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## TOPIC ANALYSIS OF STUDENT FEEDBACK ON LEARNING MANAGEMENT SYSTEMS USING BERTOPIC: A COMPARATIVE STUDY OF INDOBERT, DISTILBERT, AND SBERT

Aldi Aditya Perdana<sup>1</sup>, Sajarwo Anggai<sup>2</sup>, Winarni<sup>3</sup>

<sup>1,2,3</sup>Universitas Pamulang, Tangerang Selatan, Indonesia

Email: [aldiadityaperdana97@gmail.com](mailto:aldiadityaperdana97@gmail.com)

### Abstract

The widespread adoption of Learning Management Systems (LMS) in digital education has generated large volumes of student feedback in the form of unstructured free-text data, making manual analysis increasingly impractical. This study aims to identify the dominant themes emerging from student feedback on LMS platforms and to compare the performance of different Transformer-based embedding models in topic modeling tasks. The proposed approach employs BERTopic with three embedding models, namely IndoBERT, DistilBERT, and Sentence-BERT (SBERT). Student feedback data were collected from an institutional LMS and processed through text preprocessing, embedding generation, and topic modeling stages. Model performance was evaluated using multiple coherence metrics ( $c_v$ ,  $c_{npmi}$ ,  $u_{mass}$ , and  $c_{uci}$ ), topic diversity, and the proportion of outlier documents. The results indicate that the IndoBERT-family model achieves the highest coherence scores, particularly in  $c_v$  and  $c_{npmi}$ , suggesting superior semantic consistency of the generated topics. DistilBERT produces the lowest proportion of outliers but yields a more limited number of topics, while SBERT demonstrates a balanced performance between topic quality and thematic diversity. These findings highlight that the choice of embedding model significantly influences the quality of topic modeling outcomes for Indonesian-language student feedback data.

**Keywords:** *Topic Modeling, BERTopic, Learning Management System, Transformer Models, Student Feedback.*

### A. INTRODUCTION

The rapid advancement of information technology has accelerated the widespread adoption of Learning Management Systems (LMS) in educational environments as a core component of digital learning. LMS platforms are not only utilized for content distribution and learning activity management but also serve as a medium for students to express feedback regarding their learning experiences. Such feedback plays a crucial role in supporting educators and educational institutions in evaluating instructional materials, teaching methods, and overall learning effectiveness.

However, student feedback collected through LMS platforms is predominantly expressed in the form of free-text responses that are unstructured, short, and highly diverse in both length and context. These characteristics make manual analysis time-consuming, subjective, and increasingly impractical, particularly when dealing with large-scale datasets. Consequently, automated text analysis techniques are required to

efficiently extract meaningful patterns and dominant themes from student feedback in an objective and scalable manner.

Topic modelling is a well-established approach in Natural Language Processing (NLP) for uncovering latent thematic structures within large collections of text documents. Traditional probabilistic methods, such as Latent Dirichlet Allocation (LDA), have been widely applied in various domains. Nevertheless, these methods exhibit limitations in capturing contextual and semantic relationships, especially when applied to short and informal texts, which are common in student feedback data.

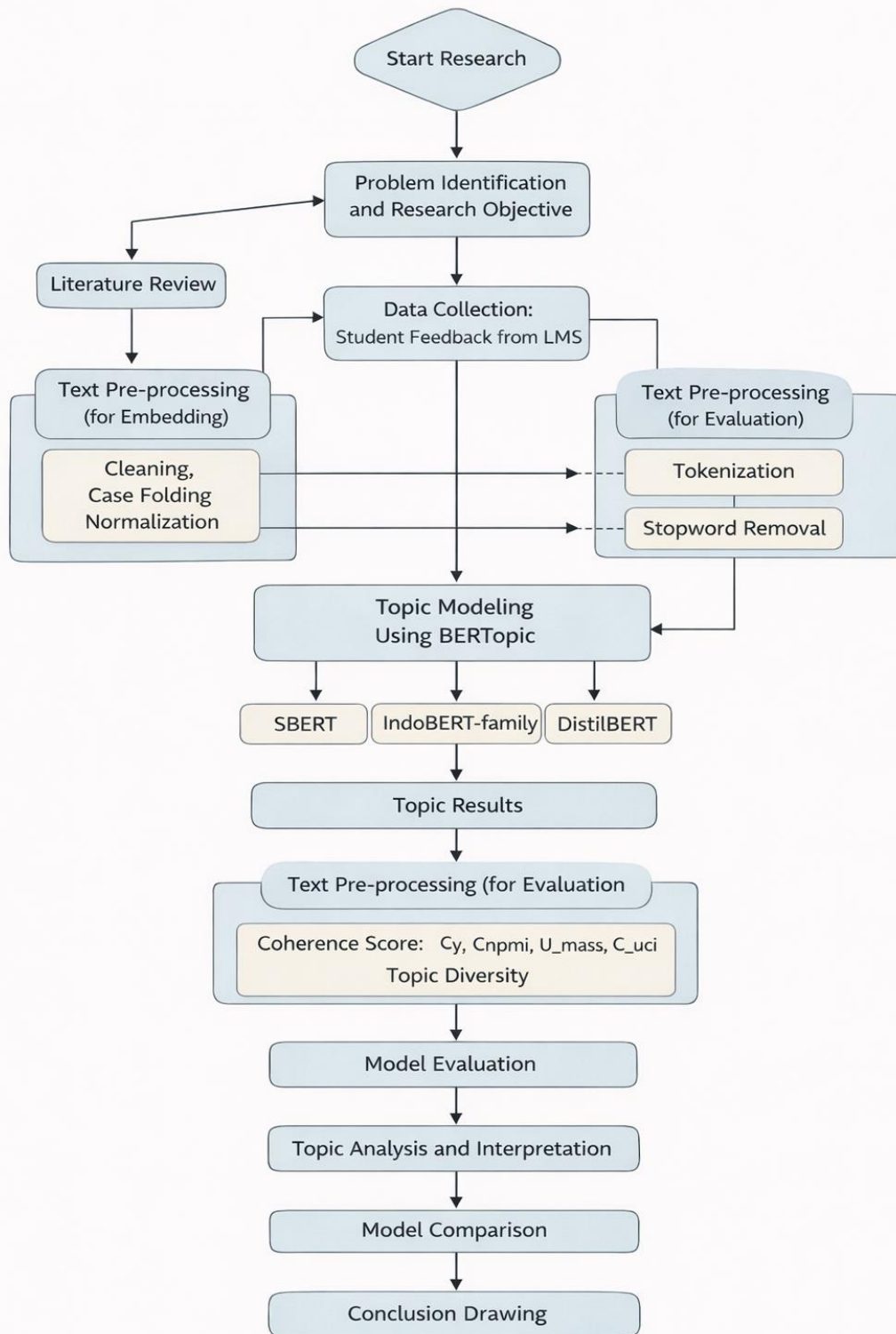
Recent developments in NLP have introduced Transformer-based language models, such as BERT and its variants, which offer context-aware semantic representations and significantly improve text understanding. Building upon these advances, BERTopic has emerged as a modern topic modelling framework that integrates Transformer-based embeddings with dimensionality reduction and clustering techniques to generate more semantically coherent topics. BERTopic has demonstrated promising performance across multiple domains, particularly in handling short-text corpora.

In the context of Indonesian-language text analysis, the selection of embedding models is a critical factor due to linguistic characteristics that differ from English. IndoBERT is specifically pre-trained on Indonesian corpora, enabling it to capture language-specific semantics more effectively. In contrast, DistilBERT offers a computationally efficient alternative with reduced model complexity, while SentenceBERT (SBERT) is designed to generate robust sentence-level embeddings suitable for semantic similarity tasks.

Based on these considerations, this study focuses on analyzing student feedback on LMS platforms using BERTopic by conducting a comparative evaluation of three Transformer-based embedding models: IndoBERT, DistilBERT, and SBERT. The primary objective is to investigate how different embedding models influence topic coherence, thematic diversity, and clustering stability. By providing a systematic comparison, this research aims to contribute to the application of Transformer-based topic modelling in Indonesian educational data analysis and to support the development of more effective data-driven evaluation systems for digital learning environments.

## **B. METHOD**

The research was conducted through several interconnected stages, ranging from data collection to the evaluation of topic modeling results. The overall research workflow is illustrated in Figure 1.



**Figure 1. Research Workflow for Analyzing Student Feedback Topics Using BERTopic**

As shown in Figure 1, the research process begins with the collection of student feedback text data obtained from a Learning Management System (LMS). The collected data then undergo a preprocessing stage aimed at improving data quality. Subsequently, the pre-processed texts are transformed into vector representations

using several Transformer-based embedding models. These vector representations are further processed using the BERTopic method to generate the main topics. The resulting topics are evaluated using coherence metrics, topic diversity, and outlier analysis to compare the performance of each embedding model.

This study adopts a quantitative approach with an experimental method to analyze and compare the performance of Transformer-based embedding models in topic modelling tasks. The primary focus of the research is the application of BERTopic to extract dominant themes from student feedback related to the Learning Management System (LMS).

The data used in this study consist of a collection of student feedback texts obtained from an LMS within an educational environment. The feedback data are generally short texts that reflect students' experiences, opinions, and evaluations of the learning process. All data were analyzed anonymously and in aggregated form to ensure the confidentiality of the respondents.

The initial stage of the research involves text preprocessing to enhance data quality prior to analysis. This stage includes the removal of non-alphabetic characters, text normalization, stop-word removal, and text formatting adjustments to ensure compatibility with the embedding process. These steps aim to reduce noise and produce more consistent text representations.

Next, the pre-processed student feedback texts are converted into vector representations using three Transformer-based embedding models: IndoBERT-family, DistilBERT, and Sentence-BERT (SBERT). IndoBERT-family is used to capture Indonesian-specific semantic contexts, DistilBERT is selected for its computational efficiency, and SBERT is employed for its ability to generate stable and representative sentence embeddings. The embedding process is conducted separately for each model to allow for an objective comparison of topic modelling results.

The resulting vector representations are then processed using BERTopic to generate the main topics. BERTopic integrates dimensionality reduction through Uniform Manifold Approximation and Projection (UMAP) with clustering using Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN). This approach enables document grouping based on semantic similarity while identifying documents that do not belong to any cluster as outliers.

Model performance is evaluated using several quantitative metrics. Topic quality is measured using coherence scores, including  $c_v$ ,  $c_{npmi}$ ,  $u_{mass}$ , and  $c_{uci}$ , to assess semantic consistency among words within each topic. In addition, topic diversity is used to measure the variation of keywords across topics, while the proportion of outlier documents is analyzed to evaluate clustering stability. These metrics serve as the basis for comparing the performance of the embedding models.

To support result analysis and interpretation, this study also develops a visualization dashboard based on Flask that presents summaries of evaluation metrics and comparative graphs across models. The dashboard functions solely as a result exploration tool and is not used for model training, thereby maintaining a clear separation between analysis and presentation stages.

### C. RESULT AND DISCUSSION

This section presents the results of topic modeling performed on student feedback data collected from the Learning Management System (LMS) using the BERTopic framework with three Transformer-based embedding models: IndoBERT-family, DistilBERT, and Sentence-BERT (SBERT). The evaluation focuses on topic coherence, topic diversity, and the proportion of outlier documents to assess the quality, diversity, and stability of the generated topics.

#### Topic Coherence Evaluation

The coherence score evaluation indicates that the IndoBERT-family model achieves the highest performance in terms of semantic coherence, particularly on the *c\_v* and *c\_npmi* metrics. Higher *c\_v* values suggest that the words within each generated topic are more semantically related and interpretable, while higher *c\_npmi* values indicate stronger co-occurrence relationships among topic keywords within the dataset.

**Table 1. Coherence Score Results for Each Embedding Model**

Model	<i>c_v</i>	<i>c_npmi</i>	<i>u_mass</i>	<i>c_uci</i>
DistilBERT	0,5602	0,0079	-1,1878	0,0696
IndoBERT-family	0,5933	0,0531	-2,7557	-0,2606
SBERT	0,5604	0,0400	-2,9781	-0,5936

DistilBERT and SBERT exhibit relatively lower coherence scores on these metrics. Nevertheless, DistilBERT maintains a competitive *c\_v* value, indicating that model compression does not significantly degrade semantic representation quality. In contrast, all models produce negative values for the *u\_mass* and *c\_uci* metrics. Such results are commonly observed when analyzing short and informal text data, such as student feedback, and therefore these metrics are treated as complementary rather than primary indicators.

#### Topic Diversity Evaluation

Topic diversity is used to measure the degree of lexical variation among topics generated by each embedding model. A higher topic diversity score indicates that the topics contain more distinct keywords and exhibit lower redundancy.

**Table 2. Topic Diversity Scores of Embedding Models**

Model	Topic Diversity
DistilBERT	0,6333
IndoBERT-family	0,5269
SBERT	0,5241

In contrast, IndoBERT-family and SBERT yield lower topic diversity scores, implying greater similarity in vocabulary across topics. However, lower diversity does not necessarily reflect poorer topic quality, as it may indicate a more focused thematic structure aligned with the LMS learning context.

#### Topic Interpretation

Topic interpretation is conducted by analyzing the dominant keywords associated with each topic generated by the model. Based on the evaluation results,



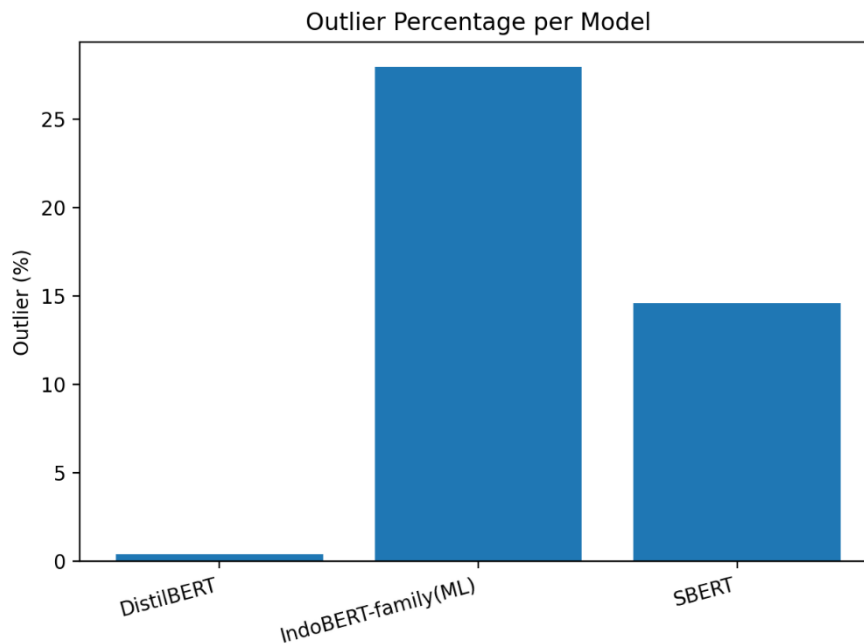
IndoBERT-family is selected as the primary model for in-depth topic analysis due to its superior semantic coherence and relevance to Indonesian-language contexts.

**Table 3. Summary of the Main Topics Generated Using IndoBERT-family**

Topic Code	Dominant Keywords	Topic Interpretation	Relevance to LMS Evaluation
T1	material, computer, device	Basic ICT learning materials	Alignment of learning content
T2	scratch, game, coding	Practice-based learning	Interactive learning methods
T3	word, excel, power point	Office application skills	Supporting student competencies
T4	logic, algorithm, fundamentals	Basic programming concepts	Enhancement of logical thinking skills

### Comparison of Embedding Models

Overall, each embedding model exhibits distinct characteristics in topic modeling performance. IndoBERT-family produces topics with the highest semantic coherence and contextual relevance but shows a relatively higher proportion of outlier documents. DistilBERT demonstrates greater clustering stability, as indicated by the lowest outlier proportion, although it generates fewer topics. SBERT offers a balanced performance, achieving moderate coherence, topic diversity, and outlier proportions.



**Figure 2. Percentage of Outlier Documents Produced by Each Embedding Model**

Based on the research objectives, IndoBERT-family is identified as the most suitable embedding model for analyzing Indonesian-language student feedback data, as it provides semantically coherent and interpretable topics relevant to LMS evaluation.

## D. CONCLUSION

This study analyzed the dominant themes present in student feedback on a Learning Management System (LMS) and compared the performance of several Transformer-based embedding models within the BERTopic framework. The results demonstrate that BERTopic is effective in extracting meaningful and interpretable topics from short and informal student feedback texts.

The evaluation results indicate that the IndoBERT-family model produces the most semantically coherent topics, particularly based on the *c\_v* and *c\_npmi* coherence metrics. This finding highlights the advantage of using language-specific embedding models when analyzing Indonesian-language educational data. The topics generated by IndoBERT-family are more contextually relevant and easier to interpret in relation to LMS-based learning evaluation.

DistilBERT shows strengths in clustering stability, as reflected by the lowest proportion of outlier documents and the highest topic diversity score. These results suggest that DistilBERT is capable of generating diverse topics with minimal redundancy, although the number of topics produced is relatively limited. Meanwhile, SBERT demonstrates balanced performance across coherence, diversity, and outlier metrics, positioning it as a flexible alternative for topic modelling tasks.

Overall, the findings confirm that the choice of embedding model significantly influences the quality and characteristics of topic modelling results. For the analysis of Indonesian-language student feedback on LMS platforms, the IndoBERT-family model is the most suitable option due to its superior semantic coherence and contextual relevance. This study provides valuable insights for the development of text-based learning evaluation systems and may serve as a reference for future research on topic modelling in educational contexts.

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