes towards Statistics and Technology, can affect their involvement and learning of contents in the scope of this discipline.

The present research, through a questionnaire, aims to better understand the attitudes that students have towards Statistics and Technology and what are the factors that can affect their learning. The Questionnaire used includes, among other variables, the Life Satisfaction Scale (Diener et al., 1985), consisting of five items measured in a 5-point Likert scale (1- Strongly Disagree to 5-Strongly Agree), and a set of twenty-eight items related to the students' attitudes towards Statistics and Technology, measured in a 7-point Likert scale (1- Strongly Disagree to 7-Strongly Agree). According to Anastasiadou (2010), this set of items is distributed into five different attitude subscales (Statistics Cognitive Competence-Confidence (6 items); Technology Cognitive Competence-Confidence (4 items); Attitudes to learning statistics with technology (6 items); Value (6 items); Affect (6 items)).

The participants in this study were students from Portuguese Universities who had already attended Statistics courses during the 1st cycle of higher education. A structural equation model analysis, performed using PLS, revealed a statistically significant relationship between satisfaction with life and the five subscales of Students Attitudes toward Statistics and Technology Scale. In the model used, almost all the interrelationships between the factors of attitudes of students were statistically significant at level 0.01, suggesting that the use of technology affects the students' attitudes regarding the components "Affect" (emotions concerning statistics) and "Value" (usefulness of statistics in students' personal and professional life).

Keywords: Effects of life satisfaction, Students' attitudes, Statistics and Technology.

1 INTRODUCTION

Life satisfaction is regarded as the cognitive component of subjective well-being and involves a global evaluation of the quality of one's own life. Life satisfaction is often studied as the best indicator of an individual's perceived life quality [1]. Individuals with a high satisfaction with life have positive well-being in terms of health and social skills [2]. In this context, the same authors consider that the acquisition of good levels of satisfaction in life has a positive link to social relationships. In this sense, a research developed by Delle Fave et al. [3] suggested that social relations and family relations are strongly linked to feelings of happiness and meaningfulness in life.

Undergraduate students that have higher life satisfaction have a better academic performance, less academic stress, and are more goal-oriented compared to those with average or lower life satisfaction [4-5]. In fact, several studies have demonstrated that high life satisfaction is an important facilitator of student engagement and academic achievement among university students [6-7]. Furthermore, students with high life satisfaction tend to be more satisfied with their academic experiences [8]. Life satisfaction is also associated with more positive academic expectations, increased academic self-efficacy, greater perceived progress toward goals, and less academic stress [9].

Many undergraduate students have negative feelings about the area of statistics (*e.g.,* [10]), probably due to its association with Mathematics. Thereby, in nowadays, with the technological advances and the widespread use of technology, it is important to ascertain whether the use of technological devices has an impact on the students' attitudes towards Statistics. To achieve this purpose, Anastasiadou [11] developed the Students Attitudes toward Statistics and Technology Scale (SASTSc), which comprises five dimensions (factors), among which are the Affect and Value dimensions. The Affect dimension is a means of measuring the students' positive or negative feelings on statistics learning [12]. According to Larwin [13], this construct can be used to identify the attitudes on statistics that may have derivate from past experiences or feedbacks from others. On the other hand, the Value factor, intends to measure the attitudes of students concerning the usefulness, relevance and worth of Statistics in the students' personal and professional life [12].

According to Chance et al. [14], the types of technology used in statistics and probability instruction can be divided into the following categories: Statistical software packages, educational software, spreadsheets, applets/stand-alone applications, graphing calculators, multimedia materials, and data repositories". The same authors also emphasize *that "different types of statistical software programs have been developed exclusively for helping students learn statistics" and that "Some of these educational packages are also making it easier for students to access large datasets (e.g., Census data) and for teachers to access pre-developed classroom exercises*".

This work aims to deepen the knowledge about Effects of life satisfaction on students' attitudes towards Statistics and Technology and the main factors that can affect these attitudes, based on the identification of possible interrelationships among constructs (subscales) of the SASTSc, which will be described in Section Methodology.

2 METHODOLOGY

The target population of this study was the higher education students from Portuguese universities who have already attended at least one course in Statistics. The empirical study examined a sample of 508 undergraduate university students, who have already attended Statistics courses in a Portuguese university. Most respondents are female (63.4%) and are very satisfied with their lives (65.6%), as will be explained later in this section.

The self-administered questionnaire also presents a section concerning the Satisfaction With Life Scale (SWLS [15]) that was used to assess the participants' life satisfaction. This scale is a reliable and well-established measure that includes five statements that reflect a positive evaluation of life quality. The participants were asked to state their level of agreement with each sentence, on a five-point ordinal scale (1- Strongly disagree; 2 - Slightly disagree, 3- Neither agree nor disagree, 4 - Slightly agree, 5 - Strongly agree). The scale items are: SAT1 "In most ways my life is close to my ideal", SAT2 "The conditions of my life are excellent", SAT3 "I am satisfied with my life", SAT4 "So far I have gotten the important things I want in life" and SAT5 "If I could live my life over, I would change almost nothing". The scores obtained in the SWLS can vary between 5 to 25, and in the present study the average of the scores obtained by the students was 19.31 (SD = 4.23), verifying that the majority (65.6%) of these students have high levels of satisfaction (above average).

The values of Cronbach's alpha reliability coefficient for the SWLS have ranged from .79 to .89 in previous studies [6,16], and in the present sample, the value of this coefficient was .88, revealing a good internal consistency of the scale items. have a satisfactory internal consistency,

Other important section of the questionnaire corresponds to the Students Attitudes toward Statistics and Technology Scale (SASTSc). This instrument comprises 28 items distributed over five different attitude subscales, as follows [11]: (i) Statistics Cognitive Competence or Cognitive Competence in Statistics (CCS) - positive and negative attitudes concerning a student's knowledge and skills as applied to statistics (items CCS1, CCS2, CCS3, CCS4, CCS5, CCS6); (ii) Technology Cognitive Competence or Cognitive Competence in Technology (CCT) – positive and negative attitudes concerning a student's knowledge and skills as applied to technology –computers (CCT1, CCT2, CCT3, CCT4); (iii) Attitudes to learning statistics with technology (Tec) -positive and negative attitudes concerning the student's attitudes to learning Statistics with technology (Tec1, Tec2, Tec3, Tec4, Tec5, Tec6); (iv) Value (Value)- positive and negative attitudes to the worth and usefulness of statistics in students' personal and professional life (V1, V2, V3, V4, V5, V6); (v) Affect (Affect)- positive and negative emotions concerning Statistics (Af1, Af2, Af3, Af4, Af5, Af6). Table 1 contains the description of the scale items.

Table 1 – List of items distributed over different attitudes subscales

CCS1 - "I am confident with statistics"; **CCS2** - "I can understand statistical reasoning easily"; **CCS3** - "I can understand statistical inference easily"; **CCS4** - "I can learn statistics easily"; **CCS5** - "I can solve difficult statistical test hypothesis problems"; **CC6** - "I take high marks in statistics".
Cognitive Competence in Technology (CCT)
CCT1 - "I am very good at computers"; **CCT2** - "I don't have problems at using software"; **CCT3** - "I can easily run SPSS"; **CCT4** - "I can fix many hardware problems in computers".
Technology (Tec)
Tec1 - "Technology makes the learning of Statistics easier"; **Tec2** - "Technology makes the learning of Statistics more interesting"; **Tec3** - "Technology helps me to understand Statistics"; **Tec4** - "I prefer to use technology to evaluate statistical problems"; **Tec5** - "I like to use computers to make statistical graphs"; **Tec6** - "SPSS software helps me to discover many different statistical applications".
Value (Value)
V1 - "Statistics is valuable"; **V2** - "Statistics makes me overqualified"; **V3** - "Statistics is a part of our daily life"; **V4** - "Statistics helps me to understand economy"; **V5** - "Statistics helps me to understand politics"; **V6** - "Statistics helps me to understand reports on the newspapers".
Affect (Affect)
Af1 - "Learning Statistics is enjoyable"; **Af2** - "I like learning Statistics"; **Af3** - "Statistics is interesting"; **Af4** - "Statistics is not a frustrating discipline"; **Af5** - "I get a lot of satisfaction solving statistical problems"; **Af6** - "I am not afraid of Statistics".

The respondents were asked to indicate their level of agreement with each item, through a seven-point Likert-scale where 1 represents strong disagreement and 7 strong agreements. The value of the Cronbach's alpha coefficient for this instrument was 0.96, indicating a good internal consistency of the scale items.

This study investigates the relationships between satisfaction with life, and factors associated students' attitudes about statistics and Technology. Taking into consideration our main research question, "*Do students' attitudes towards Statistics and Technology differ according to their satisfaction with their life*?", we formulated the following research hypotheses to address these issues:

- Hypothesis 1 (H1): Satisfaction with life has effect on Statistics Cognitive Competence;
- Hypothesis 2 (H2): Satisfaction with life has effect on Technology Cognitive;
- Hypothesis 3 (H3): Satisfaction with life has effect on Technology;
- Hypothesis 4 (H4): Satisfaction with life has effect on Affect;
- Hypothesis 5 (H5): Satisfaction with life has effect on Value;
- Hypothesis 6 (H6): Statistics Cognitive Competence has effect on Affect;
- Hypothesis 7 (H7): Technology Cognitive Competence has effect on Affect;
- Hypothesis 8 (H8): Technology has effect on Affect;
- Hypothesis 9 (H9): Technology has effect on Value;
- Hypothesis 10 (H10): Statistics Cognitive Competence has effect on Value;
- Hypothesis 11 (H11): Technology Cognitive Competence has effect on Value;
- Hypothesis 12 (H12): Affect has effect on Value.

All participants were informed about the aims of the study and signed an informed consent form. Moreover, the privacy and confidentiality of data were secured (there are no individual or institutional identifiers in the dissemination of the results). The collected data were analysed using several statistical procedures. Here, we focus our attention only in the results from Partial Least Square Structural Equation Modeling (PLS-SEM), in order to assess the formulated hypotheses.

3 RESULTS

The evaluation of the measurement model started with a confirmatory factor/composite analysis, as indicated by Henseler et al. [17]. According to Henseler et al. [18], the global model adjustment can be carried out through inferential statistics via bootstrap. Djikstra and Henseler [19] state that several indices (e.g., standardized root mean squared residual (SRMR), unweighted least squares (ULS) discrepancy (dULS), and geodesic discrepancy (dG) for the saturated model) can be used for the correct adjustment of the estimated model and they must have values lower than 95% or 99% [18] of Bootstrap quantile (Bootstrap Q). Table 2 presents the results concerning the evaluation of these indices for the estimated model.

Table 2. Measures of global adjustment of the estimated model

	SRMR		***dULS***		***dG***	
	Estimated model	***Bootstrap Q***	***Estimated model***	***Bootstrap Q***	***Estimated model***	***Bootstrap Q***
HI95	0.048	0.033	1.285	0.626	0.412	0.366
HI99	0.055	0.035	1.696	0.697	0.496	0.398

Based on the results presented in Table 2, it can be stated that optimal conditions are met [18], with all index values lower than the corresponding bootstrap quantile (HI95 or HI99). Therefore, the model is considered well-fitting.

Regarding the measurement model under analysis, all factor loadings surpass the threshold value of 0.6 and the values concerning the Composite Reliability (CR) of all constructs are higher than 0.90, exceeding the reference value of 0.7 (see Table 3).

Table 3. Assessment of the measurement model

Latent variables	***Indicators***	***Convergent validity***		***Internal Consistency Reliability***	
		Loadings	***AVE***	***CR***	***Cronbach's Alpha***
SWLS	SAT1	0,876	0,694	0,919	0,888
	SAT2	0,803			
	SAT3	0,909			
	SAT4	0,841			
	SAT5	0,725			
Tec	Tec1	0,900	0,730	0,942	0,924
	Tec2	0,910			
	Tec3	0,908			
	Tec4	0,882			
	Tec5	0,784			
	Tec6	0,723			
CCS	CCS1	0,913	0,820	0,965	0,956
	CCS2	0,935			
	CCS3	0,883			
	CCS4	0,938			
	CCS5	0,886			
	CCS6	0,874			

CCT	CCT1	0,786	0,694	0,901	0,853
	CCT2	0,853			
	CCT3	0,863			
	CCT4	0,828			
Affect	Af1	0,943	0,803	0,960	0,950
	Af2	0,946			
	Af3	0,945			
	Af4	0,835			
	Af5	0,900			
	Af6	0,794			
Value	V1	0,899	0,765	0,951	0,939
	V2	0,837			
	V3	0,906			
	V4	0,904			
	V5	0,833			
	V6	0,868			

Notes: CR – Composite reliability (CR); AVE – Average Variance Extracted

According to Farrel [20], "The AVE estimate is the average amount of variation that a latent construct is able to explain in the observed variables to which it is theoretically related". In this context, as for the convergent validity, all constructs have an AVE estimate greater than 0.50, confirming the good convergent validity of the five subscales.

The discriminant validity was assessed through the Heterotrait-monotrait ratio of correlations (HTMT), the more demanding criterion [17], which confirms discriminant validity, taking into account the threshold value of 0.85 (Table 4).

Table 4. Discriminant validity of the constructs – Heterotrait-Monotrait Ratio (HTMT)

	1	*2*	*3*	*4*	*5*	*6*
1. Affect						
2. CCS	0,798					
3. CCT	0,584	0,654				
4. SWLS	0,220	0,385	0,355			
5. Tec	0,606	0,545	0,786	0,223		
6. Value	0,696	0,528	0,416	0,225	0,629	

With the reliability and validity of the measurement model confirmed, the structural model was assessed by examining the estimates, in order to ascertain the hypothesized relationship, as well as the values of the R^2 coefficient (amount of explained variance of the endogenous constructs in the structural model) of the endogenous constructs. The results of hypothesis testing concerning the research model are exhibited in Figure 1.

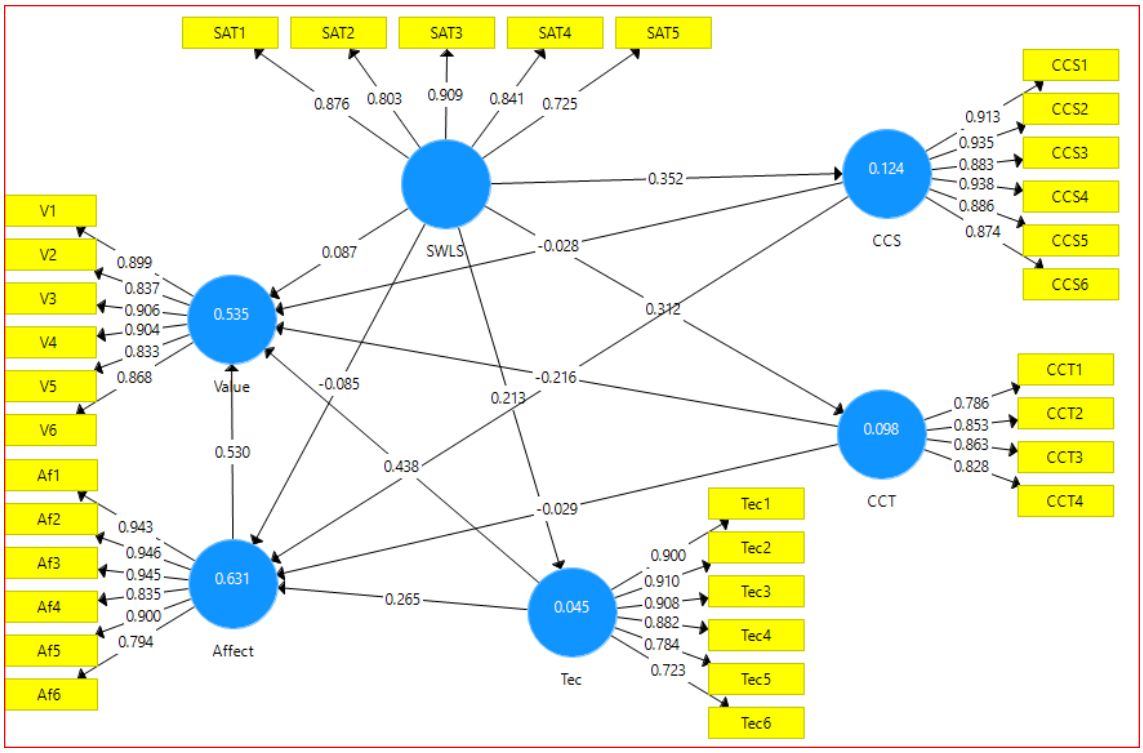

Figure 1 – Results of hypothesis testing

The explained variance (R^2) of the endogenous constructs, ranging between 0.045 and 0.631 (Figure 1), supports the predictive power of the research model. The exact interpretation of the R^2 value depends on the particular research discipline, and in social sciences studies, a value of 0.2 may be considered suitable (Hair et al., 2014). The constructs SWLS, CCS, CCT, and Tec explain 63.1% of the variance of the dimension Affect. Around 53.5 % of the variance of the latent variable Value is explained for all the remained constructs. Although Life Satisfaction (assessed by SWLS) appears to have significant impacts on cognitive skills in Statistics and Technology (CCS and CCT), and in the latent variable Tec, the percentage of variance of these constructs that is explained, in an isolated way, by the SWLS is relatively low. This fact is understandable, since there is a multiplicity of factors that can contribute to the explanation of cognitive competences in these areas, and to the positive and negative student's attitudes towards the learning of Statistics with technology. Moreover, ten of the twelve hypotheses under analysis were supported (Table 5).

The five hypotheses (H1 to H5), predicting that satisfaction with life influences all factors (dimensions) of Students Attitudes toward Statistics and Technology Scale, were all found significant at the 0.02 level. It should be noted that the model predicts a positive and significant impact of satisfaction with life on cognitive competence (Statistics and Technology), Tec and Value (hypotheses H1 to H3 and H5). Conversely, this model suggests that satisfaction with life has a negative effect on Affect (H4).

As for hypothesis H6, the Statistics Cognitive Competence has a positive effect on Affect (β=0.673, $p<0.001$). This fact is not surprising, since that several authors (e.g., [21, 22]) refer that there is a strong positive correlation, statistically significant, between the variables Affect and cognitive competences. In turn, the effect of the Statistical Cognitive Competence on Value (H7) was found non-significant. Moreover, when total indirect effects are considered (Table 6), the Statistics Cognitive Competence exhibits a high impact on Value (β=0.356, $p<0.001$). This may be indicative that the Affect has a mediating role on the relationship between Statistics Cognitive Competence and Value.

The Technological Cognitive Competence revealed significant impacts on Value (H9), however the effect of the Technological Cognitive Competence on Affect was found non-significant (H8). Based on Table 6 and Figure 1, it can also be seen that Affect does not have a mediating role on the relationship between Cognitive Competence in Technology (CCT) and Value.

Table 5. Hypothesis testing

Path	Coefficient (β)	t-value	p-value	Supported
H1: SWLS -> CCS	0,352	8,297	0,000	Yes
H2: SWLS -> CCT	0,312	6,903	0,000	Yes
H3: SWLS -> Tec	0,213	3,649	0,000	Yes
H4: SWLS -> Affect	-0,085	3,559	0,000	Yes
H5: SWLS -> Value	0,087	2,425	0,015	Yes
H6: CCS -> Affect	0,673	18,810	0,000	Yes
H7: CCS -> Value	-0,028	0,380	0,704	No
H8: CCT -> Affect	-0,029	0,740	0,459	No
H9: CCT -> Value	-0,216	5,269	0,000	Yes
H10: Tec -> Affect	0,265	6,915	0,000	Yes
H11: Tec -> Value	0,438	8,497	0,000	Yes
H12: Affect -> Value	0,530	6,716	0,000	Yes

** t-values were obtained with the bootstrapping procedure (5000 samples)*

As for hypotheses H10 to H11, predicting that the latent variable Tec influences positively Affect and Value, the results revealed significant effects at level of 0.01. Concerning the hypothesis H12 the Affect records a highest impact on Value (see Table 5 and Figure 1).

Table 6. Total indirect effects

Path	Total indirect effects		
	Coefficient	t-value	p-value
CCS -> Value	0,356	6,264	0,000
CCT -> Value	-0,016	0,710	0,478
SWLS -> Affect	0,284	7,057	0,000
SWLS -> Value	0,121	2,676	0,007
Tec -> Value	0,140	5,056	0,000

In the adjusted model there is multiple mediation, which address the significance of the indirect and direct effects. According to the Table 6, there are three types of mediations: i) Complementary mediation, the indirect effect and the direct effect both are significant and point in the same direction (SWLS -> Value, Tec -> Value), ii) competition mediation, the indirect effect and the direct effect both are significant and point in opposite directions (SWLS -> Affect), iii) indirect-only mediation, the indirect effect is significant but not the direct effect (CCS -> Value), and one type of nonmediation: Direct-only nonmediation, the direct effect is significant but not the indirect effect (CCT -> Value).

Technology has a complementary effect of mediation on the relationship from Satisfaction with life to Value. In the case of relationship from life satisfaction to Affect, the Technology represents a competitive mediation or an inconsistent mediation, and suggests that another mediator may be present, whose indirect effect's sign equals that of the direct effect.

4 CONCLUSIONS

PLS-SEM approach is a powerful tool to exploring the relationships between the constructs included in the structural model. The used reflective constructs (SWLS, CCS, CCT, Tec, Affect, Value) revealed good reliability indicators, as well as a satisfactory (convergent and discriminant) validity. Our findings support the idea that life satisfaction influences all factors (dimensions) of Students Attitudes toward Statistics and Technology Scale. In this context, it is important to highlight that the Affect (students' feelings concerning Statistics and Technology) is the construct whose percentage of variance explained by all other constructs considered, with the exception of the Value (usefulness that they attribute to Statistics and Technology for their future personal and professional life), is higher. On the

other hand, it was possible to conclude that the latent variable Value is explained by all the remaining subscales included in the reflective structural model. In this model there is a multiple mediation, and it should be noted that the student's attitudes to learning Statistics with technology (Tec) has a complementary effect of mediation on the relationship from Satisfaction with life to Value.

Our findings can help to make all educational stakeholders aware of the importance of creating a classroom environment that promotes the psychological well-being of students, their involvement and learning of contents in the scope of Statistics. In this context an appropriate integration of Technological devices in the teaching-learning process of Statistics can provide an important contribution to the academic achievement of university students. Furthermore, knowledge about their attitudes towards Statistics and Technology, the interrelationships between the various constructs validated by the adjusted structural model, and the existence of mediating variables in some of these relationships may help to define pedagogical strategies that foster conditions conducive to learning and well-being of students.

Some possible guidelines for future research include the extension of the research to a larger sample of students, involving a larger number of universities, and other constructs related to the scales used in the present study. Other possibility is the consideration of different groups of students, taking into account the scientific area of the study programs, the age group, and other academic and sociodemographic variables.

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