



Predictors of Positive Attitudes Towards Statistics in University Students

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Abstract. This study aimed to analyze the predictive relationships among perceived enjoyment of using statistics, perceived usefulness of statistics, and self-efficacy in using statistical tools, and university students' attitudes towards statistics. The research employed a quantitative approach with an explanatory, non-experimental, cross-sectional design. The sample consisted of 637 undergraduate students from six private universities in Arequipa, Peru. Data were collected using a structured questionnaire that measured the main constructs of the proposed model. The instrument was examined through exploratory factor analysis, while the measurement and structural models were assessed using partial least squares structural equation modeling. The most important finding was that perceived enjoyment in using statistics emerged as the strongest predictor of positive attitudes towards statistics. It was also positively associated with perceived usefulness and self-efficacy, indicating that enjoyable learning experiences are related to students' recognition of the value of statistics and to greater confidence in using statistical tools. The study concludes that positive attitudes towards statistics are strengthened when university teaching integrates engaging, practical, and meaningful learning experiences. Therefore, statistics instruction should move beyond procedural content and incorporate contextualized activities, authentic data, and technological resources that promote enjoyment, perceived usefulness, and confidence among students during their education.

Keywords: Statistics education, attitudes, self-efficacy, perceived usefulness, perceived enjoyment, PLS-SEM.

1 Introduction

Statistics constitutes a transversal axis in university education, as it underpins decision-making across natural sciences, social sciences, business, and public policy [1-3]. However, its learning is often accompanied by negative attitudes, anxiety, and stress, factors that adversely affect academic performance and students' disposition towards the subject [4,5]. This issue is intensified when an excessively theoretical approach predominates, with limited practical application and scarce use of statistical

software, thereby creating a gap between taught content and the professional competencies required [6]. Consequently, strengthening a positive Attitude towards statistics (ATS) becomes essential to enhance the understanding, interpretation, and application of quantitative concepts.

From the Technology Acceptance Model (TAM), Perceived usefulness of statistics (PUS), Perceived enjoyment in using statistics (PEUS), and Self-efficacy in the use of statistical tools (SUS) emerge as key determinants in the acceptance and use of academic tools [7,8]. When students perceive statistics as relevant to their academic and professional lives, they exhibit higher motivation and improved performance [9]. Likewise, perceived usefulness is positively associated with self-efficacy and academic achievement [10,11]. Recent research indicates that higher levels of Self-efficacy in the use of statistical tools (SUS) are associated with more favourable attitudes, lower anxiety, and better outcomes in statistics courses [12,13].

The Theory of Planned Behavior posits that attitude is a central predictor of behavioral intention, reflecting favorable or unfavorable evaluations towards a given activity. In the context of statistics, Attitude towards statistics (ATS) refers to students' disposition towards quantitative tasks and directly influences their learning. Within this framework, Self-efficacy in the use of statistical tools (SUS) not only has a direct impact on Attitude towards statistics (ATS) but may also exert indirect effects through emotional and cognitive variables [14]. When students trust their ability to solve statistical problems, they experience lower anxiety and higher motivation [15,16].

Perceived enjoyment in using statistics (PEUS) is an intrinsic motivational component that enhances persistence, participation, and the intention to continue using statistical tools [17,18]. Evidence from e-learning contexts indicates that Perceived enjoyment in using statistics (PEUS) has a direct, positive effect on Attitude towards statistics (ATS) in relation to the use of educational technologies [19]. Furthermore, interventions that integrate playful and technological elements strengthen engagement and reduce emotional barriers [20]. Consequently, promoting enjoyable statistical learning experiences fosters more positive attitudes towards statistics.

Perceived usefulness of statistics (PUS) has consistently been identified as a significant predictor of Attitude towards statistics (ATS) in quantitative subjects [7,21]. When students recognize the practical value of statistics, they tend to develop greater disposition and engagement [22]. Models based on TAM and UTAUT suggest that perceived usefulness may mediate the relationship between Self-efficacy in the use of statistical tools (SUS) and Attitude towards statistics (ATS), by translating confidence in one's competence into a practical valuation of the discipline [23,24].

Based on the Technology Acceptance Model and the literature on academic self-efficacy and statistics education, the proposed model posits that attitudes towards statistics arise from the interaction between affective and cognitive evaluations. Perceived enjoyment is expected to contribute to more favorable attitudes because positive learning experiences encourage engagement and reduce emotional resistance. It is also expected to strengthen perceived usefulness and self-efficacy by making statistical activities more meaningful and manageable. Perceived usefulness may directly contribute to attitudes and reinforce self-efficacy when students recognize that statis-

tical tools have practical applications in academic and professional settings. Finally, self-efficacy is expected to be positively associated with attitudes because confidence in performing statistical tasks reduces avoidance and promotes active participation.

The study extends previous research by evaluating these relationships simultaneously among university students in Arequipa, Peru. In doing so, it seeks to identify which affective and cognitive factors have the strongest predictive associations with attitudes towards statistics and to provide evidence to inform the design of more engaging, relevant, and confidence-building learning experiences.

Accordingly, the general objective of this study was to analyze the predictive associations of Perceived enjoyment in using statistics, Perceived usefulness of statistics, and Self-efficacy in using statistical tools with university students' Attitude towards statistics.

The specific objectives were:

1. To determine the association between Perceived enjoyment in using statistics and Attitude towards statistics.
2. To examine the associations of Perceived enjoyment with Perceived usefulness of statistics and Self-efficacy in the use of statistical tools.
3. To determine the association between Perceived usefulness of statistics and Attitude towards statistics.
4. To examine the association between Perceived usefulness of statistics and Self-efficacy in the use of statistical tools.
5. To determine the association between Self-efficacy in the use of statistical tools and Attitude towards statistics.
6. To estimate the explanatory capacity of the proposed structural model.

Based on these objectives and the reviewed literature, the following hypotheses were formulated:

H1: Perceived enjoyment in using statistics is positively associated with Attitude towards statistics.

H2: Perceived enjoyment in using statistics is positively associated with Perceived usefulness of statistics.

H3: Perceived enjoyment in using statistics is positively associated with Self-efficacy in the use of statistical tools.

H4: Perceived usefulness of statistics is positively associated with Attitude towards statistics.

H5: Perceived usefulness of statistics is positively associated with Self-efficacy in the use of statistical tools.

H6: Self-efficacy in the use of statistical tools is positively associated with Attitude towards statistics.

2 Methodology

This study adopted a quantitative, explanatory-correlational approach with a non-experimental, cross-sectional design to analyze the relationships among psychological and cognitive variables associated with university students' learning of statistics. Spe-

cifically, the proposed model examined the predictive associations of Self-efficacy in the use of statistical tools (SUS), Perceived usefulness of statistics (PUS), and Perceived enjoyment in using statistics (PEUS) with Attitude towards statistics (ATS), conceptualized as latent variables within an explanatory framework of academic behavior. Given the cross-sectional nature of the study, the relationships tested in the structural model were interpreted as theoretically grounded predictive associations rather than causal effects.

The study population consisted of undergraduate students enrolled at six private universities in Arequipa, Peru. Data were collected between [month] and [month] [year]. A non-probability convenience sampling strategy was employed because participation depended on students' availability, voluntary willingness to participate, and authorization from the participating institutions.

The final sample comprised 637 university students, with no missing data in the sociodemographic variables analyzed. Participants ranged in age from 17 to 30 years, with a mean age of 20.5 years ($SD = 3.32$) and a median age of 20 years. Of the total sample, 388 participants were women (60.9%) and 249 were men (39.1%).

The participants were distributed across six private universities. The largest proportion was enrolled at Universidad Tecnológica del Perú (UTP), with 189 students (29.7%), followed by Universidad Católica de Santa María (UCSM), with 168 students (26.4%); Universidad César Vallejo (UCV), with 127 students (19.9%); Universidad Continental, with 92 students (14.4%); Universidad Católica San Pablo (UCSP), with 33 students (5.2%); and Universidad La Salle, with 28 students (4.4%). The students were enrolled in different undergraduate degree programs, including [specify the principal academic programs or fields of study].

The sample size was considered adequate for PLS-SEM, given the number of latent variables, indicators, and structural relationships included in the proposed model. Nevertheless, the use of convenience sampling, the predominance of women in the sample, and the concentration of participants in private universities from a single city limit the statistical generalizability of the findings.

Data were collected using a structured questionnaire containing [total number] items distributed across four reflective constructs: Attitude towards statistics (ATS; 5 items), Perceived enjoyment in using statistics (PEUS; 5 items), Perceived usefulness of statistics (PUS; 5 items), and Self-efficacy in the use of statistical tools (SUS; 5 items). The items were adapted from previous research on statistics education, technology acceptance, academic attitudes, and self-efficacy.

Attitude towards statistics assessed students' general favorable or unfavorable evaluations of learning and using statistics. An example item is: "*ATS1: I believe that statistics is essential for the correct interpretation and analysis of data in my studies*". Perceived enjoyment in using statistics evaluated the extent to which students considered statistical activities interesting or enjoyable; for example, "*PEUS1: I feel motivated when working with statistics*". Perceived usefulness of statistics measured students' beliefs about the academic and professional value of statistics; for example: "*PUS1: Statistical analysis directly contributes to improving my academic performance*". Self-efficacy in the use of statistical tools assessed students' confidence in

applying statistical procedures and using statistical software; for example: "*SUS1: I am confident in my ability to use basic statistical programs*".

All items were measured on a five-point Likert-type scale ranging from 1 = strongly disagree to 5 = strongly agree. The adaptation process focused on semantic clarity, relevance to the university context, and correspondence between each item and its theoretical construct.

Before the final application, the questionnaire was reviewed to ensure the clarity, coherence, and adequacy of the items in relation to the university context. In addition, a preliminary review was conducted to identify potential comprehension issues and to verify that the wording of the items was appropriate for students with varying levels of familiarity with statistics. This process contributed to improving the instrument's content validity and strengthening the study's methodological transparency. Ethical considerations were observed throughout the research process. Participation was voluntary and anonymous, and students were informed of the study's academic purpose before completing the questionnaire.

3 Results

The results presented in Table 1 indicate that the measurement model achieves adequate levels of internal reliability and convergent validity for the constructs Attitude towards statistics (ATS), Perceived enjoyment in using statistics (PEUS), Perceived usefulness of statistics (PUS), and Self-efficacy in the use of statistical tools (SUS), thereby providing empirical support for the psychometric quality of the variables analysed in the context of higher education.

First, the standardized factor loadings of all indicators exceed the recommended threshold of 0.70, ranging from 0.722 to 0.854, indicating that the items adequately and consistently represent their respective latent constructs and confirming a substantive relationship between the observed indicators and their theoretical dimensions.

Regarding internal reliability, Cronbach's α , ρ_A , and composite reliability (ρ_C) exceed the 0.70 criterion across all constructs (α ranging from 0.818 to 0.892), demonstrating a high level of internal consistency. Notably, the Perceived enjoyment in using statistics (PEUS) construct shows the highest values, reinforcing the stability and coherence of its indicators.

In terms of convergent validity, the Average Variance Extracted (AVE) values exceed the recommended threshold of 0.50 in all cases (ranging from 0.579 to 0.698), indicating that each construct explains more than 50% of the variance of its indicators, thus confirming that the items adequately converge in measuring their respective latent variables.

Finally, the Variance Inflation Factor (VIF) values remain within acceptable ranges, ruling out multicollinearity among the indicators and ensuring stable estimates. Overall, these results confirm that the measurement model is valid, reliable, and suitable for evaluating the proposed structural model.

Table 1. Factor Loadings and Indicator Reliability

Construct	Item	Factor Loading	VIF	Cronbach's alpha	rho_a	rho_c	AVE
Attitude towards statistics	ATS1	0.722	1.637	0.818	0.821	0.873	0.579
	ATS2	0.770	1.688				
	ATS3	0.759	1.684				
	ATS4	0.809	1.859				
	ATS5	0.742	1.686				
Perceived enjoyment in using statistics	PEUS1	0.829	2.156	0.892	0.892	0.920	0.698
	PEUS2	0.848	2.348				
	PEUS3	0.814	2.033				
	PEUS4	0.833	2.219				
	PEUS5	0.854	2.419				
Perceived usefulness of statistics	PUS1	0.749	1.573	0.848	0.850	0.891	0.621
	PUS2	0.817	1.911				
	PUS3	0.808	1.916				
	PUS4	0.803	2.014				
	PUS5	0.763	1.767				
Self-efficacy in the use of statistical tools	SUS1	0.753	1.532	0.840	0.841	0.886	0.610
	SUS2	0.792	1.817				
	SUS3	0.770	1.747				
	SUS4	0.793	1.865				
	SUS5	0.795	1.788				

The results in Table 2 confirm discriminant validity according to the Heterotrait-Monotrait Ratio (HTMT). All HTMT values are below the conservative threshold of 0.85, ranging from 0.521 to 0.731. This indicates that the constructs Attitude towards statistics (ATS), Perceived enjoyment in using statistics (PEUS), Perceived usefulness of statistics (PUS), and Self-efficacy in the use of statistical tools (SUS) are empirically distinct and do not present excessive conceptual overlap. Therefore, the measurement model provides adequate evidence of discriminant validity and supports the subsequent evaluation of the structural model.

Table 2. Discriminant validity matrix

Heterotrait-Monotrait Ratio (HTMT)				
	ATS	PEUS	PUS	SUS
ATS				
PEUS	0.731			
PUS	0.692	0.630		
SUS	0.612	0.713	0.521	

Figure 1 presents a structural equation model estimated using PLS-SEM to analyze the influence of Self-efficacy in the use of statistical tools (SUS) and Perceived enjoyment in using statistics (PEUS) on Attitude towards statistics (ATS), while also considering the mediating role of Perceived usefulness of statistics (PUS).

First, the results show that Perceived enjoyment in using statistics (PEUS) has a direct, positive, and statistically significant effect on Self-efficacy in the use of statistical tools (SUS) ($\beta = 0.539$, $p < .001$), indicating that students who experience greater enjoyment when using statistics tend to develop a higher perception of competence in applying statistical tools. Likewise, perceived enjoyment in using statistics (PEUS) significantly influences perceived usefulness of statistics (PUS) ($\beta = 0.553$, $p < .001$), demonstrating that the affective component of learning strengthens the perceived functional value of statistics.

Regarding direct effects on Attitude towards statistics (ATS), Perceived enjoyment in using statistics (PEUS) shows a positive and significant effect ($\beta = 0.370$, $p < .001$), suggesting that enjoyment in using statistics directly contributes to a more favorable attitude towards the discipline. Similarly, Self-efficacy in the use of statistical tools (SUS) also has a significant effect on Attitude towards statistics (ATS) ($\beta = 0.151$, $p < .001$), although with a smaller magnitude, indicating that perceived competence plays a complementary role in shaping attitudes.

With respect to Perceived usefulness of statistics (PUS), it presents a direct and significant effect on Attitude towards statistics (ATS) ($\beta = 0.302$, $p < .001$), confirming that when students perceive statistics as useful and relevant, they develop a more positive attitude towards its learning. Additionally, Self-efficacy in the use of statistical tools (SUS) shows a significant effect on perceived usefulness of statistics (PUS) ($\beta = 0.146$, $p = .001$), suggesting an indirect relationship in which perceived competence reinforces the perceived utility of statistics.

From the perspective of explained variance (R^2), the model shows moderate explanatory power. Self-efficacy in the use of statistical tools (SUS) yields an R^2 of 0.399, indicating that perceived enjoyment in using statistics explains 39.9% of the variability. Perceived usefulness of statistics (PUS) presents an $R^2 = 0.306$, implying that PEUS and SUS explain 30.6% of its variance. Finally, Attitude towards statistics (ATS) reaches an R^2 of 0.484, indicating that the set of explanatory variables accounts for 48.4% of its variability, a moderate-to-high level in educational re-search.

Overall, the results of the structural model indicate that Attitude towards statistics (ATS) is mainly explained by Perceived enjoyment in using statistics (PEUS) and Perceived usefulness of statistics (PUS), while Self-efficacy in the use of statistical tools (SUS) plays a complementary role, both directly and indirectly. Furthermore, perceived enjoyment in using statistics (PEUS) emerges as a key factor that activates both perceived usefulness and self-efficacy, consolidating its role as a central element in shaping positive attitudes towards statistics among university students.

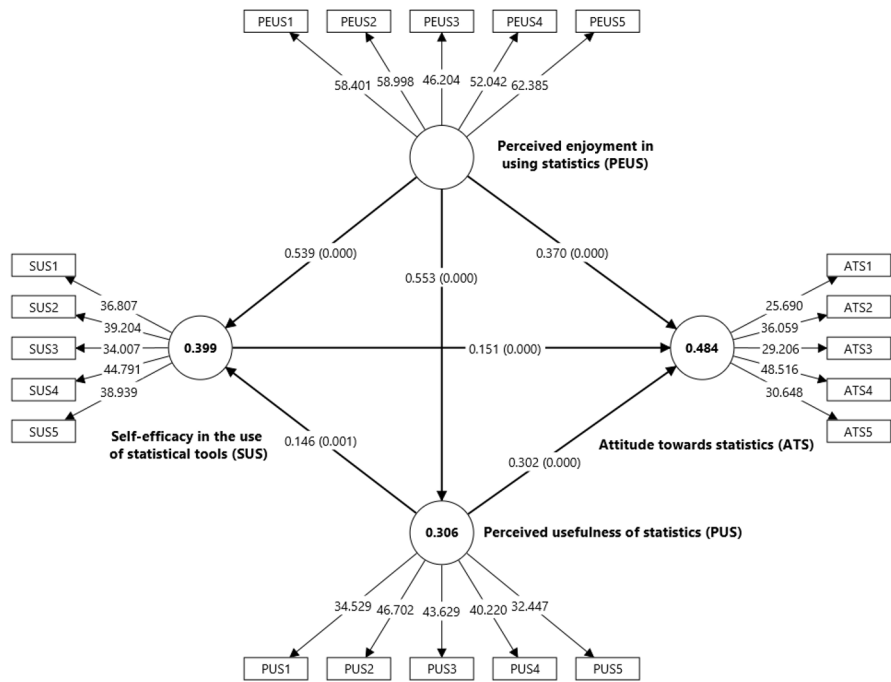


Fig. 1. Estimated structural model showing standardized path coefficients, p-values, and coefficients of determination.

The results presented in Table 3 allow for an empirical evaluation of the direct hypotheses of the structural model, aimed at explaining Attitude towards statistics (ATS) based on Perceived enjoyment in using statistics (PEUS), Perceived usefulness of statistics (PUS), and Self-efficacy in the use of statistical tools (SUS) among university students.

First, the direct effects show that Perceived enjoyment in using statistics (PEUS) has a positive and statistically significant influence on Attitude towards statistics (ATS) ($\beta = 0.370$; $t = 7.199$; $p < 0.001$), confirming Hypothesis H1. This result indicates that students who experience greater enjoyment when using statistics tend to develop more favorable attitudes towards the discipline, reinforcing the role of the affective component in learning.

Regarding the effects on mediating variables, Hypothesis H2 was confirmed, showing that Perceived enjoyment in using statistics (PEUS) significantly influences Perceived usefulness of statistics (PUS) ($\beta = 0.553$; $t = 16.984$; $p < 0.001$), suggesting that enjoyment enhances the perceived value of statistics as a useful tool. Similarly, Hypothesis H3 was supported, indicating that Perceived enjoyment in using statistics (PEUS) significantly impacts Self-efficacy in the use of statistical tools (SUS) ($\beta = 0.539$; $t = 12.798$; $p < 0.001$), implying that enjoyment strengthens perceived competence in the use of statistical tools.

With respect to direct effects on Attitude towards statistics (ATS), Hypothesis H4 confirms that Perceived usefulness of statistics (PUS) has a positive and significant

influence ($\beta = 0.302$; $t = 6.257$; $p < 0.001$), indicating that when students perceive statistics as relevant, they develop more favorable attitudes. Likewise, Hypothesis H6 shows that Self-efficacy in the use of statistical tools (SUS) significantly influences Attitude towards statistics (ATS) ($\beta = 0.151$; $t = 3.759$; $p < 0.001$), although with a smaller magnitude, evidencing a complementary effect.

Additionally, Hypothesis H5 was also supported, showing that Perceived usefulness of statistics (PUS) significantly influences Self-efficacy in the use of statistical tools (SUS) ($\beta = 0.146$; $t = 3.314$; $p = 0.001$), suggesting that the functional valuation of statistics contributes to strengthening perceived competence.

Overall, all hypothesized relationships in the model are statistically significant, demonstrating that Perceived enjoyment in using statistics (PEUS) acts as a key exogenous variable that influences Attitude towards statistics (ATS) both directly and indirectly. Perceived usefulness of statistics (PUS) and Self-efficacy in the use of statistical tools (SUS) play complementary mediating roles, configuring a robust explanatory model in which affective and cognitive factors interact to shape students' attitudes towards statistics in the university context.

Table 3. Structural model results and direct hypothesis testing.

Hypothesis	β	M	STDEV	t	p values	Result
H1: Perceived enjoyment in using statistics (PEUS) -> Attitude towards statistics (ATS)	0.370	0.369	0.051	7.199	0.001	Supported
H2: Perceived enjoyment in using statistics (PEUS) -> Perceived usefulness of statistics (PUS)	0.553	0.554	0.033	16.984	0.001	Supported
H3: Perceived enjoyment in using statistics (PEUS) -> Self-efficacy in the use of statistical tools (SUS)	0.539	0.540	0.042	12.798	0.001	Supported
H4: Perceived usefulness of statistics (PUS) -> Attitude towards statistics (ATS)	0.302	0.303	0.048	6.257	0.001	Supported
H5: Perceived usefulness of statistics (PUS) -> Self-efficacy in the use of statistical tools (SUS)	0.146	0.146	0.044	3.314	0.001	Supported
H6: Self-efficacy in the use of statistical tools (SUS) -> Attitude towards statistics (ATS)	0.151	0.151	0.040	3.759	0.001	Supported

4 Conclusions

The general objective of the study was to analyze the predictive associations among perceived enjoyment of using statistics, perceived usefulness of statistics, and Self-efficacy in using statistical tools, and university students' Attitude towards statistics. The findings addressed this objective by showing that all three variables were positively and significantly associated with Attitude towards statistics. Together, the pre-

dictors explained 48.4% of the variance in students' attitudes, indicating that the proposed model had moderate explanatory capacity.

Regarding the first specific objective, perceived enjoyment in using statistics showed the strongest direct association with Attitude towards statistics ($\beta = 0.370$, $p < 0.001$), supporting H1. This finding indicates that students who perceive statistical learning as enjoyable tend to express more favorable attitudes towards the subject.

In relation to the second specific objective, perceived enjoyment was positively associated with both Perceived usefulness of statistics ($\beta = 0.553$, $p < 0.001$) and Self-efficacy in the use of statistical tools ($\beta = 0.539$, $p < 0.001$). Therefore, H2 and H3 were supported. These results show that enjoyment is associated not only with attitudes but also with students' recognition of the practical value of statistics and their confidence in using statistical tools.

The third specific objective examined the relationship between perceived usefulness and Attitude towards statistics. The results supported H4 because Perceived usefulness was positively associated with Attitude towards statistics ($\beta = 0.302$, $p < 0.001$). Students who recognized the academic and professional relevance of statistics displayed more favorable attitudes towards learning it.

Regarding the fourth specific objective, perceived usefulness was positively associated with Self-efficacy in using statistical tools ($\beta = 0.146$, $p = 0.001$), supporting H5. Although this relationship was smaller than the associations involving perceived enjoyment, it suggests that recognizing the practical usefulness of statistics may reinforce students' confidence in applying statistical procedures and technologies.

The fifth specific objective concerned the relationship between Self-efficacy and Attitude towards statistics. H6 was supported because Self-efficacy showed a positive and statistically significant association with Attitude towards statistics ($\beta = 0.151$, $p < 0.001$). Nevertheless, its coefficient was smaller than those of Perceived enjoyment and Perceived usefulness, indicating that confidence in using statistical tools plays a complementary rather than predominant role in explaining attitudes.

Overall, the findings show that Attitude towards statistics is associated with the integration of affective and cognitive factors. Perceived enjoyment emerged as the most relevant predictor because it was directly associated with attitudes and was also strongly related to usefulness and self-efficacy. Consequently, university statistics instruction should combine technical development with contextualized activities, authentic datasets, interactive digital tools, and applied problem-solving experiences that make statistical learning more enjoyable, meaningful, and accessible.

The results should be interpreted as predictive associations rather than causal effects because the study employed a cross-sectional, non-experimental design. In addition, the use of self-reported data, convenience sampling, and participants from private universities in a single city limits the generalizability of the findings. Future studies should employ longitudinal or experimental designs, include students from different disciplines and public universities, and examine how instructional strategies influence the development of attitudes towards statistics.

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