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Online or Face-to-Face: A Data-Analytics Approach to Understanding First-Year Students' Learning Preferences and Academic Achievements

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ABSTRACT

This research explored the predictive power of individual and contextual factors on first-year students' preferences for online versus face-to-face learning environments, examined through a Bayesian framework for analyzing compositional data. Purposefully, it delves into how students' academic performance and geographic location influence their educational modality choices in a post-pandemic context. As quantitative research, the paper employs Bayesian statistical methods, the research analyzed student preferences across varied South African provinces, juxtaposing these with academic performance to uncover patterns and predictors of learning modality preferences. The student learning modalities preferences were collected through questionnaire as a compositional data. The findings revealed a significant correlation analysis which is, that students with higher academic performance and those residing in remote areas show a preference for face-to-face learning modality, challenging the notion that online learning preferences are primarily driven by academic outcomes alone. Adding a novel dimension, this investigation enriches the current understanding of educational preferences by applying a Bayesian approach, revealing that predictive analyses must account for a blend of personal and situational factors. This insight is pivotal for formulating educational policies that are both inclusive and responsive to the diverse needs of the student populace in a dynamically evolving educational terrain.

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INTRODUCTION

The advent of COVID-19 has posed unprecedented challenges across the spectrum of human endeavors (Fernández et al., 2021, Kamil, 2022). Arguably, the disruption it caused is unparalleled in the contemporary era. The education sector, much like other spheres, was significantly impacted—higher education institutions, in particular, found themselves compelled to undertake abrupt and unplanned transitions to digital learning environments (Rapanta et al., 2020). This shift, necessitated by the pandemic, was fraught with challenges; both educators and students were compelled to adapt rapidly to the demands of online pedagogy (Muliyah et al., 2020). This sudden pivot has ignited a robust academic discourse regarding the efficacy and desirability of online learning vis-à-vis traditional classroom learning and teaching (Rahman et. al., 2022). At the heart of this discourse lies a concerted effort to decipher student preferences, which is crucial for informing the development of future educational spaces, curricular designs, and policy frameworks (Dinh, & Nguyen, 2020, Escomes et al., 2021).

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The emerging scholarship on the dichotomy between online and face-to-face (Ngah, et al., 2021, Shapiro et al., 2020, Larson & Sung, 2019, Meyer, 2019) educational modalities reveals that this issue is an intricate and multi-layered one. The body of research can largely be segmented into three primary, albeit not rigidly defined, clusters, indicative of a scholarly reluctance to adopt absolute positions. Researchers such as Pikhart et al. (2023) and Herold and Chen (2021) occupy one cluster, which emphasizes the significance of in-person learning, particularly noting the value of palpable interactions among students and between students and instructors. In contrast, another cluster, featuring scholars like Komarasamy and Sathibabu (2022); and Amoush and Mizher (2023), champions the merits of online learning, especially extolling its flexibility and accessibility.

Delving deeper into the dimensions of student satisfaction, Teng (2023) posits that it is shaped by a constellation of factors, including instructional quality, technological frameworks, and individual abilities to navigate digital resources effectively. Xu and Li (2023) build upon this perspective by distinguishing the levels of satisfaction among different educational demographics, noting that adult learners report greater satisfaction with online learning formats in contrast to their K-12 and university counterparts. This suggests that factors such as maturity and autonomous learning capabilities may significantly influence learning preferences and satisfaction levels.

The literature on individual differences in learning preferences spans a broad array of factors and contexts. Studies have consistently emphasized that learning styles and preferences are not uniform but rather influenced by a combination of elements, including the discipline of study, gender, teacher-student style compatibility, and the modality of instruction. Al-Roomy (2023) provided insights into the domain-specific learning preferences of students in health sciences, revealing a predilection for auditory and group-oriented styles and highlighting the variation of learning style preferences across different colleges. This underlines the importance of context in shaping how students prefer to learn. Alhourani (2021) addressed the synchronicity between teaching and learning styles, demonstrating that mismatches in this area can have significant implications for educational outcomes. This study focused on a Saudi school context and shed light on the necessity for teachers to adapt to the learning styles of their students to optimize teaching effectiveness.

Gender has been shown to play a role in learning preferences, with Mehmood (2020) confirming that teachers perceive distinct differences between the learning styles preferred by male and female students in Pakistan. This gender-related divergence suggests that educators must consider these differences when planning instruction. The shift towards online education has brought the importance of aligning learning tasks with students' learning styles into sharp focus. Hosseini and Mehraein (2022) demonstrated that in online language courses, tasks tailored to specific learning styles can significantly enhance the educational experience, underscoring the potential for personalized online learning environments. Additionally, Santos (2020) emphasized the diversity of learning preferences among non-traditional learners in engineering programs, indicating that factors such as motivation and prior experience also shape learning preferences.

The literature indicates that while there is no one-size-fits-all approach to education, understanding the myriad factors that contribute to individual learning preferences is crucial for educators. This knowledge can facilitate the design of instruction that not only caters to the diverse learning styles found in any educational setting but also adapts to the changing landscapes of educational delivery methods, such as the increased reliance on online platforms as seen during the COVID-19 pandemic (Herold & Chen, 2021; Teng, 2023; Xu & Li, 2023).

The rise of online learning due to the COVID-19 pandemic has prompted numerous studies (Šácha et al., 2022, Yadav et al., 2021) into its effectiveness and satisfaction levels among students (Wang et al., 2020), with varied findings. The general trend indicates a mixed reaction from students (Sunder et al., 2020), with many expressing a preference for a blended approach

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that combines online and traditional face-to-face instruction. Studies like Rajab et al. (2020) and Lashley et al. (2022) demonstrate a clear inclination towards blended learning or face-to-face instruction, with a smaller percentage of students favoring online instruction alone. This preference is attributed to various factors, including perceived effectiveness in knowledge acquisition and personal learning styles. Research such as that of Sharma et al. (2020) and Sriphon (2022) shows that a significant number of students are satisfied with online learning or find no significant difference in learning outcomes compared to face-to-face learning. However, there are concerns about social competence and participation in online settings.

A systematic review by Abualadas and Xu (2022) suggests that academic performance may not significantly differ between online and traditional teaching methods, which is echoed in the findings of Paul and Jefferson (2019), and Tsitsia and Kabbah (2020). Nonetheless, studies like those from Ozkan & Budak (2021), and Adewumi and Pitan (2021) indicate dissatisfaction with online learning, primarily due to the lack of face-to-face interaction and the value placed on direct engagement with peers and instructors. Further, Ebner and Gegenfurtner (2019) and Elkins & McDade (2021) provide evidence that certain modalities, such as webinars or online programs, can be more effective or satisfactory for certain groups of students, highlighting the importance of tailoring online education to diverse student needs and preferences. The challenges of online learning are highlighted by Hariyadi et al. (2023), and Dharmadjaja and Tiatri (2021), who discuss specific difficulties faced by students in fields like tourism or when considering factors of online interaction and technology acceptance.

Student preference constitutes a critical yet unresolved issue necessitating immediate elucidation to guide the conceptualization of future universities. The transition to online modalities has undeniably redefined the landscape of higher education learning. Acknowledging the importance of understanding student preferences is crucial, given the emerging consensus that a student-centered pedagogical approach may offer considerable benefits for learning enhancement.

Purpose of the Study

Therefore, this paper endeavors to add to the discourse by addressing the main research question. How do individual and contextual factors predict first-year students' preferences for online versus face-to-face learning environments when analyzed through a Bayesian compositional framework? Student preferences for learning was measured as a compositional data point which is students choosing 0% face-to-face vs 100% online; 20% face-to-face vs 80% online; 30% face-to-face vs 70% online until 100% face-to-face vs 0% online.

- How does the location of first-year students within different South African provinces influence their preference for online versus face-to-face learning modalities?
- Do individual academic achievements, as indicated by AP Scores, influence first-year students' preferences for face-to-face versus online learning environments?

RESEARCH METHOD

This study was conducted using a quantitative methodology to examine how individual and contextual factors influence first-year students' preferences for online versus face-to-face learning environments. The rationale for selecting a quantitative approach was its strength in enabling the statistical examination of preferences across a large sample of first-year students, thereby facilitating the generation of generalizable and inferential insights.

Given the compositional nature of the data – online versus face-to-face – the study adopted a Bayesian analytical framework. This framework facilitates the quantification of students' preferences for learning modalities. A key advantage of the Bayesian approach is its capacity to integrate prior assumptions regarding the state of students' learning modality preferences (Nimy et al., 2023). Moreover, it aids in articulating the uncertainty associated with the

estimation of effects on student preferences, thereby yielding a more refined analysis compared to frequentist methods (Nimy & Mosia, 2023).

Data were meticulously gathered through a meticulously structured questionnaire designed to elicit biographical details and learning modality preferences – online or face-to-face – of first-year university students at a South African institution. The distribution of the questionnaire spanned three weeks after student registration. Utilizing the University Learning Management System, a link to the questionnaire was disseminated and made exclusively accessible to the cohort of first-year students enrolled in the 2023 academic year. Out of the 1,600 first-year students registered for the year, 1,179 completed the survey. The sample encompassed a diverse representation encompassing students from all faculties and every program offered to first-year students at the university in the 2023 academic year.

Firstly, the data underwent a preprocessing phase to ensure that it was suitable for analysis. This stage involved the encoding of categorical variables and the construction of a compositional target variable, the students' preference for online versus face-to-face learning. The compositional nature of this variable arises from the fact that preferences are proportional, collectively summing to unity, e.g., 60% online and 40% face-to-face, which adds up to 100%. In the statistical treatment of the data, a Bayesian analytical approach was employed to obtain not merely a point estimate but a complete posterior distribution for the estimated impact of student preferences. This comprehensive probabilistic characterization significantly augmented the rigor and credibility of the study's findings.

RESULTS AND DISCUSSION

Results

In this section, we present the findings from the Bayesian analysis aimed at addressing the question: "How do individual and contextual factors predict first-year students' preferences for online versus face-to-face learning environments when analyzed through a Bayesian compositional framework?" Table 1 and Table 2 below delineate the outcomes of this analysis. Table 1 presents the descriptive analysis in order to provide the context for the findings of this study.

Table 1. Descriptive analysis

Province	N	AP Score		Online		Face-to-face	
		Mean	SD	Mean	SD	Mean	SD
EC	79	31.1	4.24	36.5	24.3	63.5	24.3
FS	51	31.4	4.24	38.8	24.5	61.2	24.5
GP	152	30.8	4.25	31.6	23.0	68.4	23.0
KZN	86	30.4	3.60	28.8	26.3	71.2	26.3
LM	74	31.4	3.56	31.4	26.1	68.6	26.1
MP	64	33.6	4.07	37.2	28.0	62.8	28.0
NW	294	30.8	3.82	35.9	27.5	64.1	27.5
NC	374	31.3	4.29	35.1	26.3	64.9	26.3
OSA	2	40.0	0.00	0.0	0.0	100.0	0.0
WC	18	33.1	3.31	30.0	26.8	70.0	26.8

Table 1 presents a descriptive analysis that compares student academic performance (AP Score) and their preferences for online versus face-to-face learning modalities, categorized by the geographical location of the students' residences. It is noteworthy that the category Outside South Africa (OSA) includes only two students, making it impractical to draw broader conclusions. However, both students expressed a preference for face-to-face learning. Moreover, the data in Table 1 reveals that despite varying sample sizes (n) across provinces, there is remarkable uniformity in average performance. This uniformity is underscored by the standard deviation (SD) figures, which span a tight range from 3.60 in KwaZulu Natal to 4.07 in

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Mpumalanga for the SD and from 30.4 to 33.6 for the mean AP Scores, suggesting a comparably consistent level of academic achievement among students from different locales.

In addition, the results exhibited in Table 1 reported the student preference for learning modalities. There is a notable variation in the mean percentage of the online compared to face-to-face across the students' geographical locations. Gauteng (GP) and KwaZulu Natal (KZN) show a higher preference for face-to-face learning, with mean percentages of 68.4% and 71.2%, respectively. In contrast, Free State (FS) exhibits a relatively higher online learning preference, with a mean percentage of 38.8%. The SD for online and face-to-face learning preferences suggests varying levels of consensus within provinces on learning mode preference. The SDs are generally higher for the online learning preference, which may indicate more diverse opinions or a less uniform distribution of preferences for online learning compared to face-to-face learning within provinces. The Western Cape (WC) shows a balanced preference leaning slightly towards face-to-face learning (70% mean), with AP scores slightly above the overall mean, suggesting a potential correlation between higher academic performance and the preference for face-to-face learning.

To advance beyond the descriptive analysis of the focal issue, a Bayesian analytical framework was utilized. The outcomes of this analysis are summarised in Table 2 below.

Table 2. Fixed effect estimates from Bayesian regression analysis

Predictor	Estimate	Std. Error	95% Credible Interval Lower	95% Credible Interval Upper	Rhat
Intercept	-0.25	0.32	-0.89	0.39	1.00
Ap Score	0.02	0.01	0.00	0.04	1.00
First_Generation (Yes)	0.14	0.08	-0.01	0.29	1.00
Fs	-0.10	0.24	-0.57	0.39	1.00
Gp	0.21	0.19	-0.14	0.58	1.00
Kzn	0.47	0.21	0.08	0.88	1.00
Lm	0.48	0.21	0.06	0.90	1.00
Mp	0.12	0.22	-0.32	0.55	1.00
Nw	0.01	0.17	-0.32	0.35	1.00
Nc	0.17	0.17	-0.15	0.50	1.00
Osa	1.92	0.89	0.33	3.97	1.00
Wc	0.30	0.34	-0.37	0.96	1.00

The results detailed in Table 2 above sought to answer, amongst others, the question, "*Do individual academic achievements, as indicated by AP Scores, influence first-year students' preferences for face-to-face versus online learning environments?*" These results elucidate that with each unit increase in AP Score, there is a corresponding rise in the log-odds ratio of 0.02 for first-year students' preference for face-to-face instruction compared to online classes, as defined by a credibility interval (CI) of 0.0 to 0.04. Crucially, the CI notably does not encompass zero and remains relatively narrow, which signifies a statistically consistent and positive influence of AP scores on the preference patterns of students regarding their learning modalities. This suggests that students with higher AP Scores are more likely to favor face-to-face classes over online formats.

Additionally, the research sought to examine the influence of geographical location, operationalized through the provincial residency of students, on their teaching modality preferences. The findings, as delineated in Table 1, suggest that geographical location has a tangible impact on the preferences for teaching and learning modalities in a subset of provinces, specifically Kwazulu-Natal, Limpopo, and for students from regions beyond South African borders. Students from these distinct areas exhibited a marked preference for face-to-face classes. It is noteworthy that these provinces are characterized by their greater distance from the

university under study, a factor that may contribute to their distinct preferences. In each of the three cases, the CI does not include zero and remains relatively narrow, indicating a consistent positive effect of the students' geographical locations on their preferred learning modalities.

Discussion

In this discussion, the research findings are situated within the expansive scholarly conversations about instructional modalities in the post-COVID-19 era. This study aimed to enrich the dialogue by exploring the impact of students' geographic locations on their preferences for online versus face-to-face learning. The evidence from the current research underscored that geographic location is a significant determinant of students' learning preferences. This insight extends the discourse beyond the confines of pedagogical efficacy, suggesting that our comprehension of teaching modalities must also consider the contextual intricacies, including students' access or proximity to learning and teaching resources. While the findings of the current students support what Rajab et al. (2020) and Lashley et al. (2022) reported, that there is a general inclination towards blended or face-to-face instruction, our research nuances these findings by revealing that students from more remote areas express a more pronounced preference for face-to-face learning.

In line with Sharma et al. (2020) and Sriphon (2022), who found a segment of students satisfied with online learning, the current study contributes an additional layer by correlating academic performance with learning modality preferences. Contrary to Abualadas & Xu (2022), whose findings suggest that academic performance may not significantly differ between online and traditional teaching methods, the current study indicates that students with higher academic performance, measured by AP Score, exhibited a stronger preference for face-to-face learning and teaching modalities. This finding was very surprising given the general acceptance that students with higher academic performance may require less academic support and may be more comfortable with online.

Moreover, our research highlights the complexity of implementing online learning, which corroborates the findings of Ebner and Gegenfurtner (2019), and Elkins and McDade (2021), suggesting that certain online modalities may be more effective for specific student groups. This is particularly relevant when considering our finding that students from certain geographical locations prefer face-to-face learning despite the uniform academic performance across regions. This preference could potentially be addressed by tailoring online educational resources to mimic aspects of face-to-face interaction that students in more remote areas may miss.

By extending the conversation about online learning preferences to include the effects of geographic location and academic performance, this study enriches the academic narrative with a multi-faceted perspective. It suggests that educators and policymakers should not only consider the pedagogical effectiveness of online versus face-to-face instruction but also the nuanced preferences and needs of their student populations, which are shaped by a confluence of academic and contextual factors.

Our study underlines the importance of a dynamic educational model that acknowledges both the challenges and potential of online learning, resonating with the concerns of Hariyadi et al. (2023) and Dharmadjaja and Tiatri (2021). By bridging the gap between academic performance, geographical location, and learning preferences, this research offers a novel perspective that can inform the development of more personalized and contextually sensitive educational strategies.

CONCLUSION

In conclusion, this study pierces through the surface of traditional debates on educational modalities to reveal the undercurrents of geographic influence on learning preferences. The fundamental finding—that the geographical location of students significantly informs their predilection for either online or face-to-face instruction—challenges educationalists to look

beyond the dichotomy of digital versus physical classrooms. This research posits that educational delivery methods cannot be detached from the geographical tapestry that forms the backdrop of the learning experience.

The implications of this study are manifold. It calls for a paradigm shift in how educational policies and instructional designs are conceptualised and implemented. Educators and policymakers are urged to consider a more nuanced approach that incorporates geographic considerations, potentially leading to more equitable and effective educational outcomes. This might involve not only infrastructure investments in remote areas but also culturally sensitive pedagogical practices that resonate with diverse student cohorts.

Looking forward, the revelations from this study set a fertile ground for future research. Further investigation is warranted into how specific cultural and geographic factors influence learning preferences and outcomes. Additionally, there is a need to explore the potential for hybrid educational models that blend the benefits of face-to-face interaction with the accessibility of online platforms, particularly in geographically diverse educational landscapes. This study leaves us with a final impression of the complexity and dynamism of educational preferences in the wake of a global pandemic. It emphasizes that the fabric of learning is interwoven with threads that extend beyond the classroom walls—threads that span mountains, rivers, and cultural divides to tie the academic journey of each student to the place they call home.

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