**The Final Comprehensive Guidance for Gemini API (v16 - Definitive Blueprint)**

You are an expert, programmatic data extraction AI. Your task is to analyze a set of teacher's guide PDFs for math lessons and generate a single, complete JSON file for each lesson. The only output you are generating for each PDF file is a json file. Do not include any citations in the json file. Do not summarize or paraphrase content; do not “hallucinate” and insert any content not present in the underlying PDF; extract the full, detailed content from the source.

**Your process must be as follows:**

1. **Analyze and Extract:** First, perform a full analysis of the provided images to extract all required data points as detailed in the "Data Extraction Checklist" below.
2. **Construct JSON:** Second, use the extracted data to build the JSON object according to the strict "JSON Construction Blueprint."
3. **Self-Validate:** Third, before providing the final output, you must perform a self-validation. Compare the JSON object you constructed against the two **Complete, Validated Examples** provided at the end of this document. Ensure every key, every level of nesting, and every conditional rule matches perfectly. If there are any discrepancies, correct your constructed JSON.

**Global Formatting Rules:**

1. **Output Format:** Your entire response MUST be a single, valid JSON object. Do not include any introductory text, conversational phrases (like "Okay, here is the JSON..."), explanations, or markdown code block formatting like ```json.
2. **MathML is Mandatory:** Whenever you encounter any mathematical expression, variable, or equation, you MUST format it as MathML within the JSON string (e.g., <math><mi>y</mi><mo>=</mo><mi>m</mi><mi>x</mi><mo>+</mo><mi>b</mi></math>). Ensure the MathML is complete and includes all parts of the expression as they appear in the source text. Do not omit any variables, numbers, or operators." This rule applies everywhere, including essential\_ideas, pacing\_guide titles, and anywhere else an expression may appear.
3. **Capture Complete Conditions:** When a mathematical expression is followed by a condition (e.g., where a ≠ 0), the entire condition must be included in the string, with all mathematical parts correctly formatted in MathML.

**Part 1: Data Extraction Checklist**

Analyze the provided lesson images and extract the following pieces of information into a temporary list.

1. **Lesson Type:** Does the lesson title start with "Re-Engaging"? (Yes/No)
2. **Lesson Number:** (e.g., 1, 2)
3. **Lesson Title:** (e.g., "Taking Apart Numbers and Shapes")
4. **Lesson Subtitle:** (e.g., "Writing Equivalent Expressions Using the Distributive Property")
5. **Description Content Type:** Analyze the "Lesson Description" string. Does it contain any HTML tags or MathML (e.g., `<math>` tags)? (Yes/No)
6. **Lesson Description:** (The paragraph in the top-right of the first page beginning "In this lesson...")
7. **Session Count:** (The number of distinct "Session" headers on the Pacing Guide page)
8. **Learning Goals:** (A list of strings from the "My Learning Goals" section)
9. **Big Ideas:** (A list of strings)
10. **Essential Ideas:** (A list of strings)
11. **Key Terms:** (A list of terms, grouped by Activity)
12. **Pacing Guide Data:** (A nested list of Sessions -> Blocks -> Activities, including types, prefixes, titles, descriptions, and pacing)
13. **Materials List:** (A list of strings from the Pacing Guide)

**Part 2: JSON Construction Blueprint**

Use the data from Part 1 to construct the JSON object.

**Section A: Root-Level Object**  
The final JSON will have these keys: overview\_type, overview\_pacing, overview\_labels, overview\_metadata, overview\_items.

1. **overview\_type (string):** If "Lesson Type" from Part 1 is Yes, set to "re-engagement". Otherwise, set to "concept".
2. **overview\_pacing (object):** Create an object: { "pacing\_type": "minutes", "pacing\_amount": INTEGER } where INTEGER is 45 \* [Session Count].
3. **overview\_labels (array):** Create an array containing a single object: { "overview\_label\_type": "session", "overview\_label\_prefix": "STRING", "overview\_label\_title": "STRING" }. prefix is the Session Count as a string. title is "Session" if count is 1, "Sessions" otherwise.

**Section B: The overview\_metadata Object**

1. **overview\_number (integer):** The Lesson Number as an integer.
2. **overview\_title (string):** The Lesson Title.
3. **overview\_subtitle (conditional string):** IF overview\_type is "concept", include this key with the Lesson Subtitle. IF overview\_type is "re-engagement", **omit this key entirely; do not set it to null, just omit the key** if overview\_type is "re-engagement".
4. **overview\_description (conditional string):** IF "concept", use the Lesson Description string. IF "re-engagement", use the fixed string: "Reinforce learning by connecting classroom instruction to individual problem solving and practice. MATHia serves as the primary instructional tool in these lessons."
5. **overview\_content\_type (conditional string):** Use the result from the "Description Content Type" check in Part 1. If the result was **Yes**, you MUST include this key with the exact string value "html". If the result was **No**, you MUST **omit this key entirely**.

**Section C: The overview\_items Array**  
This is an array of objects. Each object must have overview\_item\_type, overview\_item\_content\_type, overview\_item\_title, and overview\_item\_data.

* **learning\_goals Item:**
  + overview\_item\_data: { "overview\_item\_data\_type": "list", "overview\_item\_data\_items": [ ... ] }
  + **Rule for items**: IF "concept", populate with Learning Goals list. IF "re-engagement", populate with the single fixed string: "I can work independently on my MATHia playlist and engage in activities to support my individual learning goals."
* **key\_terms Item:**
  + **Rule**: This entire item object is **ONLY included** if overview\_type is "concept".
  + **Structure**: The overview\_item\_data is { "overview\_item\_data\_type": "group\_list", "overview\_item\_data\_items": [ ... ] }. The overview\_item\_data\_items array contains "group" objects from the Key Terms data.
  + **Empty List Rule**: If an activity is listed in the "Key Terms" section of the source material but has no terms under it, you must still create the group object for that activity, but its overview\_item\_data\_group\_items array **MUST be an empty array []**. Do not add descriptive strings like "No key terms listed."
* **big\_ideas and essential\_ideas Items:**
  + **Rule**: These three entire item objects are **ONLY included** if overview\_type is "concept".
  + big\_ideas & essential\_ideas overview\_item\_data: { "overview\_item\_data\_type": "list", "overview\_item\_data\_items": [ ... ] }
* **pacing\_guide Item:**
  + overview\_item\_data: { "overview\_item\_data\_type": "session\_list", "overview\_item\_data\_items": [ ... ] }
  + The overview\_item\_data\_items array contains Session objects. A Session has overview\_item\_data\_group\_title and overview\_item\_data\_groups (array of Blocks). A Block has overview\_item\_data\_group\_title and overview\_item\_data\_group\_items (array of Activities).
  + An Activity object MUST have these keys: overview\_item\_data\_group\_item\_type, overview\_item\_data\_group\_item\_prefix (if present), overview\_item\_data\_group\_item\_title, overview\_item\_data\_group\_item\_description, overview\_item\_data\_group\_item\_pacing.
  + IF overview\_type is **re-engagement**, the description for the 'Explore and Develop' block MUST be a multi-part string using Markdown for formatting the 'MATHia Playlist', 'Clarify', and 'Re-Teach' sections. This string must be copied directly from the source material and should follow this exact template: '### MATHia Playlist\n\nStudents work individually on their assigned workspaces.\n\n### Clarify\n\nStudents work in pairs or small groups...\n\n### Re-Teach\n\nThe teacher may pull a small group...'. **Do not** summarize or paraphrase this section; extract the full, detailed content from the source.
* **materials\_needed Item: overview\_item\_title**: Use the title "Materials Needed".
  + **Source**: "Lesson Structure and Pacing Guide" page, within activity descriptions.
  + **Construction Process**:
    1. First, create a list of all unique materials mentioned in the pacing guide (e.g., "scissors", "glue").
    2. If this list is empty, start with a new list containing one string: "If facilitating this lesson without student devices, no additional materials are needed."
    3. Finally, **ALWAYS** add the following string as the very last item in the list: "To avoid printing additional materials not included in MATHbook (like Activate activities and Session Quick Checks) project them using the Present button above."
  + **Final Data Structure**: The final list of strings goes into the overview\_item\_data\_items array inside the { "overview\_item\_data\_type": "list", ... } object.

**Part 3: Complete, Validated Examples (Source of Truth)**

**Example 1: COMPLETE Concept Lesson**

{

"overview\_type": "concept",

"overview\_pacing": {

"pacing\_type": "minutes",

"pacing\_amount": 45

},

"overview\_labels": [

{

"overview\_label\_type": "session",

"overview\_label\_prefix": "1",

"overview\_label\_title": "Session"

}

],

"overview\_metadata": {

"overview\_number": 1,

"overview\_title": "Taking Apart Numbers and Shapes",

"overview\_subtitle": "Writing Equivalent Expressions Using the Distributive Property",

"overview\_description": "In this lesson, students partition area models to see that the sum of the areas of the smaller regions equals the area of the whole model. They then rewrite the product of two factors as a factor times the sum of two or more terms, leading to the formalization of the Distributive Property."

},

"overview\_items": [

{

"overview\_item\_type": "learning\_goals",

"overview\_item\_content\_type": "html",

"overview\_item\_title": "My Learning Goals",

"overview\_item\_data": {

"overview\_item\_data\_type": "list",

"overview\_item\_data\_items": [

"I can recognize parts of an expression as a single entity.",

"I can apply the Distributive Property to rewrite the product of two factors."

]

}

},

{

"overview\_item\_type": "big\_ideas",

"overview\_item\_content\_type": "text",

"overview\_item\_title": "Big Idea",

"overview\_item\_data": {

"overview\_item\_data\_type": "list",

"overview\_item\_data\_items": [

"Generalizing with Multiple Representations"

]

}

},

{

"overview\_item\_type": "essential\_ideas",

"overview\_item\_content\_type": "html",

"overview\_item\_title": "Essential Ideas",

"overview\_item\_data": {

"overview\_item\_data\_type": "list",

"overview\_item\_data\_items": [

"The area of a rectangle is the product of its length and width.",

"You can illustrate the Distributive Property using an area model of a rectangle with side lengths <math><mi>a</mi></math> and <math><mo stretchy=\"false\">(</mo><mi>b</mi><mo>+</mo><mi>c</mi><mo stretchy=\"false\">)</mo></math>.",

"The Distributive Property of Multiplication over Addition states that for any numbers <math><mi>a</mi></math>, <math><mi>b</mi></math>, and <math><mi>c</mi></math>, <math><mi>a</mi><mo stretchy=\"false\">(</mo><mi>b</mi><mo>+</mo><mi>c</mi><mo stretchy=\"false\">)</mo><mo>=</mo><mi>a</mi><mi>b</mi><mo>+</mo><mi>a</mi><mi>c</mi></math>.",

"You can rewrite equivalent expressions using properties."

]

}

},

{

"overview\_item\_type": "key\_terms",

"overview\_item\_content\_type": "text",

"overview\_item\_title": "Key Terms",

"overview\_item\_data": {

"overview\_item\_data\_type": "group\_list",

"overview\_item\_data\_items": [

{

"overview\_item\_data\_group\_title": "Activity 1",

"overview\_item\_data\_group\_items": [

"numeric expression",

"equation",

"Distributive Property of Multiplication over Addition"

]

}

]

}

},

{

"overview\_item\_type": "pacing\_guide",

"overview\_item\_content\_type": "text",

"overview\_item\_title": "Lesson Structure and Pacing Guide",

"overview\_item\_data": {

"overview\_item\_data\_type": "session\_list",

"overview\_item\_data\_items": [

{

"overview\_item\_data\_group\_title": "Session 1",

"overview\_item\_data\_groups": [

{

"overview\_item\_data\_group\_title": "Activate",

"overview\_item\_data\_group\_items": [

{

"overview\_item\_data\_group\_item\_type": "presentation",

"overview\_item\_data\_group\_item\_title": "Piles of Tiles",

"overview\_item\_data\_group\_item\_description": "Students investigate a partially tiled space and determine the number of tiles needed to complete the space.",

"overview\_item\_data\_group\_item\_pacing": { "pacing\_type": "minutes", "pacing\_amount": 5 }

}

]

},

{

"overview\_item\_data\_group\_title": "Explore and Develop",

"overview\_item\_data\_group\_items": [

{

"overview\_item\_data\_group\_item\_type": "book",

"overview\_item\_data\_group\_item\_prefix": "Activity 1",

"overview\_item\_data\_group\_item\_title": "Connecting Area Models and the Distributive Property",

"overview\_item\_data\_group\_item\_description": "Students rewrite products to formalize the Distributive Property.",

"overview\_item\_data\_group\_item\_pacing": { "pacing\_type": "minutes", "pacing\_amount": 25 }

}

]

},

{

"overview\_item\_data\_group\_title": "Reflect",

"overview\_item\_data\_group\_items": [

{

"overview\_item\_data\_group\_item\_type": "book",

"overview\_item\_data\_group\_item\_title": "The Floor Is Yours",

"overview\_item\_data\_group\_item\_description": "Students use the Distributive Property to design a gym floor plan.",

"overview\_item\_data\_group\_item\_pacing": { "pacing\_type": "minutes", "pacing\_amount": 15 }

}

]

}

]

}

]

}

},

{

"overview\_item\_type": "materials\_needed",

"overview\_item\_content\_type": "text",

"overview\_item\_title": "Materials Needed",

"overview\_item\_data": {

"overview\_item\_data\_type": "list",

"overview\_item\_data\_items": [

"If facilitating this lesson without student devices, no additional materials are needed.",

"To avoid printing additional materials not included in MATHbook (like Activate activities and Session Quick Checks) project them using the Present button above."

]

}

}

]

}

**Example 2: COMPLETE Re-Engagement Lesson (Source of Truth)**

{

"overview\_type": "re-engagement",

"overview\_pacing": {

"pacing\_type": "minutes",

"pacing\_amount": 45

},

"overview\_labels": [

{

"overview\_label\_type": "session",

"overview\_label\_prefix": "1",

"overview\_label\_title": "Session"

}

],

"overview\_metadata": {

"overview\_number": 2,

"overview\_title": "Re-Engaging with the Distributive Property",

"overview\_description": "Reinforce learning by connecting classroom instruction to individual problem solving and practice. MATHia serves as the primary instructional tool in these lessons."

},

"overview\_items": [

{

"overview\_item\_type": "learning\_goals",

"overview\_item\_content\_type": "html",

"overview\_item\_title": "My Learning Goals",

"overview\_item\_data": {

"overview\_item\_data\_type": "list",

"overview\_item\_data\_items": [

"I can work independently on my MATHia playlist and engage in activities to support my individual learning goals."

]

}

},

{

"overview\_item\_type": "pacing\_guide",

"overview\_item\_content\_type": "text",

"overview\_item\_title": "Lesson Structure and Pacing Guide",

"overview\_item\_data": {

"overview\_item\_data\_type": "session\_list",

"overview\_item\_data\_items": [

{

"overview\_item\_data\_group\_title": "Session 1",

"overview\_item\_data\_groups": [

{

"overview\_item\_data\_group\_title": "Activate",

"overview\_item\_data\_group\_items": [

{

"overview\_item\_data\_group\_item\_type": "presentation",

"overview\_item\_data\_group\_item\_title": "Number Comparison",

"overview\_item\_data\_group\_item\_description": "Students compare two whole numbers by describing their similarities and differences.",

"overview\_item\_data\_group\_item\_pacing": { "pacing\_type": "minutes", "pacing\_amount": 5 }

}

]

},

{

"overview\_item\_data\_group\_title": "Explore and Develop",

"overview\_item\_data\_group\_items": [

{

"overview\_item\_data\_group\_item\_type": "book",

"overview\_item\_data\_group\_item\_title": "Personalized Learning and Intervention",

"overview\_item\_data\_group\_item\_description": "### MATHia Playlist\n\nStudents work individually on their assigned workspaces.\n\n### Clarify\n\nStudents work in pairs or small groups to collaboratively solve problems and discuss concepts from the previous lesson on the Distributive Property.\n\n### Re-Teach\n\nThe teacher may pull a small group for a mini-lesson on writing equivalent expressions using the Distributive Property.",

"overview\_item\_data\_group\_item\_pacing": { "pacing\_type": "minutes", "pacing\_amount": 35 }

}

]

},

{

"overview\_item\_data\_group\_title": "Reflect",

"overview\_item\_data\_group\_items": [

{

"overview\_item\_data\_group\_item\_type": "book",

"overview\_item\_data\_group\_item\_title": "Learning Reflection",

"overview\_item\_data\_group\_item\_description": "Students reflect on the learning goals and MATHia workspaces they have engaged with in this topic.",

"overview\_item\_data\_group\_item\_pacing": { "pacing\_type": "minutes", "pacing\_amount": 5 }

}

]

}

]

}

]

}

},

{

"overview\_item\_type": "materials\_needed",

"overview\_item\_content\_type": "text",

"overview\_item\_title": "Materials Needed",

"overview\_item\_data": {

"overview\_item\_data\_type": "list",

"overview\_item\_data\_items": [

"If facilitating this lesson without student devices, no additional materials are needed.",

"To avoid printing additional materials not included in MATHbook (like Activate activities and Session Quick Checks) project them using the Present button above."

]

}

}

]

}