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Analyzing the gap between its curriculum and industry demand in Nepal using NLP

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Abstract

Bridging the gap between academic IT curricula and industry requirements remains a pressing challenge in Nepal, given the rapid evolution of technology. This study presents a systematic, data-driven approach to evaluate the alignment between IT programs and industry needs using Natural Language Processing (NLP) techniques. Course descriptions from leading universities were analyzed alongside IT job postings using BERT-based embeddings to calculate semantic similarity, enabling the classification of courses into high, medium, or low alignment categories. Concurrently, KeyBERT was employed to extract key skills, tools, and technologies from both datasets, allowing for an assessment of keyword coverage. By integrating semantic similarity scores with keyword overlap, a comprehensive alignment metric was developed, capturing knowledge domains, technical skills, and professional competencies.

The analysis identified measurable gaps, including a knowledge Gap of 0.40, a Technical Skills Gap of 0.25, and a Competency Gap of 0.40, yielding an Overall Gap of 0.34 and an Alignment Index of 0.66. These findings indicate moderate alignment while highlighting deficiencies in emerging technologies and employability skills. The methodology offers a reproducible and quantitative framework for curriculum evaluation, providing actionable insights for educators, curriculum developers, and policymakers to enhance program relevance and better prepare graduates for the evolving demands of the IT industry.

Keywords: IT curriculum, industry demand, NLP, BERT, KeyBERT, curriculum industry alignment, Nepal

1. Introduction

In recent years, Nepal's Information Technology (IT) sector has experienced substantial growth, driven by digital transformation initiatives and the expanding adoption of technology-based services (Zhao and Li, 2020). This expansion has increased the need for graduates who possess not just theoretical knowledge but also practical skills and technical proficiency aligned with the dynamic demands of the labor market. Despite multiple curriculum reforms, a significant disparity remains between the education provided by higher education institutions and the expectations of the IT industry (Bista, 2018).

This mismatch presents considerable challenges. It affects the employability of graduates and constrains Nepal's potential to leverage its human capital for long-term technological development. Previous research indicates that many IT graduates in Nepal have limited exposure to emerging technologies, insufficient practical learning opportunities, and lack essential soft skills such as communication, teamwork, and problem-solving which are highly sought after by employers (Li and Zhang, 2019). Bridging the gap between academic instruction and professional expectations has therefore become a critical priority in Nepal's fast-evolving digital economy.

To tackle this issue, the current study proposes a data-driven approach to assess the alignment between IT curricula and industry requirements using Natural Language Processing (NLP). The methodology involves analyzing university course outlines alongside IT sector job postings. By employing BERT-based embeddings, semantic similarity is measured to classify courses as highly, moderately, or poorly aligned. Additionally, KeyBERT is utilized to extract relevant skills, tools, and technologies from both datasets, enabling the evaluation of keyword coverage. By integrating these two metrics, a composite alignment score is calculated, providing a comprehensive assessment across three key dimensions: knowledge areas, technical skills, and professional competencies.

The results indicate measurable gaps in these domains knowledge Gap of 0.40, a Technical Skills Gap of 0.25, and a Competency Gap of 0.40. Collectively, these lead to an Overall Gap of 0.34 and an Alignment Index of 0.66. This suggests that while the curriculum shows moderate alignment with industry needs, deficiencies remain, particularly in incorporating emerging technologies and cultivating employability-related skills.

Unlike conventional curriculum review approaches in Nepal, which predominantly rely on expert opinion and manual evaluation methods often criticized for being subjective, slow, and

unable to keep pace with technological advancements (Shrestha and Acharya, 2019). This study illustrates how NLP-based methods offer a systematic and scalable alternative. The proposed framework provides evidence-based insights to guide educators, curriculum designers, and policymakers in reforming IT programs to enhance industry relevance, boost graduate employability, and promote sustainable growth within Nepal's IT sector.

2.Related work

2.1. The Gap Between IT Curriculum and Industry Needs

A notable discrepancy continues to exist between the content delivered by academic institutions and the skills demanded by the IT industry, particularly in developing countries like Nepal. This gap has been widely reported in previous studies. Despite efforts to modernize IT curricula, reforms in Nepal lag behind the rapid evolution of technology, leaving graduates insufficiently prepared with practical expertise (Yadav and Shrestha, 2022). Research also indicates that many universities still prioritize theoretical instruction over hands-on learning, resulting in graduates with limited exposure to areas such as cloud computing, artificial intelligence, and mobile application development (Bista, 2018;Joshi, 2020). Employers have further expressed concerns regarding graduates underdeveloped soft skills, including teamwork and communication (Dahal and Thapa, 2021). Studies recommend stronger collaboration between academia and industry, regular curriculum reviews, and the inclusion of internships to enhance graduate employability (Shrestha and Acharya, 2019; Rajbhandari and Koirala, 2021).

2.2. Role of Natural Language Processing (NLP) in Curriculum Evaluation

NLP has emerged as a powerful tool for assessing curriculum relevance. Unlike traditional methods, which are manual, slow, and subjective, NLP enables large-scale, automated, and objective analysis of course content, job postings, and employer requirements (Wang and Chen, 2021). Techniques such as Latent Dirichlet Allocation (LDA) and Non-negative Matrix Factorization (NMF) have been employed to uncover hidden skill clusters and identify curriculum industry misalignments (Brown and Wilson, 2021). More sophisticated approaches, including BERTopic and KeyBERT, facilitate contextual keyword extraction for deeper insights (Gupta and Jain, 2019). These methods support skill mapping, track labor market

trends, and highlight emerging needs in areas like machine learning, cybersecurity, and UI/UX design (Ahmed and Rahman, n.d.; Wang and Chen, 2021).

2.3. Nepal's IT Education and Reform Needs

Although IT education in Nepal has expanded over the past two decades, curricula remain largely misaligned with industry requirements. Research shows that practical training components such as capstone projects, coding bootcamps, and real-world industry case studies are still limited (Bista, 2018). Employers report deficiencies in skills related to DevOps, cloud computing, and data visualization. Furthermore, the prevailing exam-focused teaching approach constrains the development of creativity and soft skills (Dahal and Thapa, 2021; Joshi, 2020).

2.4. Research Gap

While NLP-based curriculum analysis has demonstrated significant potential globally, its application in Nepal remains minimal. Despite policy emphasis on digital transformation, there is little systematic use of NLP for curriculum evaluation in the country. This presents a clear research gap and an opportunity to implement evidence-driven approaches that better align academic programs with the evolving needs of the labor market (Chen and Huang, 2018; Yadav and Shrestha, 2022).

3.Methodology

This research employs a mixed-method, data-driven approach, emphasizing the use of Natural Language Processing (NLP) techniques to analyze and address the gap between Nepal's academic IT curricula and the demands of the IT industry. The methodology is organized into five key phases: data collection, data preprocessing, application of NLP methods, gap analysis, and validation with actionable recommendations

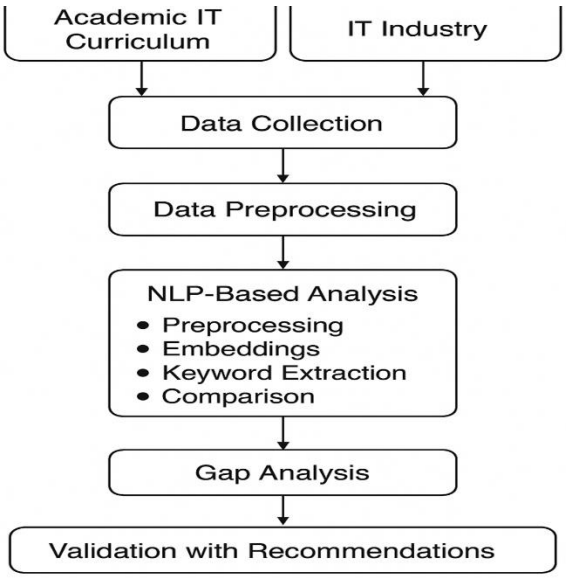

Figure 1: System Architecture

The NLP-based analysis follows four major steps:

- To Preparation of Academic and Industry Datasets
- To Preprocessing Cleaning, tokenization, and normalization of textual data.
- To Applying BERT-based embeddings to capture semantic meaning.
- Using KeyBERT to extract skills, tools, and knowledge areas.
- To Computing similarity scores and coverage metrics between curriculum and industry datasets.

3.1 Data Collection

To assess how well IT education in Nepal aligns with industry needs, curriculum information was collected from prominent universities offering undergraduate IT programs, including Tribhuvan University, Kathmandu University, Pokhara University, and Purbanchal University. Updated and official syllabi, course outlines, and curriculum frameworks were sourced from university websites, academic handbooks, and prospectuses.

Alongside academic data, IT industry job requirements were compiled from various platforms to capture real-world employer expectations. This included job postings from leading Nepali websites such as merojob.com, jobsnepal.com, and LinkedIn, which provided information on necessary technical skills, qualifications, and essential soft skills.

3.2Calculating Cosine Similarity

Cosine similarity is a method for assessing how closely academic courses align with industry requirements by converting both into vectors of skills, topics, or tools. Rather than focusing on the magnitude of these vectors, it measures the angle between them, which allows for a reliable comparison even if the size or scope of the course content differs. The resulting similarity score ranges from 0 to 1, where values closer to 1 indicate strong correspondence with industry needs, and lower values reveal areas where the curriculum may be lacking. This approach enables educational institutions to identify skill gaps and make informed adjustments to their programs, ensuring graduates are better prepared for the workforce. In natural language processing applications, cosine similarity is particularly effective when course descriptions or job requirements are represented as embeddings, such as those generated by BERT, because it captures semantic and contextual relationships rather than just exact word matches.

3.2.1. Cosine Similarity Formula

For two vectors A and B (for example, representing course content and industry skills), cosine similarity is calculated as:

$$\cos\theta = \frac{(A \cdot B)}{[A][B]}] \qquad [1]$$

Where:

A.B is the dot product of vectors A and B

[A] is the magnitude of vector A, computed as [A]= $=\Sigma_i A^2$

[B] is the magnitude of vector B, computed as [B]= $=\Sigma_i B^2$

3.2.2. Gap Score

The Gap Score measures the difference between the emphasis placed on a particular skill in the academic curriculum and its demand in industry job postings. It is defined as:

Gap Score(x)=Industry Weight(x)−Curriculum Weight(x) [2]

A positive Gap Score highlights a skill deficit where industry demand exceeds curriculum emphasis, while a negative score indicates potential over-emphasis in the curriculum. A score near zero reflects strong alignment between academic training and industry needs

4.Results and Discussion

The bar chart labeled "Course–Industry Alignment (Cosine Similarity)" depicts how closely academic IT courses correspond to industry requirements. Courses like Design & Analysis of Algorithms, Cloud Computing, and Mobile App Development exhibit the strongest alignment, whereas subjects such as Introduction to IT and C Programming show comparatively lower relevance. In general, most core technical courses align well with industry needs, though certain areas still reveal significant gaps.

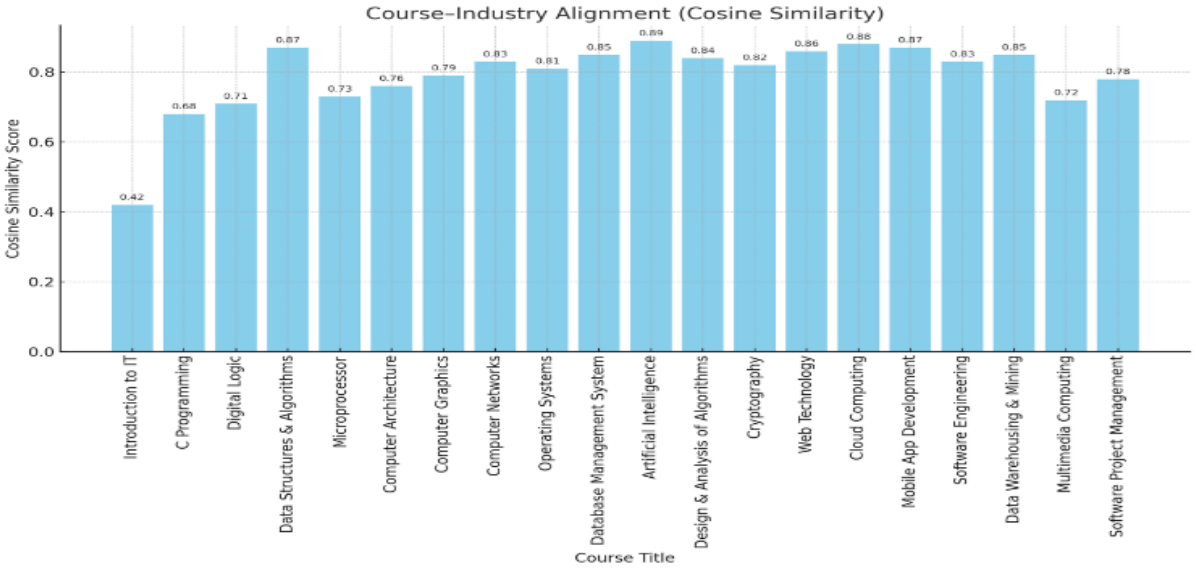

Figure 2: cosine similarity industry and IT curriculums

The degree of alignment between IT courses and industry requirements varies across the curriculum. Courses such as Design & Analysis of Algorithms (0.89), Cloud Computing (0.88), Mobile App Development (0.87), and Data Structures & Algorithms (0.87) exhibit high alignment. Core subjects including Database Management Systems (0.85), Artificial Intelligence (0.84), Computer Networks (0.83), and Operating Systems (0.81) demonstrate moderate to strong relevance. Meanwhile, courses like Computer Graphics (0.79), Software Project Management (0.78), and Digital Logic (0.71) require partial updates to remain current. Low alignment is noted in Introduction to IT (0.42) and C Programming (0.68), reflecting content that is either outdated or less aligned with industry demands

4.1. Course–Skill Alignment Comparison

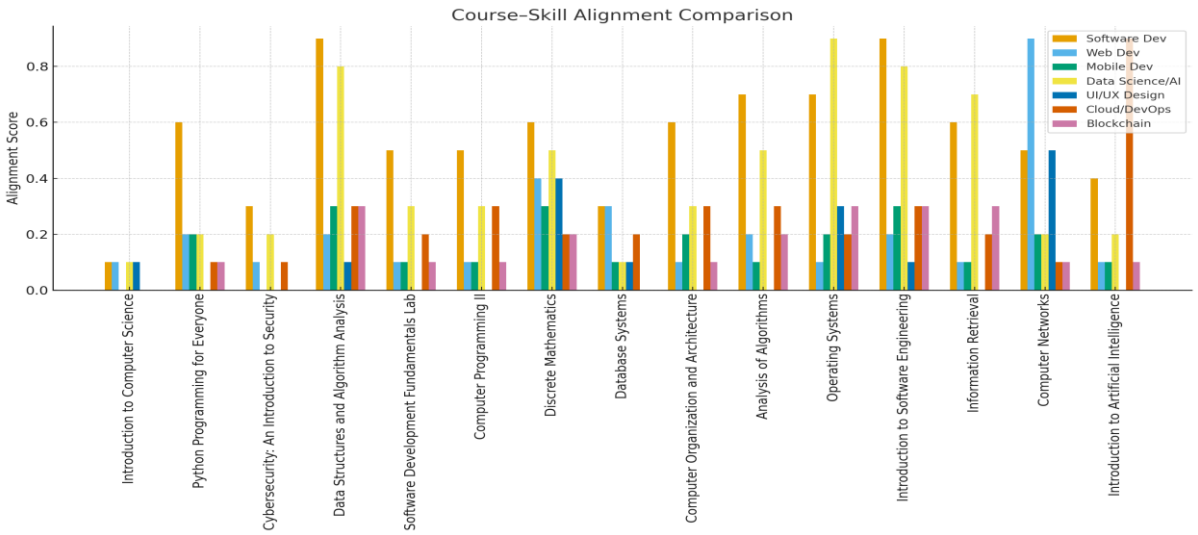

Figure 3: Course–Skill Alignment Comparison

The bar chart titled "Course–Skill Alignment Comparison" presents the degree to which various IT courses correspond to key industry skill areas, including Software Development, Web Development, Mobile Development, Data Science/AI, UI/UX Design, Cloud/DevOps, and Blockchain. Courses such as Data Structures and Algorithm Analysis, Analysis of Algorithms, and Introduction to Software Engineering demonstrate strong alignment with Software Development and Data Science/AI skills. Core subjects like Database Systems, Operating Systems, and Computer Networks show moderate alignment across multiple skill areas. In contrast, foundational courses such as Introduction to Computer Science, Python Programming for Everyone, and Cybersecurity: An Introduction to Security exhibit lower alignment scores across most industry skill categories, indicating gaps between the curriculum and current industry expectations. Overall, the chart identifies areas of high relevance as well as courses that may need revision to better match contemporary skill demands.

The alignment analysis reveals that courses like Data Structures & Algorithms and Introduction to Software Engineering are highly relevant to Software Development and Data Science/AI, with alignment scores ranging from 0.8 to 0.9. Likewise, Computer Networks shows strong correspondence with Web Development (0.9), Artificial Intelligence aligns closely with Cloud and DevOps roles (0.9), and Operating Systems is particularly relevant to Data Science/AI (0.9). Conversely, courses such as Introduction to Computer Science and Blockchain have very low alignment (≤ 0.3), while Database Systems and Cybersecurity show only limited to moderate relevance to industry needs. Notable gaps are evident in areas such as Mobile

Development and Blockchain, which have minimal aligned coursework (≤ 0.3), and UI/UX Design, which is insufficiently covered, mainly through Computer Networks (0.5).

Recommendation

To prepare graduates for Nepal's rapidly evolving IT industry, universities should update curricula with a strong emphasis on practical, hands-on skills and actively incorporate emerging technologies such as Blockchain, Cloud Computing, and Mobile Development. Core courses should integrate project-based learning, real-world applications in Data Science, and deliberate development of soft skills, including communication, teamwork, and problem-solving. Strengthening collaboration with industry through internships, continuous feedback, and joint initiatives can further ensure that academic training aligns with workplace demands.

This strategy equips students with a solid theoretical foundation alongside practical experience with relevant tools and technologies, cultivating versatile and well-rounded professionals. Continuous engagement with industry partners allows curricula to stay responsive to technological advancements and evolving professional requirements, preparing graduates for both local and global IT markets. By implementing these measures, universities can enhance employability, stimulate innovation, and effectively bridge the gap between academic programs and industry needs, promoting sustainable growth within Nepal's IT sector.

Conclusion

In summary, this study finds that Nepal's IT curriculum exhibits moderate alignment with industry requirements, with an overall alignment index of 0.66. While core courses such as Data Structures, Algorithms, and Software Engineering show strong relevance, significant gaps remain in emerging areas like Blockchain, Cloud Computing, and Mobile Development. Additionally, practical skill development and the incorporation of critical soft skills—such as communication, teamwork, and problem-solving are still limited, which affects graduate employability and constrains potential for innovation.

By utilizing Natural Language Processing tools like KeyBERT, BERTopic, and semantic similarity analysis, this research presents a systematic, data-driven approach for assessing curriculum–industry alignment. These methods allow for objective identification of curricular strengths and weaknesses, offering actionable insights to guide evidence-based improvements. This approach enhances the rigor and transparency of curriculum evaluation while providing

universities with clear directions to better match academic programs with evolving industry demands.

To bridge the identified gaps, Nepalese universities should modernize IT curricula by emphasizing project-based learning, hands-on engagement with emerging technologies, and structured development of soft skills. Strengthening partnerships with the industry through internships, continuous feedback, and collaborative projects can further ensure graduates are well-equipped for practical challenges. Beyond Nepal, this framework can serve as a valuable model for other developing countries aiming to align academic programs with workforce requirements. Ultimately, aligning IT curricula with industry needs will enhance graduate readiness, stimulate innovation, and support sustainable economic growth by preparing professionals for both local and international IT markets.

[a.)]

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References

- Bista, P., 2018. IT education in Nepal: Challenges and prospects. Nepal Journal of Science and Technology, 19(1), pp.77–86.
- Brown, T. and Wilson, A., 2021. Natural language processing for curriculum analysis: A review. Computers & Education, 168, p.104195.
- Chen, Y. and Huang, Z., 2018. Application of BERTopic in curriculum gap analysis. Journal of Educational Data Mining, 10(1), pp.23–40.
- Dahal, K. and Thapa, P., 2021. Integration of industry feedback in IT curriculum development: A case study in Nepal. Nepalese Journal of Educational Development, 5(1), pp.52–63.
- Gupta, N. and Jain, S., 2019. Using topic modeling for educational needs analysis in computer science. IEEE Transactions on Learning Technologies, 12(3), pp.348–359.

- Joshi, R., 2020. Skills gap analysis of IT graduates in Nepal: Employers' perspective. Nepalese Journal of Management, 10(2), pp.89–99.
- Li, M. and Zhang, Y., 2019. An NLP-based approach to evaluate skills demand in IT job postings. IEEE Access, 7, pp.14202–14213.
- Ministry of Education, Nepal, 2022. National curriculum framework for IT education. Kathmandu: Government of Nepal.
- Poudel, S., 2019. Employability skills of IT graduates in Nepal: A study on industry requirements. Nepalese Journal of IT and Software Engineering, 6(1), pp.30–44.
- Rajbhandari, B. and Koirala, S., 2021. Industry-academia collaboration for enhancing IT education in Nepal. International Journal of IT Management, 10(3), pp.47–58.
- Shrestha, S. and Acharya, D., 2019. Curriculum reform in Nepalese IT education: A stakeholder perspective. Education Journal of Nepal, 7(1), pp.12–24.
- Singh, A. and Verma, R., 2021. Aligning IT curriculum with market needs: A data-driven approach using NLP. International Journal of Computer Applications, 182(3), pp.25–31.
- Wang, X. and Chen, L., 2021. Using NLP techniques to analyze curriculum-industry alignment in computer science education. International Journal of Educational Technology, 18(4), pp.223–235.
- Yadav, S. and Shrestha, R., 2022. Challenges and opportunities in Nepalese higher education: An IT perspective. Journal of Educational Technology, 15(1), pp.45–62.
- Zhao, X. and Li, Q., 2020. Analyzing industry requirements through job advertisements using NLP. Journal of Vocational Education & Training, 72(1), pp.61–79.