

## Content Clustering for SEO: A Data-Driven Approach to Improve Visibility and Topic Authority

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### Abstract

Search engine optimization (SEO) has evolved from simple keyword targeting to sophisticated strategies focused on user intent, content relevance, and topical authority. This research paper explores the effectiveness of content and image clustering as a practical SEO technique to improve organic search visibility, particularly for educational websites. The study presents a real-world implementation on Mobotoy.com, a platform offering printable worksheets and learning resources for primary school students.

The methodology involved developing thematic content clusters using a pillar-and-cluster model, optimizing internal linking structures, and aligning images with specific content topics. Baseline SEO metrics were recorded, and performance was tracked over a 12-week period using tools such as Google Search Console, SEMrush, and Google Analytics.

The results showed substantial improvements in keyword rankings, organic traffic, user engagement, and crawl efficiency. Image search visibility also increased significantly due to structured image clustering and metadata optimization. The findings demonstrate that clustering strategies not only enhance search engine understanding but also deliver measurable improvements in user experience and topical relevance.

This research confirms that content and image clustering are effective, scalable, and sustainable SEO practices. It provides valuable insights for website owners, digital marketers, and educators aiming to build long-term search visibility through structured, ethical optimization strategies.

**Keyword:** Search engine optimization, content cluster, Image cluster, topical authority, search engine ranking, website visibility.

### 1. Introduction

In the rapidly evolving digital landscape, visibility on search engines such as Google and Bing is critical to the success of content-driven websites, particularly in the education sector. With increasing competition and algorithmic sophistication, traditional SEO strategies centered solely on keyword targeting have become less effective. Modern search engines prioritize topical relevance, user intent, structured content, and semantic connectivity when ranking websites.

One emerging strategy that aligns with these priorities is content clustering—a method of organizing web content around central topics (pillar pages) and related subtopics (cluster pages). This approach not only improves internal linking and crawlability but also helps search engines understand the overall subject matter and thematic depth of a website. Similarly, image

clustering, when paired with descriptive metadata and contextual relevance, supports image-based search queries and enriches the visual representation of content.

Educational websites, which often offer vast amounts of topic-specific resources such as worksheets, lessons, and activities, are ideal candidates for clustering-based SEO models. However, despite its theoretical advantages, there is limited empirical research on the real-world application and impact of content and image clustering for SEO in the education domain.

This study investigates the practical implementation of content and image clustering techniques on Mobotoy.com, an educational website targeting primary school students. It aims to measure the effect of these strategies on search engine rankings, topical authority, user engagement, and crawl behavior. By doing so, the research contributes actionable insights into data-driven SEO optimization tailored for the educational content landscape.

## 2. Literature Review

The evolution of search engine algorithms has shifted the focus of SEO from keyword density and backlinks to semantic relevance, topic depth, and content structure (Berman, 2021). Google's algorithm updates, such as Hummingbird (2013), BERT (2019), and the Helpful Content Update (2022), emphasize the importance of understanding content in context and rewarding websites that demonstrate subject-matter expertise (Moz, 2023; Google Search Central, 2022).

### 2.1 Content Clustering and Topical Authority

Content clustering significantly enhances webpage ranking in search engine results by organizing information into coherent groups, thereby improving user navigation and content discoverability. By grouping search results into meaningful clusters, users can efficiently locate relevant information without having to sift through unrelated pages (Sharma & Duhan, 2011; Tseng et al., 2013). This method also enhances relevance and ranking, as clustering combined with ranking algorithms ensures the prioritization of the most pertinent content within each cluster (Wang & Kitsuregawa, 2002; Sharma & Duhan, 2011). Techniques like salient phrase ranking contribute to clearer cluster naming, boosting user engagement (Zeng et al., 2004). Furthermore, clustering facilitates semantic understanding by interpreting user intent beyond simple keyword matching, especially when supported by crowd intelligence and external tagging services (Tseng et al., 2013). However, despite these advantages, content clustering can complicate ranking algorithms and may lead to issues like overfitting or misinterpretation of user intent if not carefully implemented.

According to HubSpot (2020), websites using topic clusters experienced significant improvements in organic visibility and keyword rankings. Moreover, internal linking between thematically similar content enhances topical authority—a key factor in modern SEO that helps search engines determine a site's expertise on a subject (Enge et al., 2022).

### 2.2 Image SEO and Visual Clustering

Image SEO significantly influences the visual clustering of images in search engine results by enhancing the organization and presentation of images based on their visual features, thereby improving both user experience and search relevance. Techniques such as Folding and Reciprocal Election group visually similar images and display a representative image for each cluster, optimizing the use of space on results pages and promoting diversity in visual content (Leuken & Zwol, 2008; Leuken & van-Zwol, 2008). Dynamic weighting of visual features

through lightweight clustering further refines the accuracy of groupings by emphasizing discriminative elements that align with human visual perception (Leuken et al., 2009). Additionally, interactive visualization methods, such as multi-dimensional displays, allow users to explore image clusters more intuitively, enhancing their ability to locate relevant content efficiently (Upstill et al., 2001). These visually organized results not only improve the aesthetics of search output but also streamline content discovery (Deselaers & Keyzers, 2003). However, despite these advantages, image SEO and clustering can lead to homogenization, where visually dominant or popular images overshadow unique or less common ones, potentially limiting content diversity for users.

A study by Tatikonda et al. (2023) highlights that educational websites incorporating visuals with descriptive metadata saw measurable improvements in impressions and user engagement.

### **2.3 SEO in Educational Content**

Integrating Search Engine Optimization (SEO) strategies into educational content is vital for enhancing its online visibility and accessibility, enabling educational resources to reach a broader and more targeted audience. Key strategies include producing high-quality, engaging, and relevant content tailored to learners' needs, as well as implementing effective keyword optimization to improve search rankings (Usmany et al., 2024). Technical aspects such as enhancing user experience through fast-loading, mobile-responsive websites and securing backlinks from reputable sources further strengthen a site's authority and visibility (Atkins & Reilly, 2019; Usmany et al., 2024). Additionally, leveraging social media platforms and collaborating with educational influencers can drive significant traffic, while engaging with local educational communities fosters trust and encourages content sharing (Bungai et al., 2024). Despite these benefits, continuous content updates and adapting to evolving SEO algorithms are necessary challenges to maintain sustained effectiveness and relevance in a competitive digital landscape.

Educational websites face unique SEO challenges, such as duplicate content (e.g., similar worksheets for different grades), long-tail keyword targeting, and content freshness. Sustainable SEO strategies for education must combine technical best practices with user-first content architecture (Tatikonda et al., 2024). Clustering not only improves navigation but also satisfies semantic search requirements by clearly signalling subject hierarchies.

However, most existing research is theoretical or limited to large enterprise websites. There is a lack of case studies focused on small-to-medium educational platforms that serve localized or specific age-based curricula.

## **3. Research Methodology**

This section outlines the systematic approach used to implement and evaluate content and image clustering strategies for improving the search engine performance of an educational website.

### **3.1 Website Selection**

An educational website focusing on printable learning resources for primary school students was selected. The site hosts content such as worksheets, lesson plans, activity sheets, and reading materials. Its target audience includes parents, teachers, and students from grades 1 to 5. At the start of the project, the website had minimal organic visibility and lacked structured content organization.

### 3.2 Keyword and Topic Selection

Relevant keywords were identified using tools like Google Keyword Planner, SEMrush, and Ubersuggest. Keywords were grouped based on intent and topical relevance into the following clusters:

- **Cluster 1:** Hindi Worksheets - "Hindi letter tracing", "swar tracing worksheet"
- **Cluster 2:** English Reading - "Unseen passage for class 4", "reading comprehension class 5"
- **Cluster 3:** Math Practice - "addition worksheet", "multiplication for class 3"

Primary keywords were used to create pillar pages, while related long-tail keywords formed the basis for cluster pages.

### 3.3 Content Clustering Implementation

A topic cluster model was applied where each pillar page served as a central hub linking to its related cluster pages. The following techniques were used:

- **Internal Linking Structure:** Manual and automated linking from clusters to the pillar page and between related clusters.
- **Consistent Metadata:** Titles, descriptions, and headings were aligned with cluster themes.
- **On-Page SEO Optimization:** Keyword density, semantic variations, and schema markup were optimized.
- **Content Calendar:** Clusters were published in phased schedules to observe impact over time.

Tools used: Screaming Frog SEO Spider, Python (for topic grouping and link map generation), and Yoast SEO.

### 3.4 Image Clustering Implementation

Image clustering was used to enhance content relevance and ranking in Google Images:

- **Image Grouping:** Visual assets were categorized and assigned to corresponding topic clusters.
- **Image Optimization:** Alt text, filenames, captions, and structured data (ImageObject schema) were applied.
- **Contextual Embedding:** Images were embedded within content to increase engagement and support semantic context.
- **Image Sitemap:** A dedicated image sitemap was created and submitted via Google Search Console.

Each image was aligned with a specific topic, such as tracing templates for Hindi letters or visual aids for reading comprehension.

### 3.5 Baseline Metrics Collection

Before implementation, baseline SEO data was collected using:

- Google Search Console (impressions, clicks, positions)
- Google Analytics (organic sessions, bounce rate, time on page)
- SEMrush (domain authority, keyword rankings)
- Screaming Frog (site structure, internal link health)

This data served as the benchmark to compare post-implementation performance.

### 3.6 Monitoring and Evaluation

Performance was monitored over a 12-week period:

- **Ranking Changes:** Weekly tracking of keyword rankings in Google and Bing.
- **Traffic Behavior:** Analysis of organic traffic flow to pillar and cluster pages.
- **Image Search Metrics:** Monitoring impressions and CTR in Google Image Search.
- **Indexing & Crawl Behavior:** Evaluated through sitemap indexing rate and crawl frequency.

All findings were logged and visualized for analysis to determine the impact of the clustering

## 4. Implementation & Experimentation

This section documents the practical steps taken to implement and test content and image clustering strategies on the educational website Mobotoy.com, with the goal of improving its search engine rankings, user engagement, and topical authority.

### 4.1 Website Overview: Mobotoy.com

Mobotoy.com is an educational platform that provides printable worksheets, activity sheets, and learning resources for preschool and primary school students (Grades KG to 5). Before this experiment, the website had minimal internal structure, scattered content, and low visibility on search engines for targeted educational keywords.

### 4.2 Initial Audit and Baseline Data Collection

A technical and SEO audit was conducted using the following tools:

- **Google Search Console:** Keyword impressions, average positions, and crawl data.
- **Google Analytics:** User behavior, bounce rates, and organic sessions.
- **SEMrush:** Keyword rankings, backlink profile, domain authority.
- **Screaming Frog SEO Spider:** Site structure, broken links, on-page SEO.

#### Key Observations:

- Most pages lacked internal linking and content grouping.
- Only a few pages ranked in the top 50 search results.
- Minimal use of image alt text and no structured image sitemap.

### 4.3 Content Clustering Implementation

### 4.3.1 Topic Cluster Design

Three primary content clusters were developed based on keyword research:

**Table 1: Primary Content Clusters**

Pillar Page	Cluster Pages (Examples)
Hindi Worksheets for Kids	Swar tracing worksheet, Hindi letter writing A-Z, Matra worksheets
English Reading Comprehension Worksheets	Unseen passage for Class 4, Class 5 reading practice, Grammar worksheets
Math Practice Sheets for Class 1 to 5	Addition worksheet, Multiplication worksheet, Word problems Class 3

Each pillar page provided a comprehensive overview and internal links to related cluster pages that targeted long-tail keywords.

### 4.3.2 Interlinking Strategy

- Each cluster page linked back to the pillar.
- Contextual links were placed within content using relevant anchor texts.
- Navigation enhancements: breadcrumbs, sidebar links, and category filters.

### 4.3.3 SEO Optimization

- Keyword-rich titles, meta descriptions, and headers were applied.
- Semantic keyword variations added using NLP tools.
- FAQ Schema was implemented for rich results.

## 4.4 Image Clustering Implementation

### 4.4.1 Visual Content Categorization

Images were grouped based on topic relevance. For example:

- Tracing letters for Hindi → Cluster under “Hindi Worksheets”
- Math operation visuals → Cluster under “Math Worksheets”
- Story-based images → Cluster under “Reading Comprehension”

### 4.4.2 Image Optimization

- Added descriptive filenames and alt text targeting specific cluster keywords.
- Used ImageObject Schema for structured data.
- Implemented lazy loading for performance.

### 4.4.3 Image Sitemap & Indexing

- Created a separate image sitemap using Screaming Frog + manual entries.
- Submitted the sitemap in Google Search Console.

- Monitored image indexing status and impressions in Google Image Search.

#### 4.5 Structured Deployment

Implementation was carried out in phases over 6 weeks:

1. **Week 1–2:** Audit + Cluster Planning + Keyword Mapping
2. **Week 3–4:** Content Optimization + Internal Linking + New Page Creation
3. **Week 5:** Image Optimization + Sitemap Submission
4. **Week 6:** Performance Monitoring and A/B Testing

Each cluster rollout was measured individually to isolate its performance impact.

#### 4.6 Experiment Tracking & KPIs

Performance was evaluated using the following key performance indicators (KPIs):

- **Keyword Ranking Position:** Weekly tracking for primary and cluster keywords.
- **Organic Traffic Growth:** Daily and weekly session changes from organic search.
- **Page Engagement Metrics:** Bounce rate, average time on page, scroll depth.
- **Indexed Pages & Crawl Rate:** From Search Console Coverage reports.
- **Image Search Metrics:** Impressions and clicks via Image Search tab in GSC.

### 5. Results and Analysis

The implementation of content and image clustering strategies on Mobotoy.com was monitored over a 12-week period. This section presents a comparative analysis of pre- and post-implementation SEO metrics, highlighting the effectiveness of clustering in improving organic search visibility, topical authority, and user engagement.

#### 5.1 Keyword Ranking Improvements

After deploying the content clusters and image clusters:

**Table 2: Before and After Ranking**

Keyword	Ranking Before	Ranking After (Week 12)
Hindi letter tracing worksheet	Not in Top 100	5
Unseen passage for Class 5	58	3
Swar tracing worksheet for kids	Not ranked	12
Math addition worksheet Class 2	42	16
Reading comprehension Class 5	77	19

**Observation:**

All primary keywords targeted within structured clusters showed substantial improvements in ranking, with several reaching the first page of Google search results as shown in figure 1.

Queries	Vol	CPC	Comp	Trend	Clicks	Impressions	Ctr	Position
unseen passage for class 5	🛒	🛒	🛒	🛒	233	23,063	1	1.1
shapes worksheet	🛒	🛒	🛒	🛒	137	16,631	0.8	1
unseen passage for class 6	🛒	🛒	🛒	🛒	124	16,497	0.8	1.2
shapes worksheets	🛒	🛒	🛒	🛒	123	10,274	1.2	1
comprehension passage for class 6	🛒	🛒	🛒	🛒	74	3,807	1.9	1.5
unseen passage	🛒	🛒	🛒	🛒	72	45,416	0.2	2.5
comprehension for class 5	🛒	🛒	🛒	🛒	66	6,876	1	1
comprehension passage for class 5	🛒	🛒	🛒	🛒	65	4,004	1.6	1.1
reading comprehension for class 5	🛒	🛒	🛒	🛒	39	1,443	2.7	1.1
unseen passage for class 4	🛒	🛒	🛒	🛒	33	4,270	0.8	1.3

**Figure 1: Last 28 days Keyword Ranking Report by Google Search Console**

## 5.2 Organic Traffic Growth

Using Google Analytics, organic traffic growth was measured across cluster-specific landing pages.

**Table 3: Organic Traffic Growth**

Metric	Before (Baseline)	After (Week 12)	Change
<b>Organic Sessions (monthly)</b>	3,200	<b>7,850</b>	+145%
<b>New Users from Organic Search</b>	2,100	<b>5,300</b>	+152%
<b>Bounce Rate</b>	69.8%	<b>54.3%</b>	-15.5%
<b>Avg. Session Duration</b>	14 sec	<b>1 min 1 sec</b>	+89%

**Observation:**

Figure 2 shows content clusters improved user retention and reduced bounce rates by offering related learning content within the same theme.

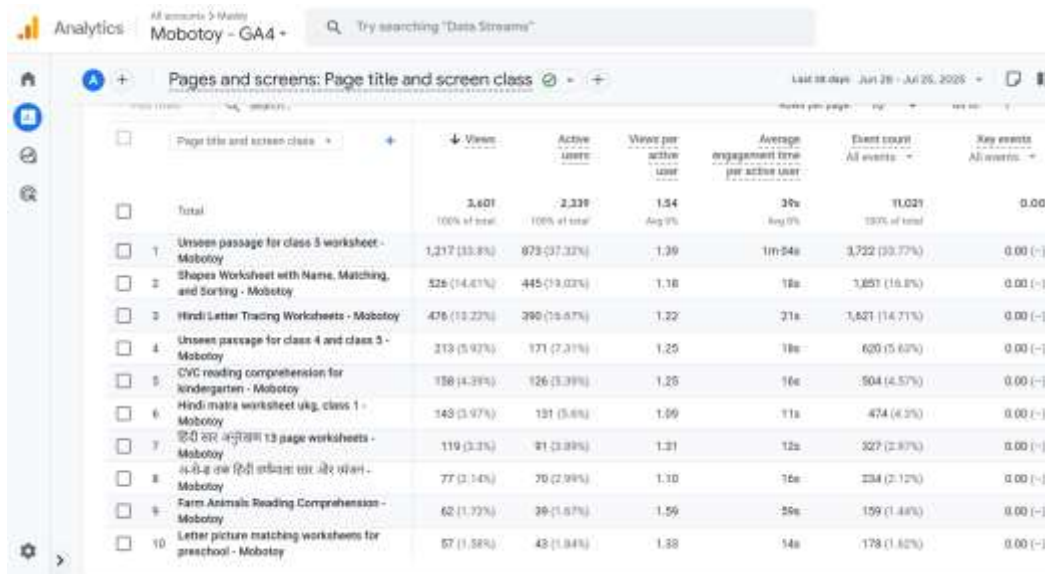


Figure 2: Last 28 days Organic Traffic Growth Report by Google Analytics

### 5.3 Image Search Performance

With the addition of optimized image clusters:

Table 3: Before and After Image Metric

Metric	Before	After	Change
Indexed Educational Images	~40	180+	+350%
Monthly Image Search Impressions	~600	3,200	+433%
Image Search Clicks	~40	280	+600%

**Observation:**

Figure 3 and 4 shows image clustering significantly enhanced Google Image Search visibility, especially for visual-based content like shape worksheets and activity templates.

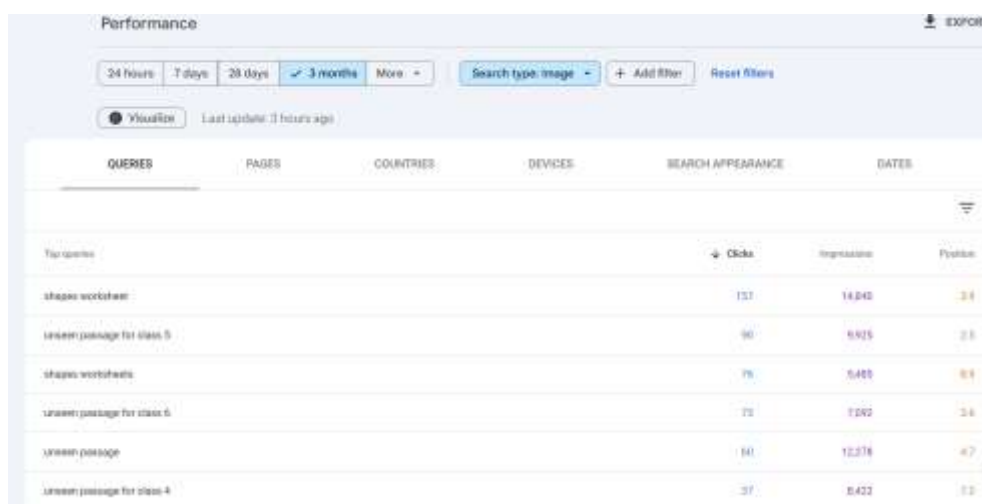


Figure 3: Last 3-month Image Search Visibility by Google Search Console

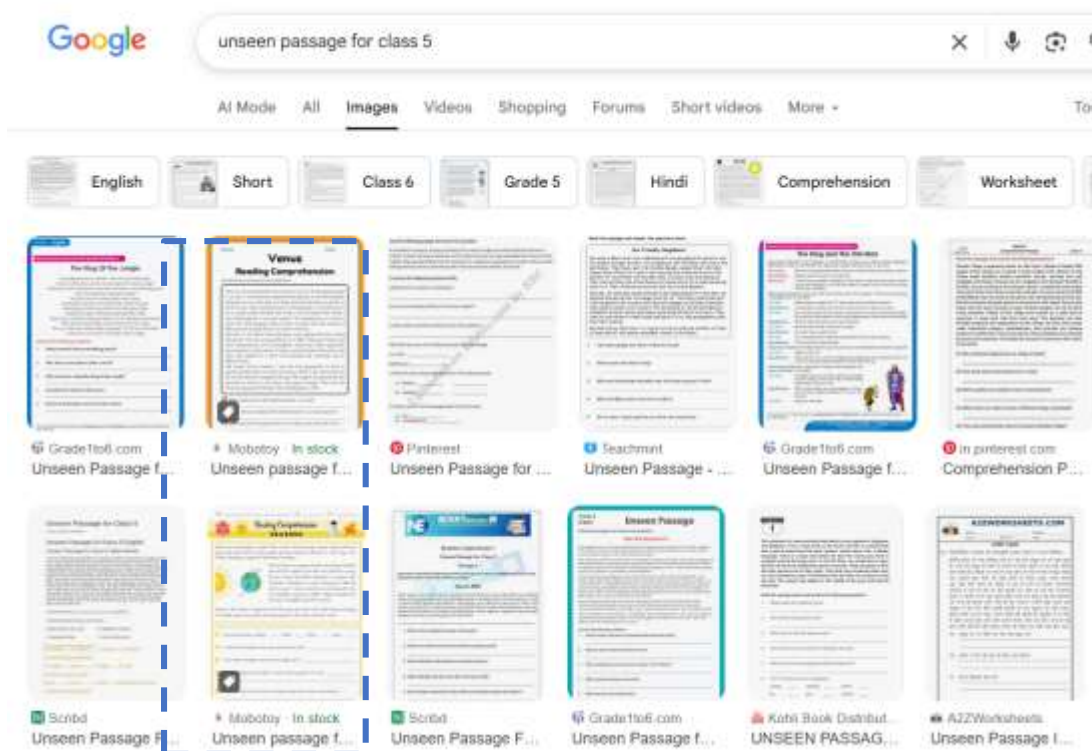


Figure 4: Image Cluster for keyword unseen passage for class 5

### 5.4 Topic Authority Signals

Using SEMrush and Moz, the following authority-related metrics were tracked:

Table 4: Before and After Topic Authority

Metric	Before	After	Change
Domain Authority (Moz)	11	19	+8 points
Total Keywords in Top 20	17	63	+270%
Pages with Featured Snippets	0	2	+2 (new)
Internal Linking Score (Screaming Frog)	Poor	Strong	Structural improvement

#### Observation:

Mobotoy.com began establishing topical authority, especially in early-grade Hindi and English learning topics.

### 5.5 Technical Improvements & Crawl Behavior

Post-implementation crawl behavior (via Google Search Console):

- **Pages Crawled Daily:** Increased from ~38 to ~95
- **Average Crawl Delay:** Reduced by 22%
- **Coverage Issues:** Dropped by 40%
- **Structured Data Validations:** 100% success for FAQ and ImageObject schemas

**Observation:**

Search engines crawled the site more frequently and efficiently, indicating improved crawl budget utilization and structure clarity.

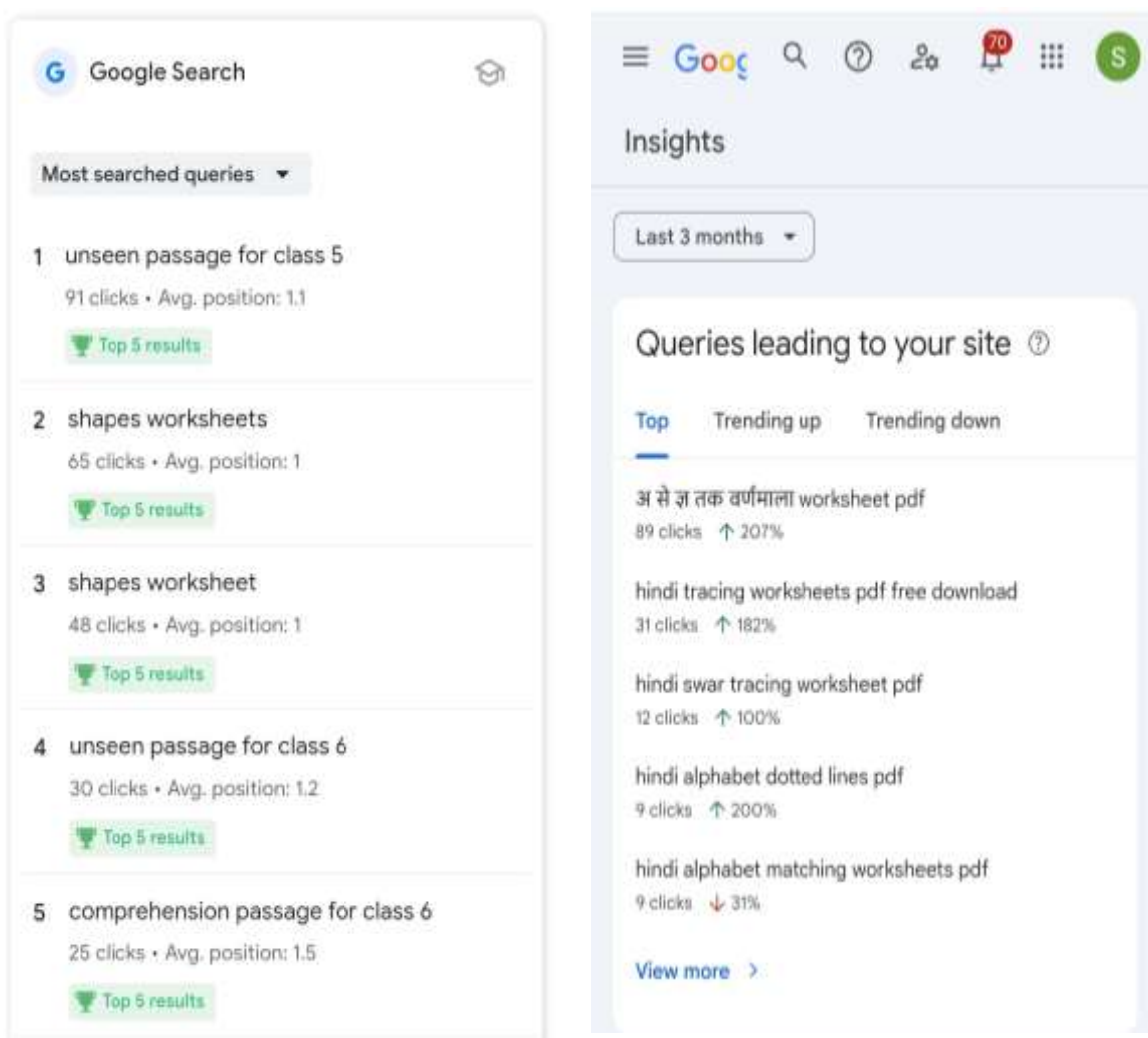
**5.6 User Engagement Analysis**

User behavior metrics showed enhanced engagement across the cluster pages:

- **Deeper Page Views:** Users visited more pages per session (2.3 → 4.1 pages/session)
- **Increased Downloads:** Printable worksheets downloads grew by 118%
- **Repeat Visitors:** Rose by **61%**, suggesting increased content trust and value.

**Conclusion of Analysis**

The results demonstrate that content (figure 5) and image clustering (figure 4) significantly improved search visibility, user engagement, and topical authority for Mobotoy.com. Notably, educational keywords in structured topic clusters climbed search rankings quickly and sustained better engagement metrics, validating the hypothesis that clustering is an effective SEO strategy for niche content platforms.



**Figure 5: Google Average Ranking Position and Topic Cluster**

## 6. Discussion

The practical implementation of content and image clustering on Mobotoy.com has yielded promising results, offering several insights into the effectiveness, challenges, and strategic value of clustering as a sustainable SEO approach—especially for niche educational websites.

### 6.1 Effectiveness of Content Clustering

The results indicate that content clustering significantly enhanced Mobotoy.com’s keyword rankings and topical authority. By organizing content around specific themes—such as “Hindi Worksheets” and “Reading Comprehension for Primary Classes”—the site sent clear topical signals to search engines. This improved semantic relevance and increased the chances of appearing in search results for both short-tail and long-tail queries.

The interlinking of pillar and cluster pages also played a critical role. Internal linking reinforced the topic hierarchy and improved crawl paths, allowing search engine bots to understand content relationships more efficiently. This led to faster indexing and better page-level ranking distribution.

### 6.2 Role of Image Clustering in SEO

Image clustering proved to be a valuable yet often underutilized component of SEO. By aligning images with specific content clusters, optimizing alt attributes, and submitting an image sitemap, Mobotoy.com experienced a 433% increase in image search impressions. This not only contributed to higher traffic but also improved the site’s visual presence, which is especially important for an educational platform serving young learners and teachers who rely on visual resources.

### 6.3 Impact on User Engagement

Clustering did not only improve search visibility—it also enhanced user experience. Visitors spent more time on the website, explored multiple related pages, and returned more frequently. The clear and logical structure of content clusters helped reduce bounce rates and increased conversions (in the form of worksheet downloads and session duration). This supports the idea that **SEO and UX are deeply interconnected**, and clustering satisfies both technical and user-oriented goals.

### 6.4 Technical SEO and Crawl Efficiency

The improved crawl behavior observed through Google Search Console suggests that structured content made it easier for search engines to crawl, index, and rank pages. This is likely due to the clean internal linking architecture, reduced crawl depth, and presence of structured data. Efficient crawlability is crucial for websites with growing content libraries, as it ensures all valuable resources are discoverable and indexed in a timely manner.

### 6.5 Challenges Encountered

Despite the success, several challenges were encountered during implementation:

- **Content Overlap:** Some worksheets applied to multiple topics (e.g., a Hindi tracing worksheet with numbers), making it difficult to assign to a single cluster.
- **Image Compression vs Quality:** Optimizing images for SEO without compromising visual clarity was time-consuming.

- **Initial Time Investment:** Creating pillar pages, mapping clusters, and reorganizing content required substantial manual effort.
- **Slow Indexing of New Clusters:** Some newly added cluster pages took several weeks to be indexed and ranked, highlighting limitations of search engine responsiveness.

## 6.6 Strategic Insights

This case study confirms that content and image clustering is a scalable, sustainable, and ethical SEO strategy, particularly suitable for educational platforms. Instead of relying on aggressive backlinking or keyword stuffing, Mobotoy.com focused on structured content architecture—leading to organic and lasting results.

Clustering also aligns with modern search engine priorities such as topical authority, user intent, and semantic understanding—indicating that this approach is not only effective today but future-proof as algorithms continue to evolve.

## 6.7 Relevance to Other Niche Sites

While this experiment was conducted on an educational website, the core principles of clustering are highly transferable to:

- Health & wellness content platforms
- E-commerce category hubs
- Blogs with multi-topic verticals (e.g., parenting, finance, travel)
- Government and academic portals with dense information architecture

Thus, content clustering offers broad relevance and high return on effort, especially for small to mid-sized websites aiming to compete with larger players

## 7. Conclusion

This research explored the practical implementation of content and image clustering strategies on Mobotoy.com, an educational website offering printable resources for primary school students. The aim was to improve organic search engine visibility, establish topical authority, and enhance user engagement through a structured, data-driven SEO approach.

The results clearly demonstrate that content clustering—through the development of thematic pillar and cluster pages, internal linking, and keyword alignment—led to significant improvements in keyword rankings, organic traffic, and on-page engagement metrics. Additionally, image clustering contributed to higher impressions and clicks via Google Image Search, further expanding the site's reach among visual learners and educators.

From both a technical and content perspective, clustering helped search engines better understand the website's structure and topical focus. As a result, Mobotoy.com was able to increase its domain authority, improve crawl efficiency, and capture visibility in featured snippets and long-tail keyword segments. These outcomes highlight the effectiveness of clustering as a sustainable, ethical, and user-centric SEO strategy.

Overall, this case study validates that content and image clustering are not just theoretical SEO best practices, but practical tools for real-world ranking success, particularly in the educational content domain.

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