

Insights into Student Engagement in Statistics Courses

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ABSTRACT

Student engagement is widely recognized as a critical factor in academic success, particularly in courses such as statistics that are often perceived as challenging. The focus of this research is to discover how students' cognitive, affective, behavioural, and learning approach in higher education institutions affect their engagement in statistics courses. The participants in this study were students enrolled in the statistical course from non-statistical major academic programs at Universiti Teknologi MARA, Cawangan Terengganu and Universiti Teknologi MARA, Cawangan Pahang. A structured questionnaire consisting of 34 items was completed by 116 students. The data was analysed by using descriptive statistics, correlation and regression analysis. Consequently, all the factors under investigation showed substantial relationships with the participants' involvement in the statistics course. The regression findings emphasize that the learning approach demonstrates the greatest impact on students' engagement in statistics, underscoring the importance of cultivating effective and reflective learning strategies. The findings of this study are expected to provide deeper insights into how students in non-statistical major programs engage with statistics learning, the factors that enhance or hinder their engagement, and the role of motivation and emotions in shaping their academic confidence and achievement. The results will contribute to the development of teaching practices that promote active learning, reduce statistics anxiety, and strengthen students' ability to apply statistical knowledge in both academic and real-life contexts.

Keywords: Students' Statistics Engagement, Cognitive, Affective, Behavioral, Learning Approach

INTRODUCTION

Statistics is a core component of higher education curricula across diverse fields and it is essential for decision-making in a variety of disciplines, including business, healthcare, education, economics, and social sciences. Learning statistics gives people the ability to interpret data, recognize trends, draw conclusions, and make informed decisions. Despite its importance, statistics is often perceived by students as a difficult and anxiety-inducing subject (Onwuegbuzie & Wilson, 2003; Baloğlu, 2004). Many students associate statistics with complicated arithmetic, which causes fear and reluctance. Concepts such as probability distributions, hypothesis testing, and inferential statistics can be abstract and difficult to understand without context or examples. Students' perceptions, emotions, and attitudes toward statistics strongly influence their ability to learn, achieve, and apply statistical knowledge (Gal et al., 1997). Anxiety, low motivation, and a fear of arithmetic and statistics are all highlighted as barriers in learning statistics (Bromage et al., 2022). These limit engagement, raise avoidance of requesting help, and may hinder performance. In this context, student

engagement has become a central theme in educational research, as engagement is widely recognized as a predictor of academic success (Fredricks, Blumenfeld, & Paris, 2004).

Student engagement is a multidimensional construct comprising cognitive, affective, and behavioral dimensions, alongside learning approaches (Kahu, 2013). The cognitive dimension refers to the mental effort and strategies used in learning, the affective dimension relates to emotions such as motivation and anxiety, and the behavioral dimension reflects observable actions such as participation, attendance, and effort. Engagement also involves students' approaches to learning, such as deep or surface learning strategies. Understanding these components is essential to address challenges in statistics education and improve teaching strategies.

The applied frameworks of statistics courses generally give insufficient attention to the integration of psychological and affective factors, such as motivation, achievement, and self-efficacy, as well as emotions, into the study of engagement. Students frequently disregard statistical knowledge as directly relevant; a lack of perceived relevance reduces willingness to engage thoroughly. Contextualized, practical examples are useful, yet many courses remain abstract or detached. Students frequently struggle to see the practical applications of statistical approaches, making learning feel disconnected. Furthermore, students commonly identify inadequate study strategies, a reliance on memorization, motivational issues, and external distractions as key obstacles. Some students focus on formulas rather than understanding the underlying concepts, resulting in superficial learning. Some students avoid learning statistics or seeking help because they are embarrassed or have failed repeatedly. This retreat behavior reduces class attendance, involvement, and resource utilization. Misconceptions and conceptual challenges can greatly diminish statistical involvement by eroding comprehension, increasing fear, decreasing motivation, and discouraging active participation. Addressing these difficulties is critical for increasing both learning outcomes and student engagement.

There is little information concerning how prior mathematics/statistics experience, English language skills, or cultural views influence engagement in statistics courses. There is little data on the effects of statistics-specific interventions (such as peer instruction, flipped classrooms, and interactive visualizations) on student engagement across the board in Malaysia. This study attempts to investigate the ways in which students' cognitive processes (such as thinking, understanding, and problem-solving), emotional responses (including motivation, attitudes, and anxiety), behavioral patterns (like participation, attendance, and effort), and preferred learning strategies (such as active learning, rote memorization, technology adoption) collectively influence their overall engagement in statistics courses specifically focusing on students enrolled in non-statistical major academic programs at Universiti Teknologi MARA (UiTM). The students only study one introductory statistical course throughout the entire semester. This study contributes to the growing body of literature on statistics education, particularly in the Malaysian context.

LITERATURE REVIEW

Student engagement has been widely acknowledged as a crucial element influencing learning outcomes and academic achievement in higher education (Kuh, 2003; Fredricks, Blumenfeld, & Paris, 2004). It serves as an important indicator of students' attention, curiosity, interest, and passion for learning, often conceptualized as a multidimensional construct encompassing cognitive, affective, and behavioral dimensions (Fredricks et al., 2004). In recent years, this concept has been expanded to include learning approaches and motivational components that shape students' interaction with knowledge domains (Skinner & Pitzer, 2012).

Cognitive engagement refers to the degree of mental investment students devote to learning tasks (Greene & Miller, 1996). It involves deep learning strategies such as elaboration, critical thinking, and self-regulation. In the context of statistics education, cognitive engagement manifests in how students approach problem-solving, interpret data, and apply statistical reasoning (Garfield & Ben-Zvi, 2007). Students exhibiting higher cognitive engagement tend to adopt deep learning approaches, resulting in a more robust understanding of statistical concepts.

On the other hand, affective engagement is associated with students' emotional responses toward learning, including interest, enjoyment, motivation, and anxiety (Pekrun & Linnenbrink-Garcia, 2012). Emotions play a particularly influential role since it has an impact on students' participation and performance (Onwuegbuzie &

Wilson, 2003). Hence, the affective domain plays a crucial role in shaping students' attitudes toward learning. Moreover, behavioral engagement reflects students' active involvement in both academic and social aspects of learning, such as attending classes, participating in discussions, completing assignments, and collaborating with peers. (Appleton et al., 2008). Behavioral engagement can be observed through consistent practice, participation in tutorials or labs, and involvement in group projects or data analysis using statistical software.

Students' learning approaches whether deep, surface, or strategic also influence how they interact with course material (Biggs, 1987; Entwistle & Ramsden, 2015). A deep approach emphasizes understanding and integration of ideas, while a surface approach focuses on rote memorization and minimal performance. In statistics education, deep approaches promote conceptual understanding and problem-solving ability (Reid & Petocz, 2002). Innovative teaching strategies such as project-based learning and real data analysis further encourage deeper engagement (Ben-Zvi & Garfield, 2008).

Statistics is often perceived as difficult, abstract, and anxiety inducing among students (Gal et al., 1997; Murtonen & Lehtinen, 2003). These perceptions influence both motivation and engagement. Studies indicate that attitudes and emotions toward statistics significantly affect learning behavior and academic success (Chiesi & Primi, 2010). Educators who implement active learning methods such as simulations, data visualization, and real life case studies report increased engagement and reduced anxiety (Garfield & Ben-Zvi, 2008; Schau & Emmioglu, 2012). Moreover, positive affective experiences and supportive classroom environments helps to enhance students' academic confidence and persistence (Tempelaar et al., 2007). Understanding these underlying issues are essential in order to improve statistics pedagogy, particularly in multidisciplinary settings where students' backgrounds and learning preferences vary widely.

Research also shows that engagement is shaped by multiple internal and external factors, including student motivation, self-efficacy, teacher support, peer collaboration, and instructional design (Trowler, 2010; Kahu, 2013). Thus, the interaction between affective and cognitive factors influences how students perceive challenges and maintain their effort throughout the learning process (Schunk, Pintrich, & Meece, 2008). Within the Malaysian higher education context, factors such as prior mathematics experience, teaching style, and language of instruction further influence engagement (Rahim et al., 2020).

Study done by (Fredricks et al., 2004) based on Student Engagement Theory and Expectancy-Value Theory (Eccles & Wigfield, 2002), both of which claimed that engagement arises from interactions between cognitive, affective, and behavioral processes. It shows that students' motivation and perceived value of learning tasks are having a direct influence on their engagement and academic performance. In addition, Constructivist Learning Theory supports the view that active participation and emotional involvement enhance understanding and knowledge retention in complex subjects such as statistics.

Means and Neisler (2022) developed four affective engagement scales with more than 850 students, demonstrating that affective engagement scores reliably predict both course performance and persistence. This finding aligns with numerous empirical studies consistently showing a strong connection between student engagement and academic achievement. Large scale analyses of secondary school mathematics demonstrated that affective, behavioral, and cognitive engagement each contribute to performance, with affective engagement exerting the strongest influence. Similar trends in higher education indicate that students with higher affective engagement earn better grades and are more likely to persist in statistics courses.

Studies conducted within specific contexts have highlighted further complexities. A fuzzy conjoint analysis of 293 Malaysian undergraduates reported uniformly negative perceptions of behavioral, emotional, cognitive, and social engagement, suggesting the need for curriculum redesign to mitigate anxiety and perceived difficulty. Smith and Dai (2023), applying the expectancy value theory, found that gender variations in perceived usefulness and effort significantly influence engagement patterns, whereby greater expectancy and value contribute to higher levels of persistence. Collectively, these findings emphasize the necessity for pedagogical interventions that not only address cognitive and affective disparities but also create supportive learning environments that foster sustained engagement. Accordingly, recent intervention-based research has shifted its focus toward technology enhanced and flexible learning designs aimed at promoting active participation and reducing learning anxiety. The Technology Enhanced Supportive Instruction (TSI) model, for

instance, implemented an Excel based interactive platform during the COVID-19 pandemic that maintained engagement levels comparable to pre-pandemic classes. Lewis (2022) demonstrated that anxiety reduction strategies and mastery-based grading improve ownership, lower anxiety, and sustain engagement. More recent developments highlight the rise of data driven diagnostics. Çali (2024) developed a survey-based tool isolating behavioral, cognitive, and emotional engagement, finding that only behavioral engagement predicted academic performance among economics students. Griffin et al. (2024) complemented self-report methods with Moodle log data to generate a cumulative engagement metric based on session frequency, immediacy, and activity diversity. Their models identified early week virtual learning activity as the most reliable predictor of final grades. In language learning contexts, studies of English as a foreign-language (EFL) online courses confirmed that behavioral, cognitive, and emotional engagement jointly predict achievement, with behavioral engagement particularly participation in online tasks showing the strongest association. Similarly, research in mathematics education during the pandemic (Joshi et al., 2022) revealed high levels of behavioral, social, emotional, and cognitive engagement in virtual classrooms but identified cognitive engagement as the central driver of the other dimensions. This finding highlights the pivotal role of deep mental processing in enhancing overall student involvement. Extending these insights, Koçak and Göksu (2023) validated the Live Online Classes Engagement Scale (LOCES), which identified six dimensions of engagement social, instructional, technological, emotional, behavioral, and withdrawal that collectively explained 63% of variance in online learning contexts. This comprehensive model offers a robust framework for evaluating student engagement in hybrid and online learning environments.

Overall, this body of research situates student engagement as a multidimensional investment of time and energy across academic and non-academic domains. It is closely linked to outcomes such as reduced dropout, enhanced self-efficacy, and improved well-being. The literature consistently underscores that student engagement in statistics education is influenced by cognitive, affective, behavioral, and learning-approach factors. The affective component particularly students' attitudes, interest, and emotions play a central role in shaping motivation and persistence. However, limited research has examined how these dimensions interact in Malaysian higher education.

Thus, the objective of this study is to determine whether there is a significant relationship between cognitive, affective, behavioural, and learning approach towards students' overall engagement in statistics courses as well as to identify the most significant factors towards students' overall engagement in statistics courses.

METHODOLOGY

This study employed a quantitative survey design to investigate the relationship between students' cognitive, affective, behavioural, and learning approaches and their engagement in statistics courses. Quantitative methods were selected to enable objective measurement of variables, establish reliability and validity of instruments, and examine associations using statistical techniques (Creswell & Creswell, 2018). The correlational design was used to determine the degree of association among independent variables (cognitive, affective, behavioural, and learning approach) and the dependent variable (student engagement).

The population of this study comprised undergraduate students enrolled in diploma-level introductory statistics courses at Universiti Teknologi MARA (UiTM). They are from Diploma in Science and Diploma in Muamalat which are non-statistical major academic programs at UiTM. All 116 students enrolled in an introductory statistics course during October 2024 to February 2025 participated in the survey. The number of respondents was deemed sufficient for correlation and multiple regression analyses, which require moderate sample sizes for stable estimates (Tabachnick & Fidell, 2019).

Data were collected using a structured questionnaire consisting of 34 items measured on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The instrument was designed based on validated scales from previous studies on student engagement and learning approaches. It included five dimensions which are cognitive, affective, behavioral, learning approach and students' engagement. Cognitive factor measured by seven items measuring how students relate the process of thinking and reasoning about statistical concepts then, apply the knowledge to real life situations. Affective factor measured by nine item emotional, attitudinal,

and motivational aspects of a student's experience with learning statistics. Behavioural factor evaluated by five items assessing actions, attitudes, assignment completion and patterns of engagement that students exhibit while learning and working with statistical concepts. Learning Approach evaluated by six items capturing students' preferred strategies or method of acquiring knowledge. Lastly, Students' Engagement used six items measuring students' level of involvement, commitment and connectedness to the statistics course.

Data collection was conducted through online surveys during a collaborative seminar on statistics courses, ensuring that all students enrolled in statistics courses at the two UiTM branches had the opportunity to participate. Data were collected and analyzed using SPSS. Descriptive statistics were used to summarize student responses. Reliability analysis for the questionnaire was tested using Cronbach's alpha. Inferential statistics included correlation analysis to explore relationships among variables, and multiple regression analysis used to identify the significant factors towards student engagement.

RESULTS AND DISCUSSION

Descriptive Statistics

In the survey, 116 students from UiTM Cawangan Terengganu and UiTM Cawangan Pahang participated. All of them enrolled in an Introductory Statistics course in that semester. The majority of the respondents are female (63.8%) and 36.2% of them are male. More than half of the respondents are from Diploma in Science (AS120) students (56.9%) while 43.1% are from Diploma Muamalat (IC110).

Table 1. Demographics of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	42	36.2
	Female	74	63.8
Program	IC110	48	43.1
	AS120	66	56.9

Reliability Analysis

An essential indicator of a student's proficiency in statistics is the extent of their active participation in the course. This participation is influenced by multiple factors, including determination, academic performance, confidence, and emotional connection with the subject. Specifically, students' engagement in statistics is shaped by four key dimensions: cognitive, affective, behavioural, and learning approaches. Accordingly, this study aims to examine how these four factors relate to the level of student involvement in statistical learning. To assess these relationships, thirty-four items were administered to measure the association between engagement and the identified variables. The reliability and internal consistency of the items representing each construct were evaluated using Cronbach's alpha coefficients. As presented in Table 2, the analysis demonstrates satisfactory internal consistency across all variables, with Cronbach's alpha values exceeding the recommended threshold of 0.70. The coefficients for Cognitive (0.823), Affective (0.842), Behavioural (0.771), Learning Approach (0.829), and Engagement (0.824) dimensions indicate strong reliability, confirming that the items used effectively and consistently measure their respective constructs (Sekaran & Bougie, 2019).

Table 2. Summary of Cronbach Alpha

Variable	Items	Cronbach's Alpha	Reliability
Cognitive	7	0.823	Very Reliable
Affective	9	0.842	Very Reliable

Behavioral	5	0.771	Reliable
Learning Approach	6	0.829	Very Reliable
Engagement	6	0.824	Very Reliable

CORRELATION

To determine the strength and direction of the relationships between students' engagement and the four independent variables (cognitive, affective, behavioural, and learning approaches), a Pearson correlation analysis was conducted, as all variables were measured on continuous scales. The correlation coefficient (r) ranges between -1 and $+1$, where values closer to $+1$ indicate a strong positive linear relationship, values near -1 indicate a strong negative relationship, and values around zero suggest the absence of a linear association (Gogtay & Thatte, 2017).

As presented in Table 3, the results reveal a significant, moderate positive correlation between student engagement and each of the four dimensions examined. Specifically, engagement correlates significantly with cognitive ($r = 0.691$, $p < 0.001$), affective ($r = 0.696$, $p < 0.001$), behavioural ($r = 0.699$, $p < 0.001$), and learning approach ($r = 0.730$, $p < 0.001$) variables. These findings provide an empirical support for the first objective, confirming that all four factors are positively associated with students' engagement in statistics learning. Among these, the learning approach demonstrates the strongest relationship with engagement, indicating that the strategies and methods employed by the lecturers play a crucial role in shaping their involvement with the subject.

The prominence of the learning approach as the strongest correlate of engagement underscores the importance of pedagogical design and learning environment in fostering active participation. Students in this study reported that lecturers who deliver topics with clarity and integrate technology-enhanced tools, such as digital whiteboards (e.g., Explain Everything, Microsoft Whiteboard), facilitate better comprehension and long-term retention of statistical concepts. These tools provide visual reinforcement, allow easy access to saved notes, and support inclusivity through accessibility features, benefiting students with diverse learning needs, including those with visual or hearing impairments. Such findings align with Önal (2017), who observed that interactive technologies promote meaningful learning, increase student focus, and encourage active classroom participation. A well-structured and supportive learning environment where students feel comfortable asking questions, engaging in discussions, and receiving guidance further enhances their willingness to participate and persist in statistical learning.

Moreover, lessons that contextualize statistics within real-world applications help bridge the gap between abstract theory and practical relevance, thereby deepening engagement. Participation in supplementary learning experiences such as webinars, collaborative projects, or expert talks allows students to connect statistical concepts with authentic scenarios, strengthening both understanding and motivation. Thus, it is important in fostering critical thinking students' skills, exposing them to expert opinions and real-world problems.

Affective factors also exhibit a significant positive relationship with engagement, suggesting that students' emotions play a pivotal role in sustaining interest in statistics. When students experience satisfaction, pride, or enjoyment from solving complex problems, their confidence and intrinsic motivation increase, encouraging persistence even when confronted with challenging material. This observation is consistent with findings by Lin et al. (2020), who demonstrated that positive emotions enhance self-regulation, perseverance, and long-term academic achievement in quantitative subjects.

Similarly, cognitive engagement reflected through mental effort, critical thinking, and problem-solving correlates positively with students' overall engagement in statistics. This finding suggests that students who actively engage in cognitive processes such as critical thinking, analytical reasoning, and reflective understanding tend to demonstrate deeper learning and greater persistence when facing complex or challenging topics. When lecturers contextualize statistical concepts within real-world applications and promote self-

directed learning, students are more inclined to engage meaningfully with the material, thereby enhancing both their comprehension and academic performance.

Taken together, these results emphasize that engagement in statistics learning is a multifaceted construct driven by both internal (cognitive and affective) and external (instructional and environmental) factors. The strength of the correlations highlights the interconnected nature of these dimensions and suggests that enhancing one aspect; particularly the learning approach, can have a reinforcing effect on others, ultimately leading to more meaningful and sustained engagement with statistics.

Table 3: Summary of Correlation for Satisfaction

Variable	Pearson Correlation, r	Strength of Relationship	p-value
Cognitive	0.691**	Moderate	< 0.001
Affective	0.696**	Moderate	< 0.001
Behavioural	0.699**	Moderate	< 0.001
Learning Approach	0.730**	Moderate	< 0.001

**. Correlation is significant at the 0.01 level (2-tailed).

Regression Analysis

The association between the cognitive, affective, behavioural, and learning approach dimensions with student engagement was further examined using multiple linear regression analysis. Multiple linear regression estimates the relationship between a response variable (y) and several explanatory variables (x), focusing on the strength and direction of associations rather than implying causality (Tranmer & Elliot, 2008).

As presented in Table 4, the regression results indicate a moderate overall linear relationship between the independent variables (cognitive, affective, behavioural, and learning approach) and students' engagement in statistics ($R = 0.802$). The coefficient of determination ($R^2 = 0.643$) shows that approximately 64.3% of the variance in engagement can be explained by these four predictors, while the remaining 35.7% may be attributed to other unmeasured factors. The overall model is statistically significant ($F = 49.909$, $p < 0.001$), suggesting that, collectively, these dimensions contribute meaningfully to students' engagement in statistics learning.

At the individual variable level, cognitive ($\beta = 0.217$, $p = 0.025$), affective ($\beta = 0.249$, $p = 0.023$), and learning approach ($\beta = 0.355$, $p < 0.001$) were found to be significant predictors of engagement, while behavioural engagement ($\beta = 0.123$, $p = 0.250$) was not statistically significant. These results imply that students' engagement in statistics is primarily shaped by their thinking processes, emotional connection, and learning strategies rather than by observable behaviours alone. The learning approach emerged as the strongest factor, indicating that the ways in which students plan, process, and internalize learning materials given by their lecturers have the greatest influence on their engagement levels.

Therefore, lecturers should use student-centered teaching tactics that create a safe, stress-free environment while promoting in-depth interaction with statistical topics in order to reduce statistics anxiety and encourage meaningful learning. This entails employing low-stakes tests and group projects to lessen failure anxiety, integrating relatable, real-world facts to boost relevance, and promoting active learning through idea mapping, peer discussions, and practical exercises. In order to assist students gain confidence and go from superficial memorization to deeper knowledge and application, lecturers should also normalize difficulties in learning statistics, offer prompt, helpful feedback, and encourage reflective thinking. Face-to-face instruction provides the best resources for fostering emotional safety, facilitating in-the-moment clarification, and assisting students in collaborating with one another, all of which are effective in lowering fear and boosting interest in statistics.

Table 4: Multiple Linear Regression

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.802 ^a	.643	.630	.29930
a. Predictors: (Constant), Learning_Approach, Affective, Cognitive, Behaviourial				

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.883	4	4.471	49.909	<.001 ^b
	Residual	9.943	111	.090		
	Total	27.827	115			
a. Dependent Variable: Engagement						
b. Predictors: (Constant), Learning_Approach, Affective, Cognitive, Behaviourial						

Coefficients^a

Model		Unstandardized Coefficients		Sig.
		B	Std. Error	
1	(Constant)	.180	.281	.523
	Cognitive	.217	.096	.025
	Affective	.249	.108	.023
	Behaviourial	.123	.107	.250
	Learning_Approach	.355	.088	<.001

CONCLUSION

The findings of this study offer valuable insights into the multidimensional nature of student engagement in statistics courses among non-statistical major academic programs. Overall, the results indicate that cognitive, affective, and learning approaches are positively related and significantly contributed factors towards students' engagement, while behavioural engagement, although positively correlated, does not significantly contribute to the prediction model. These results suggest that students from diverse academic backgrounds are capable of engaging meaningfully with statistics learning when supported by appropriate cognitive strategies, positive emotional dispositions, and effective learning approaches.

Moreover, the learning approach is the strongest factor towards students' engagement. This finding underscores the importance of fostering deep learning strategies and self-regulated learning among students, particularly in subjects like statistics that are often perceived as abstract and difficult. Lecturers should adopt student-centred pedagogical practices that foster a psychologically safe and intellectually stimulating learning environment.

The non-significance of behavioural engagement in the regression model suggests that observable actions such as attendance and participation, while important, may not fully capture the depth of student engagement unless supported by cognitive investment and positive affective experiences. In other words, students may "show up" and complete tasks but not necessarily feel or think deeply about the material, limiting their overall

engagement. This finding highlights the complexity of engagement as a multidimensional construct; wherein behavioural manifestations alone cannot fully represent students' genuine engagement in learning.

Therefore, future research should move beyond examining these components in isolation. Although cognitive, affective, and behavioural dimensions of engagement are often studied separately, limited empirical evidence exists on how these elements dynamically interact. For instance, it remains unclear whether affective factors such as anxiety might diminish cognitive engagement, subsequently leading to behavioural disengagement. A more integrated approach potentially through longitudinal or mixed-methods designs in which various aspects of engagement (behavioural, cognitive, and affective) are assessed at multiple points throughout a semester (e.g., at the beginning, midterm, post-assessment, and course completion). Such a design would enable researchers to track fluctuations in engagement levels, explore the influence of statistics anxiety over time, and gather qualitative insights into the contextual and instructional factors that shape students' engagement and learning experiences in statistics courses.

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