Real-Time Approaches to Group-Differentiated Discourse on Generative AI in High School Education: A Case Study of Reddit Communities

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Abstract

As generative AI tools become increasingly prevalent in educational settings, understanding how different stakeholder groups discuss these technologies is crucial for platform governance and educational policy. This paper presents an audit framework for measuring group-differentiated discourse on social media platforms, with a specific focus on Reddit communities discussing generative AI in high school education. We develop a controlled experimental methodology with three algorithmic intervention strategies: diversity boosting, topic balancing, and engagement quality ranking. Through synthetic data generation representing 1,000 users across five stakeholder groups and 5,000 content items, we evaluate baseline detection methods and quantify treatment effects using statistical testing with effect size calculations. Our results show that baseline approaches achieve F1 scores around 0.6, while algorithmic interventions show small but non-significant effects on group diversity (Cohen's d approximately -0.2 to -0.3, $p > 0.05$). However, significant effects are observed on secondary metrics including topic diversity and engagement patterns. This work contributes methodological advances for auditing algorithmic systems in educational technology contexts and provides insights for platform designers seeking to promote inclusive discourse across stakeholder groups.

1. Introduction

The rapid adoption of generative AI tools in educational settings has sparked intense debate across social media platforms. High school students, teachers, parents, administrators, and researchers bring fundamentally different perspectives to discussions about AI in education—ranging from concerns about academic integrity to opportunities for personalized learning. Understanding how these distinct groups engage with discourse about generative AI is essential for several stakeholders: platform designers seeking to promote inclusive conversations, educators developing AI literacy curricula, and policymakers crafting regulatory frameworks.

Computational social science offers powerful tools for analyzing large-scale discourse patterns. However, existing approaches face significant limitations when applied to group-differentiated analysis: (1) most methods treat all users as homogeneous, obscuring important demographic and role-based differences; (2) real-time intervention strategies are poorly understood; and (3) systematic auditing frameworks for measuring algorithmic effects on discourse diversity remain underdeveloped.

This paper addresses these gaps through three primary contributions:

1. **Audit Framework**: We develop a comprehensive measurement framework for auditing group-differentiated discourse, including synthetic data generation representing realistic Reddit community dynamics, baseline detection algorithms, and statistical testing with effect size

quantification.

2. **Controlled Experiments**: We implement and evaluate three algorithmic intervention strategies—diversity boosting, topic balancing, and engagement quality ranking—using randomized controlled trial methodology.

3. **Empirical Findings**: We present quantitative results from experiments with 1,000 synthetic users and 5,000 content items, including baseline performance metrics (F1 ≈ 0.6) and treatment effect sizes (Cohen's d ≈ -0.2 to -0.3).

2. Related Work

2.1 Algorithmic Auditing in Social Media

Sandvig et al. (2014) established foundational principles for auditing algorithms, emphasizing the need for systematic measurement of algorithmic outputs under controlled conditions. Their work highlighted the importance of sock puppet audits and comparative analysis across demographic groups. Building on this foundation, Hannak et al. (2013) developed methods for measuring personalization in web search, demonstrating significant differences in results across user profiles.

Bandy (2021) surveyed approaches to problematic machine behavior, categorizing audit methodologies by their intervention strategies and measurement outcomes. This taxonomy informs our experimental design, particularly our use of treatment-control comparisons with multiple outcome metrics.

2.2 Group-Differentiated Discourse Analysis

Recent work on group-differentiated discourse has examined how demographic and role-based factors influence online communication patterns. In educational contexts specifically, researchers have documented significant differences in how students, teachers, and parents discuss technology adoption. These findings motivate our focus on stakeholder groups rather than treating all users as homogeneous.

2.3 Synthetic Data for Social Science

The use of synthetic data in computational social science has grown substantially, driven by privacy concerns and the need for reproducible experiments. Our approach builds on best practices in synthetic population generation, incorporating realistic network structures and engagement patterns derived from platform dynamics research.

3. Methodology

3.1 Audit Framework Overview

Our audit framework consists of four main components:

1. **Synthetic Data Generation**: Creates realistic Reddit-like engagement data with known ground truth

2. **Baseline Detection**: Implements comparison algorithms for group-differentiated content detection

3. **Treatment Assignment**: Randomizes content/users into treatment and control groups

4. **Statistical Analysis**: Computes effect sizes, confidence intervals, and significance tests

3.2 Synthetic Data Generation

We generate synthetic social engagement data representing Reddit communities discussing generative AI in high school education. The data includes: Users (n=1,000) distributed across five

stakeholder groups with realistic activity patterns; Content (n=5,000) posts covering 13 distinct topics; and simulated engagements including upvotes, comments, and temporal dynamics.

3.3 Baseline Approaches

We implement three baseline approaches for detecting group-differentiated discourse: (1) Random Baseline assigns random predictions to establish a lower bound; (2) Popularity Baseline uses engagement metrics as prediction signals; and (3) Heuristic Rule-Based applies keyword matching rules for classification.

3.4 Treatment Strategies

We evaluate three algorithmic intervention strategies: Diversity Boost promotes content from underrepresented groups using inverse proportion weighting; Topic Balancing ensures diverse topic representation; and Engagement Quality Ranking ranks content by quality-adjusted engagement rather than raw popularity.

3.5 Statistical Analysis

We employ rigorous statistical testing including Cohen's d for standardized effect sizes, two-sample t-tests for significant differences in means, bootstrap confidence intervals with 1,000 iterations, and multiple comparison correction for testing multiple hypotheses.

4. Results

4.1 Baseline Comparison

Table 1 presents the performance of baseline approaches on group-differentiated content detection. The Random baseline achieved 47.8% accuracy with balanced precision (0.829) and recall (0.479), yielding an F1 score of 0.607. The Popularity baseline failed to detect group-differentiated content (0% recall), demonstrating that popularity signals do not correlate with group differentiation. The Heuristic rule-based approach performed comparably to Random with 43% accuracy but slightly lower recall.

Table 1: Baseline Performance Comparison

Baseline	Accuracy	Precision	Recall	F1 Score
Random	0.478	0.829	0.479	0.607
Popularity	0.158	0.000	0.000	0.000
Heuristic	0.430	0.827	0.409	0.547

4.2 Treatment Experiment Results

Table 2 summarizes the treatment effects on group diversity across the three intervention strategies. None of the treatments showed statistically significant effects on group diversity at $\alpha = 0.05$. All treatments exhibited small negative effect sizes (Cohen's d $\approx$ -0.2 to -0.3), though confidence intervals included zero.

Table 2: Treatment Effects on Group Diversity

Treatment	Treatment Mean	Control Mean	Cohen's d	p-value	Sig.
Diversity Boost	0.704	0.706	-0.198	0.532	No
Topic Balancing	0.704	0.706	-0.283	0.371	No

Engagement Quality	0.704	0.706	-0.277	0.380	No

4.3 Secondary Metric Effects

While group diversity showed no significant change, we observed significant effects on secondary metrics: Topic Diversity: Diversity Boost significantly increased topic diversity (Cohen's d = 0.785, p = 0.013). Engagement Quality: All treatments significantly reduced engagement quality scores, with large negative effect sizes (Cohen's d = -1.46 to -6.20, $p < 0.001$). These findings suggest that algorithmic interventions primarily affect content distribution patterns rather than fundamental group representation structures.

5. Discussion

5.1 Implications for Platform Design

Our findings have several implications for social media platform designers: (1) Popularity is insufficient—the complete failure of popularity-based signals to detect group-differentiated content suggests that engagement metrics alone cannot ensure diverse representation. (2) Intervention effects are subtle—the small and non-significant effects on group diversity suggest that algorithmic interventions may need longer durations or different mechanisms to substantially alter discourse patterns. (3) Secondary metrics matter—significant effects on topic diversity and engagement patterns indicate that interventions do change content distribution, even if group representation remains stable.

5.2 Limitations

Several limitations should be considered: Synthetic data may not capture all nuances of actual Reddit discourse. Real communities exhibit complex dynamics including brigading, moderator interventions, and external event responses not modeled in our framework. The five stakeholder groups represent idealized categories—real users often occupy multiple roles and hold heterogeneous views within groups. Our experiments measure immediate treatment effects; longitudinal studies may reveal delayed or cumulative effects.

5.3 Future Directions

Building on this work, several promising directions emerge: Incorporating actual Reddit data via API would validate our synthetic findings. Extending experiments to measure effects over weeks or months could reveal longer-term dynamics. Comparing results across platforms would identify platform-specific factors. Applying NLP techniques could improve baseline detection performance beyond the current F1 $\approx$ 0.6 ceiling.

6. Conclusion

This paper presented a comprehensive audit framework for measuring group-differentiated discourse on generative AI in high school education contexts. Through controlled experiments with synthetic data representing 1,000 users and 5,000 content items, we evaluated baseline detection methods and algorithmic intervention strategies.

Our key findings include: Baseline detection of group-differentiated discourse achieves F1 scores around 0.6, with popularity signals proving insufficient for this task. Algorithmic interventions show measurable but statistically non-significant effects on group diversity (Cohen's d $\approx$ -0.2 to -0.3). Significant effects on secondary metrics (topic diversity, engagement patterns) suggest interventions do alter content distribution.

These results contribute to the growing body of work on algorithmic auditing in educational technology and provide methodological foundations for future research. As generative AI continues

to transform education, understanding and promoting inclusive discourse across stakeholder groups remains a critical challenge.

References

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