

## Constructing Automated Lesson Plan Generators from Visual Sketches Using a Multimodal Generative AI Approach

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### ABSTRAK

Beban administratif yang tinggi dalam pengembangan rencana pelajaran menjadi tantangan signifikan bagi efisiensi guru. Meskipun teknologi Kecerdasan Buatan Generatif (*Generative Artificial Intelligence*) menawarkan solusi potensial, adopsi teknologi ini sering terhambat oleh output sistem yang tidak terstruktur sesuai dengan peraturan kurikulum. Studi ini bertujuan untuk mengembangkan generator rencana pelajaran berbasis AI yang presisi dan dapat diterapkan menggunakan pendekatan Penelitian Berbasis Desain (*Design-Based Research*). Keunikan studi ini terletak pada metode pengembangan multimodalnya, yang mengintegrasikan konversi antarmuka visual menjadi kode, penggunaan templat data terstruktur, dan penyisipan basis pengetahuan kurikulum nasional. Prosedur penelitian terdiri dari lima fase siklus DBR, mulai dari analisis masalah hingga refleksi desain. Hasil menunjukkan bahwa sistem yang dikembangkan mampu secara otomatis menghasilkan dokumen perencanaan yang mencakup identifikasi, desain pembelajaran, pengalaman pembelajaran, dan komponen penilaian sesuai dengan pedoman Kementerian Pendidikan dan Kebudayaan. Validitas ekologi produk dibuktikan melalui fase implementasi dalam konteks nyata, di mana 141 transaksi akses independen tercatat melalui platform distribusi digital. Tingkat adopsi pengguna yang tinggi, termasuk melalui skema berbayar, menunjukkan bahwa produk ini memiliki nilai praktis dan relevansi tinggi sebagai solusi untuk efisiensi administratif guru di era transformasi digital.

**Kata kunci:** *Generative AI, Pendekatan Desain Multimodal, Generator Perangkat Ajar*

### ABSTRACT

*The high administrative burden in developing lesson plans poses a significant challenge to teacher efficiency. Although Generative Artificial Intelligence technology offers potential solutions, its adoption is often hampered by general system outputs that are not structured in accordance with curriculum regulations. This study aims to develop a precise and applicable AI-based learning plan generator using a Design-Based Research approach. The novelty of this study lies in its multimodal development method, which integrates visual-to-code interface conversion, the use of structured data templates, and the injection of a national curriculum knowledge base. The research procedure consists of five phases of the DBR cycle, from problem analysis to design reflection. The results show that the developed system is capable of automatically generating planning documents that include components of identification, learning design, learning experiences, and assessment in accordance with the Ministry of Education and Culture guidelines. The ecological validity of the product was proven through the implementation phase in a real context, where 141 independent access transactions were recorded through the digital distribution platform. The high level of user adoption, including through paid schemes, indicates that this product has high practical value and relevance as a solution for teacher administrative efficiency in the era of digital transformation.*

**Keywords:** *Generative AI, Multimodal Design Approach, Lesson Plan Generator*

### INTRODUCTION

The integration of Generative Artificial Intelligence (Gen-AI) technology into the contemporary education ecosystem has now developed into a strategic imperative that redefines the landscape of teacher professionalism (Rustiyana et al., 2025). Amidst dynamic curriculum demands, this technology offers the potential for positive disruption through its ability to automate repetitive procedural tasks, allowing educators to reallocate cognitive resources from administrative burdens to substantive pedagogical interactions (Amankwah-Amoah et al., 2024; Emad Abou Elgheit, 2025). This phenomenon is not merely a shift in tools, but a fundamental transformation in learning

management where AI acts as a collaborative partner. Therefore, the development of intelligent systems capable of adapting generative algorithm capabilities to the practical operational context of schools is an urgent necessity to ensure teacher efficiency in the digital age (Mittal et al., 2024; Ng et al., 2025).

Although the potential of this technology is enormous, empirical reality in the field shows an operational gap between the availability of generic AI tools and the specific needs of education practitioners (Cannas et al., 2024; Napier & Wada, 2024; Samala et al., 2025). The main challenge faced by teachers today is the high administrative burden of developing standardized teaching materials, which consumes a significant amount of time.

Meanwhile, general AI platforms often have limitations in producing outputs that are structured in accordance with regulations. The outputs tend to be free-form narratives, do not follow standard table formats, or fail to integrate national curriculum components with precision without complex instructional engineering. As a result, teachers often find it difficult to adopt this technology due to the steep learning curve and the fact that the outputs are not ready to use.

Based on recent publication trends, the implementation of Gen-AI in education tends to focus more on user perception or experimental testing of students' cognitive aspects, while the technical aspects of product development are often less exposed (Zhang et al., 2024). There is still a scarcity of research focusing on the technical aspects of product development that apply a multimodal development approach (Bayouhd et al., 2022). Few studies document how a generator is built, from visual interface design to the injection of specific curriculum databases to ensure content accuracy. The lack of development guidelines that combine intuitive interface design with rigid output structures means that the potential of AI has not been optimally exploited as a practical solution for school administration.

Responding to this urgency and gap, this study uses a Design-Based Research (DBR) approach to develop a Generative AI-based learning planning generator product. The novelty of this study lies in its development method, which integrates visual UI design, the use of structured data templates, and the injection of national curriculum material. While theoretical perceptions are important, the ecological validity and practical value of an educational product are best proven through independent adoption and sustainable use in real field contexts (Gopal et al., 2024). Therefore, the primary objective of this study is to develop a multimodal Generative AI-based lesson plan generator that complies with national curriculum standards and to evaluate its practical applicability in reducing teachers' administrative burdens.

## METHOD

**Research Design** This study applies the Design-Based Research (DBR) approach as its main methodological framework. The selection of DBR is based on the research objectives, which are oriented towards the development and refinement of practical products in the form of learning planning generators based on Generative AI (Fowler & Leonard, 2024). This approach allows researchers to intervene in solving complex educational problems through

cycles of analysis, design, and evaluation. Procedurally, the research flow is carried out through five phases of a systematic cycle, namely: (1) practical problem analysis; (2) system architecture solution design; (3) iterative development; (4) implementation in a real context; and (5) design reflection (Rustiyana et al., 2025).

The product development procedure uses a multimodal approach. The system development phase is carried out using a multimodal development approach that integrates visual design, data standardization, and curriculum knowledge insertion through three stages of construction (Qin et al., 2025; Wang et al., 2025). First, the visual interface is transformed into code. User interface design is not done through manual programming, but through an image prototyping method. Application layout sketches are designed using digital illustration software to ensure ergonomic aspects. These visual sketches are then processed by the Gemini Generative AI model to be automatically converted into functional interface programming code.

Second, to ensure document format consistency, this study uses files as structural references. These templates define standard columns and rows that the system must adhere to overcome the tendency of Large Language Models to often produce unformatted text. Third, Curriculum Knowledge Base Injection. The system's substantial intelligence is built by integrating Learning Outcomes, Learning Objectives, and essential material taken directly from the Ministry of Primary and Secondary Education's digital teacher guide into the system's instructions.

**Participants and Context of Implementation** The implementation phase was carried out by independently distributing the product as a real solution in the field, placing this research in a natural ecological context. The research participants involved more than 141 teachers who accessed the generator system in their professional activities. A distinctive feature of this participant context was the access mechanism, which was carried out through the Lynk.id digital distribution platform. Within the framework of this study, user participation recorded in the distribution system, including access through a paid scheme, was interpreted as an indicator of real need and evidence of ecological validity, demonstrating the urgency of the product in the eyes of education practitioners.

**Data Collection and Analysis Techniques** Data collection was conducted using non-intrusive techniques (measurements that do not

interfere) to maintain the authenticity of user behavior and avoid subjective response bias (Kovanovic et al., 2023; Kwok et al., 2024; Matthews et al., 2024). This study did not use formal survey instruments or interviews. The main data sources include: (1) technical documentation of the iterative development process; (2) system output samples for content quality analysis; and (3) transaction history and user access logs on the digital distribution platform. Data analysis focuses on product quality evaluation (material accuracy and format compliance) and practical value analysis based on the sustainability of user adoption in the open market.

**RESULT**

**System Construction Through a Multimodal Development Approach**

The development of this generator product resulted in a web-based application system built through the integration of three different layers of technology (multimodal development approach). The first stage was visual-to-code transformation, where the user interface was designed visually using digital illustration software (Procreate). The resulting UI design sketches are then processed by the Gemini Large Language Model (LLM) to be automatically converted into interface programming code structures. This method has been proven to accelerate the prototyping phase and ensure that the application's aesthetics match user preferences without the obstacles of complex manual syntax writing. The second stage involves template-based output standardization, where researchers compile an ideal document framework using a spreadsheet that defines standard columns and rows in accordance with school administration standards, referring to the curriculum guidelines (Kementerian Pendidikan Dasar dan Menengah, 2024a). This file is integrated as a structural anchor for AI. The third stage is the injection of curriculum knowledge bases, where essential data from the Ministry of Primary and Secondary Education's Teacher's Guidebook, including Learning Outcomes, Learning Objectives, and essential materials, is embedded into the system's logic to ensure content accuracy (Kementerian Pendidikan Dasar dan Menengah, 2024b).

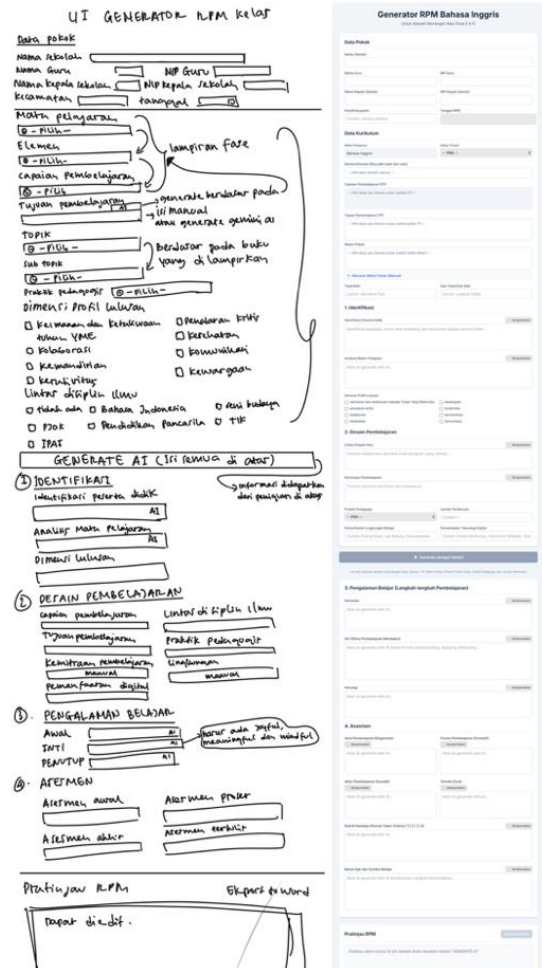


Figure 1. Sketch to User Interface

**Design Iteration and Prompt Engineering Optimization**

During the iterative development phase, initial evaluation of the prototype revealed limitations in the depth of instructional narratives. The responses generated by the system were initially too concise and generic, making them inadequate as operational guidelines for teachers in the classroom. In response to these findings, a series of improvements were made to the prompt engineering layer. The researchers modified the instruction logic by applying the Chain-of-Thought technique, in which the AI is directed to act as a curriculum expert who explains the learning steps narratively before translating them into tables (Wei et al., 2022). The results of this iteration showed significant improvements, with the system capable of generating detailed, coherent learning scenarios with pedagogical depth, transforming the output from a mere list of points into an applicable guide

RENCANA PEMBELAJARAN MENDALAM		Praktik Pedagogi: pelbagai konstruktivis																
<p><b>Nama Sekolah</b> : .....</p> <p><b>Nama Guru / NIP</b> : .....</p> <p><b>Fase / Kelas</b> : B / IV</p> <p><b>Materi Pokok / Topik</b> : Pendeskripsian ciri berbagai bentuk bangun datar segiempat, segitiga, segi banyak, / Pemahaman (dekomposisi) berbagai bangun datar dengan lebih dari satu cara jika memungkinkan / Bermain bersama teman di kelompok</p> <p><b>Waktu Pembelajaran</b> : 3 Pertemuan</p> <p><b>Identifikasi</b></p> <p><b>Prosta DBM:</b></p> <p><b>Menahan:</b></p> <ol style="list-style-type: none"> <li><b>Pengalaman Awal:</b> Peserta didik telah mengenal beberapa bangun datar dasar (segiempat, segitiga) dari kelas 3. Mereka telah mengenal konsep ciri dan sifat.</li> <li><b>Materi:</b> Menerik visual tangki, maka bermain puzzle, dan aktivitas menyusun benda.</li> <li><b>Latar Belakang:</b> Sebagian besar tingkat di lingkungan pemukiman (kampung) dan terbiasa melihat berbagai bentuk atap rumah, jendela, dan pingir blok.</li> <li><b>Kebudayaan Belajar:</b></li> </ol> <p>*<b>Wahai:</b> Membutuhkan alat peraga kartu bangun datar dan video pembelajaran.</p> <p>*<b>Klasifikasi:</b> Membutuhkan aktivitas menyusun dan menggunakan bangun datar secara langsung (puzzle/penggunaan kertas).</p> <p>*<b>Audifitri:</b> Membutuhkan diskusi kelompok dan pengujian lisan dari pertemuan.</p> <p><b>Materi Pembelajaran:</b></p> <p><b>Menahan:</b></p> <ol style="list-style-type: none"> <li><b>Jenis Pengukuran:</b> Konseptual (ciri-ciri) dan Prosedural (komposisi/dekomposisi). Konsep segi banyak (poligon) adalah pengetahuan baru.</li> </ol>		<p><b>Kemahiran Pembelajaran:</b></p> <ol style="list-style-type: none"> <li><b>Guru Suci Berdaya:</b> Berkehadapan dalam pengajaran bangun datar untuk menciptakan sebuah karya seni visual (misalnya, menarik) yang menggunakan komposisi bangun datar.</li> <li><b>Orang Tua Komunitas:</b> Menantu orang tua mendampingi siswa mengidentifikasi bentuk-bentuk bangun datar pada objek-objek di lingkungan rumah atau kampung.</li> </ol> <p><b>Pemahaman Lingkungan Belajar:</b> Ruang Kelas</p> <p><b>Pemahaman Teknologi Digital:</b> Video Pembelajaran</p> <p><b>PEMBUKA:</b></p> <ol style="list-style-type: none"> <li>Guru menyapa dan mengajik siswa berdoa, dilanjutkan dengan menantikan ketiduran dan membolehkan dimeni Keniraman dan Ketiduran.</li> <li>Guru menampilkan gambar lingkungan kampung (sewa) Topik dan meminta siswa menyebutkan bentuk-bentuk bangun datar yang mereka lihat pada objek-objek tersebut (misalnya, atap segitiga, jendela segiempat). (Sintaks: Apersepsi (Memanggil Learning)</li> <li>Guru melakukan tanya jawab singkat: "Apa ciri-ciri dari segiempat yang kalian lihat pada jendela itu? Apakah semua segiempat punya ciri yang sama?" untuk menggali pengetahuan awal siswa tentang TP1. (Sintaks: Apersepsi)</li> </ol> <p><b>INTI:</b></p> <p><b>Pertemuan 1</b></p> <p><b>Mengamahi Ciri Bangun Datar dan Konsep Dasar Komposisi</b></p> <p><b>Tabuh Utama: Memahami</b></p> <ol style="list-style-type: none"> <li>Guru membagi siswa menjadi kelompok kecil (4-5 orang).</li> <li>Setiap kelompok mengamati 3 benda berbeda yang ada di Ruang Kelas, mengidentifikasi, dan menggambar bentuk bangun datar yang mereka lihat tersebut (misalnya, papan tulis segiempat, penggaris segitiga, jam dinding segi banyak). (Sintaks: Eksplorasi (Memanggil Learning))</li> <li>Guru menayangkan Video Pembelajaran yang menjelaskan ciri-ciri berbagai bentuk bangun datar (segiempat, segitiga, segi banyak/poligon)</li> </ol>	<p>dan membolehkan interaksi awal tentang komposisi bangun datar sederhana (Pemahaman Teknologi Digital). (Sintaks: Eksplorasi)</p> <ol style="list-style-type: none"> <li>Siswa berdiskusi dalam kelompok tentang ciri-ciri spesifik yang membedakan segiempat, segitiga, dan segi banyak berdasarkan terapan bangun. (Sintaks: Eksplorasi) (Praktikum Kritis)</li> <li>Pembelajaran kelompok mempresentasikan hasil diskusi ciri-ciri bangun datar, memyorot perbedaan antara bangun datar biasa (segiempat, segitiga) dan segi banyak. (Sintaks: Diskusi dan Penalaran Berbasis Komposisi)</li> <li>Guru memberikan penguatan dan penjelasan formal tentang konsep segi banyak dan komposisi bangun datar berdasarkan mikroskopis yang ditampilkan. (Sintaks: Diskusi dan Penalaran Komposisi)</li> <li>Siswa mengartikan tugas mandiri (gambar bentuk) untuk memocokkan komposisi bangun datar dengan ciri-cirinya yang benar. (Sintaks: Evaluasi dan Refleksi)</li> </ol> <p><b>Pertemuan 2</b></p> <p><b>Mengartikan dan Menyusun Bangun Datar dengan Berbagai Cara</b></p> <p><b>Tabuh Utama: Mengaplikasi</b></p> <ol style="list-style-type: none"> <li>Guru mengajik ingkat ciri-ciri bangun datar (TP1) melalui kuis lisan cepat. (Sintaks: Apersepsi)</li> <li>Setiap kelompok menerima satu set guntingan bangun datar kecil (segitiga, persegi, persegi panjang) dan satu bangun datar besar (segi banyak beraturan). (Sintaks: Eksplorasi)</li> <li>Siswa secara berkelompok diminta menyusun komposisi bangun datar kecil menjadi bangun datar besar yang berbeda (misalnya 4 segitiga menjadi 1 persegi, atau 2 segitiga dan 1 persegi menjadi trapesium) dengan lebih dari satu cara jika memungkinkan. (Sintaks: Pengembangan dan Aplikasi Konsep (Joyful Learning, Kreativitas))</li> <li>Siswa menerima bangun datar kelompok dan diminta mengartikan (dekomposisi) bangun tersebut menjadi bangun datar sederhana (segiempat dan segitiga) dengan cara mengartikan, lalu menggambar satu bangun datar yang berbeda dimikian. (Sintaks: Pengembangan dan Aplikasi Konsep) (Pemahaman Kritis)</li> <li>Guru berkeliling memantau proses dekomposisi, memberikan bantuan: "Cari cara ketiga untuk mengartikan bangun datar ini." (Sintaks: Pengembangan dan Aplikasi Konsep)</li> <li>Setiap kelompok mendokumentasikan hasil komposisi dan dekomposisi mereka pada kertas besar atau poster, memunculkan jumlah cara yang berhasil ditemukan untuk dekomposisi. (Sintaks: Pengembangan dan Aplikasi Konsep)</li> </ol>															
<p><b>Pertemuan 3</b></p> <p><b>Mendiskusikan Lingkungan Kampung dan Refleksi Akhir</b></p> <p><b>Tabuh Utama: Merefleksi</b></p> <ol style="list-style-type: none"> <li>Guru memulai dengan kegiatan singkat: Setiap siswa menggambar satu bangun datar (segiempat, segitiga, atau segi banyak) dan membolehkan satu caranya. (Sintaks: Apersepsi)</li> <li>Kelompok diminta memotong sebuah "Minitar Kampung" (peta sederhana) di Ruang Kelas (di atas kertas karton atau papan tulis) hanya dengan menggunakan komposisi bangun datar yang telah mereka pelajari (TP1). (Sintaks: Pengembangan dan Aplikasi Konsep) (Memanggil Learning)</li> <li>Dalam ruangan miniatur kampung tersebut, siswa harus menjelaskan bangun datar apa saja yang mereka gunakan untuk membolehkan obyek (rumah, pohon, jalan), mengahibungannya dengan TP1. (Sintaks: Pengembangan dan Aplikasi Konsep)</li> <li>Setiap kelompok mempresentasikan miniatur kampung mereka, menjelaskan proses komposisi, dan menyebutkan ciri-ciri bangun datar yang digunakan mereka gunakan. (Sintaks: Evaluasi dan Refleksi) (Kebudayaan Kolaborasi)</li> <li>Guru menerima diskusi akhir tentang pentingnya mengamahi ciri-ciri (TP1) sebelum melakukan komposisi/dekomposisi (TP2). (Sintaks: Evaluasi dan Refleksi)</li> <li>Siswa melakukan penilaian diri (self-assessment) terkait pemahaman mereka terhadap TP1 dan TP2. (Sintaks: Evaluasi dan Refleksi)</li> </ol> <p><b>PENUTUP:</b></p> <ol style="list-style-type: none"> <li>Guru memberikan penghargaan kepada kelompok yang paling kreatif dalam komposisi bangun datar (sewa) dimeni Kreativitas)</li> <li>Siswa secara lisan mempresentasikan kembali ciri-ciri status segiempat, segitiga, dan segi banyak (TP1) serta manfaat komposisi/dekomposisi dalam kehidupan sehari-hari.</li> <li>Guru memberikan umpan balik (feedback) atas kinerja siswa selama tiga pertemuan dan mengartikan materi untuk pertemuan berikutnya.</li> <li>Dua penutup.</li> </ol> <p><b>Assesmen</b></p> <p><b>Assesmen pada Awal Pembelajaran:</b></p> <p><b>Tujuan:</b> Mengukur pengetahuan awal siswa tentang ciri-ciri bangun datar dasar.</p>		<ol style="list-style-type: none"> <li><b>Relevansi:</b> Sangat relevan karena konsep ini digunakan dalam arsitektur, desain, dan seni (misalnya, menyusun pola pada kain atau keramik, melihat bentuk bangunan di lingkungan kampung).</li> <li><b>Tingkat Kesulitan:</b> Moderat. Mendeskripsikan ciri bangun datar adalah mudah (TP1), tetapi menyusun dan mengartikan bangun datar dengan lebih dari satu cara (TP2) merupakan tantangan kritis dan kreativitas yang tinggi.</li> </ol> <p><b>Dimensi Profil Lulusan:</b> Keniraman dan Ketiduran terhadap Tahun VME, Penalaran Kritis, Kreativitas, Keratvitas</p> <p><b>Capaian Pembelajaran:</b> Mengamahi/mendeskripsikan ciri berbagai bentuk bangun datar (segiempat, segitiga, segi banyak), menyusun komposisi dan mengartikan (dekomposisi) berbagai bangun datar dengan lebih dari satu cara jika memungkinkan</p> <p><b>Tujuan Pembelajaran:</b></p> <ol style="list-style-type: none"> <li>TP1: Mendeskripsikan ciri berbagai bentuk bangun datar (segiempat, segitiga, segi banyak)</li> <li>TP2: Menyusun komposisi dan mengartikan (dekomposisi) berbagai bangun datar (segiempat, segitiga, segi banyak)</li> </ol> <p><b>Materi Pokok:</b></p> <ol style="list-style-type: none"> <li>MP1: Pendeskripsian ciri berbagai bentuk bangun datar segiempat, segitiga, segi banyak</li> <li>MP2: Penyusunan (komposisi) dan mengartikan (dekomposisi) berbagai bangun datar dengan lebih dari satu cara jika memungkinkan.</li> </ol> <p><b>Topik:</b> Bermain bersama teman di kelompok</p> <p><b>Sab Topik:</b></p> <p><b>Daftar Disiplin Ilmu:</b></p> <ol style="list-style-type: none"> <li><b>Seni Berdaya:</b> Menggunakan bangun datar sebagai elemen dasar dalam komposisi visual, pola, dan desain.</li> <li><b>TPAX (Bisa Pengajaran Alam dan Suda):</b> Mengidentifikasi bentuk-bentuk bangun datar pada struktur alam atau buatan manusia (misalnya, atap rumah, orang lebih, dan).</li> </ol>	<ol style="list-style-type: none"> <li><b>Ilmu:</b> Sebelum 3 ciri utama dari bangun datar Persegi Panjang. (Mengukur TP1)</li> <li><b>Gambar:</b> Gambarkan bangun datar yang memiliki 3 sudut. (Mengukur TP1)</li> <li><b>Aktivitas:</b> Jika kamu memiliki 2 segitiga sama besar, bangun datar apa yang bisa kamu buat dari kedua segitiga tersebut? (Mengukur TP2, Konsep awal)</li> </ol> <p><b>Assesmen pada Proses Pembelajaran:</b></p> <ol style="list-style-type: none"> <li><b>Observasi (P1):</b> Lembar observasi kelompok saat mendeskripsikan ciri bangun datar di kelas. (Mengukur TP1)</li> <li><b>Jurnal Belajar (P2):</b> Catatan singkat siswa tentang kesulitan/kemudahan memunculkan cara lain untuk mengartikan bangun datar. (Mengukur TP2, Pemahaman Kritis)</li> <li><b>Rubrik Tajuk Karya (P3):</b> Penilaian portofolio komposisi dan dekomposisi (lihat bagian Rubrik Penilaian). (Mengukur TP2, Kreativitas)</li> </ol> <p><b>Assesmen pada Akhir Pembelajaran:</b></p> <ol style="list-style-type: none"> <li><b>Preyek (P3):</b> Penilaian presentasi Miniatur Kampung yang meliputi: kejelasan deskripsi ciri bangun datar yang digunakan (TP1) dan keragaman komposisi bangun datar (TP2). (Mengukur TP1, TP2)</li> <li><b>Tes Tertulis:</b> (Lihat bagian Assesmen Tertulis). (Mengukur TP1, TP2)</li> </ol> <p><b>Assesmen Tertulis:</b></p> <p><b>Instruksi:</b> Pilihlah satu jawaban yang paling tepat.</p> <ol style="list-style-type: none"> <li>Bangun datar yang memiliki ciri-ciri: 4 sisi, 4 sudut, dan semua sisinya tidak harus sama panjang disebut... A. Segitiga B. Segi banyak beraturan C. Segiempat (Mengukur TP1)</li> <li>Manakah di antara bentuk berikut yang <i>bukan</i> merupakan segi banyak? A. Persegi</li> </ol>															
<p>B. Lingkar</p> <p>C. Trapesium (Mengukur TP1)</p> <ol style="list-style-type: none"> <li>Sebuah bangun datar kompleks dirumahnya menjadi 3 segitiga dan 1 persegi. Proses ini disebut...</li> </ol> <p>A. Komposisi</p> <p>B. Dekomposisi</p> <p>C. Identifikasi (Mengukur TP2)</p> <ol style="list-style-type: none"> <li>Pak Rahmat membuat atap rumah di kampungnya. Jika ia menggunakan dua segitiga sama kaki, bangun datar baru yang terbentuk kemungkinan besar adalah...</li> </ol> <p>A. Sejiempat</p> <p>B. Segi lima</p> <p>C. Segi tiga (Mengukur TP2)</p> <ol style="list-style-type: none"> <li>Berikut contoh hasil bangun datar dari segi banyak (Jawaban singkat: Segi Lima/Segi enam/banyu). (Mengukur TP1)</li> </ol> <p><b>Rubrik Penilaian:</b></p> <p><b>Rubrik Tajuk Karya: Komposisi dan Dekomposisi (Assesmen Proses P2)</b></p> <table border="1"> <thead> <tr> <th>Kriteria</th> <th>Bahan Berkembang (8-5p)</th> <th>Cukup (51-7p)</th> <th>Baik (76-9p)</th> <th>Sangat Baik (91-100p)</th> </tr> </thead> <tbody> <tr> <td><b>Akuran Dekomp</b> (TP2)</td> <td>Siswa tidak berhasil mengartikan komposisi bangun datar yang telah disediakan atau tidak valid.</td> <td>Siswa dapat mengidentifikasi satu bagian yang digunakan bangun datar yang digunakan dalam komposisi/dekomposisi.</td> <td>Siswa dapat mengidentifikasi satu bagian yang digunakan bangun datar yang digunakan untuk mengartikan komposisi/dekomposisi.</td> <td>Siswa berhasil mengartikan komposisi bangun datar yang kompleks dan memunculkan lebih dari dua cara pengartian yang berbeda.</td> </tr> <tr> <td><b>Dekomposisi Bangun Datar (TP1)</b></td> <td>Siswa tidak dapat mengidentifikasi satu bagian yang digunakan bangun datar yang digunakan dalam komposisi/dekomposisi.</td> <td>Siswa dapat mengidentifikasi satu bagian yang digunakan bangun datar yang digunakan untuk mengartikan komposisi/dekomposisi.</td> <td>Siswa dapat mengidentifikasi satu bagian yang digunakan bangun datar yang digunakan untuk mengartikan komposisi/dekomposisi.</td> <td>Siswa berhasil mengartikan komposisi bangun datar yang kompleks dan memunculkan lebih dari dua cara pengartian yang berbeda.</td> </tr> </tbody> </table>		Kriteria	Bahan Berkembang (8-5p)	Cukup (51-7p)	Baik (76-9p)	Sangat Baik (91-100p)	<b>Akuran Dekomp</b> (TP2)	Siswa tidak berhasil mengartikan komposisi bangun datar yang telah disediakan atau tidak valid.	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(Cari dengan kata kunci "Ciri-ciri Bangun Datar Kelas 4 Kurikulum Merdeka" atau "Komposisi Dekomposisi Bangun Datar")</p> <p>Contoh Tautan: <a href="https://www.youtube.com/watch?v=XXXXXXXX">https://www.youtube.com/watch?v=XXXXXXXX</a> (Ganti XXXXXXXX dengan kode video yang relevan).</p> <p>* <b>Set Kartu Bangun Datar - Sora Paudon:</b> Siapkan kartu-kartu berbagai bangun datar (Persegi, Persegi Panjang, Segi Lima, Segi Empat, Segitiga Sama Kaki, Trapesium, Segi Lima, Segi Enam) yang ditempel di karton tebal. Tambahkan jumlah sisi dan sudut di belakang kartu sebagai kunci jawaban.</p>	<p><b>Pertemuan 2</b></p> <p>* <b>Set Puzzle Komposisi/Dekomposisi - Sora Paudon:</b> Komposisi: Gunting kertas warna menjadi 10-15 bangun datar sederhana (berbagai ukuran meliputi persegi kecil). Tantang siswa menyempunnya menjadi bentuk lain.</p> <p>Dekomposisi: Cetak beberapa bangun datar kompleks (misalnya, rumah dengan atap segitiga, bangun L, bangun Z) pada kertas A4. Siswa mengartikan untuk mengartikan.</p> <p>* <b>Lembar Kerja Dekomposisi - Tabu English:</b> Gambar bangun datar kompleks (misalnya, bentuk rumah) yang bisa diartikan minimal dengan 3 cara.</p> <p>Instruksi: "Urutkan bangun di bawah ini menjadi bangun datar sederhana (segiempat atau segitiga) dengan lebih dari satu cara. Gambarkan garis dekomposisi/pada bangun tersebut."</p> <p><b>Pertemuan 3</b></p> <p>* <b>Karton/Papan Gambar Miniatur Kampung - Sora Paudon:</b> Siapkan kertas karton atau papan tulis kecil untuk setiap kelompok sebagai media perencanaan Miniatur Kampung. Sediakan gulud warna atau karton lipat berwarna untuk membuat bentuk-bentuk (rumah, pohon, jalan, dll.) yang berasal dari komposisi bangun datar.</p> <p>Mengunjungi: Kota/Kabupaten, 08 Januari 2026</p> <p>Kepala Sekolah: Gumi Kelas IV</p> <p>NIP: ..... NIP: .....</p>
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Figure 2. Output

### Structural Quality of Product Outputs

Product quality is validated based on the compliance of the resulting document structure with the national curriculum guidelines (Villegas-Ch et al., 2024). Unlike general chatbots, this generator produces documents in a structured table format that includes four integrative components in accordance with the Ministry of Education and Culture regulations. The first component is Identification, which presents an analysis of student readiness, material characteristics, and Graduate Profile dimensions. The second component is Learning Design, which automatically formulates learning objectives, contextual topics, and cross-disciplinary integration. The

third component is Learning Experience, which details the stages of activities (beginning, core, closing) with the principles of meaningful and enjoyable learning. The fourth component is Assessment, which provides comprehensive diagnostic, formative, and summative evaluation instruments. All these components are generated automatically in a single document generation cycle.

### Implementation Data and Ecological Validity

The ecological validity of this product is proven through user adoption data during the implementation phase, which ran from September 2025 to December 2025. The dissemination strategy was carried out by utilizing TikTok's social media penetration to

reach teachers organically. Based on performance records on the digital distribution platform via Lynk.id, there were 141 verified access transactions to this generator. This quantitative data is reinforced by qualitative usage indicators through direct communication channels via WhatsApp. The high level of independent adoption, including users' willingness to access the system through a paid scheme, provides strong empirical evidence that this product has practical value in solving teachers' administrative problems in the field, going beyond theoretical validation alone.

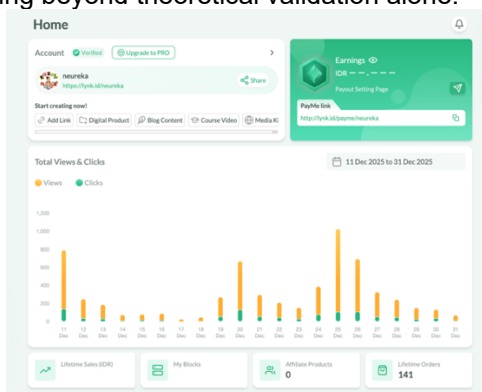


Figure 3. Lynk.id Data

Furthermore, the qualitative evidence obtained through direct user communication substantiates the product's integration into formal educational settings. As an illustrative example, educators specifically requested the adjustment of system outputs to include Student Worksheets (LKPD) in order to fulfill the administrative demands of school supervisors. This interaction confirms that the generated documents are not merely used as personal teaching aids, but are actively evaluated within the official bureaucratic framework of school inspections. The system's capacity to support teachers in meeting these rigorous supervisory standards underscores its high practical value and adaptive relevance in the real-world teaching ecosystem.

## DISCUSSION

Democratization of Educational Product Development Through a Multimodal Approach The findings of this study offer a new perspective in educational technology engineering, namely a paradigm shifts from manual code-based development to visual-multimodal-based development (Yang et al., 2025). The researchers' success in converting visual interface sketches from Procreate into functional applications using Generative AI proves that technical programming barriers can now be bridged by artificial intelligence. The theoretical implication of this finding is the democratization of software development,

where education practitioners who have pedagogical vision, but minimal programming skills now have the agency to independently develop digital tools. This image-to-code approach demonstrates significant efficiency in the prototyping phase, allowing development to focus more on the quality of pedagogical substance than on the complexity of code syntax (Gui et al., 2025).

Curriculum Accuracy Through Boundary-Based Prompting Strategies In practical terms, this research successfully overcomes the fundamental weaknesses of general Large Language Models (LLMs), which often produce unstructured output or experience content hallucinations. The application of a boundary-based prompting strategy using spreadsheet templates as structural anchors and the insertion of data from the Ministry of Primary and Secondary Education's Teacher's Guide as contextual boundaries proved effective in controlling AI creativity to comply with principles (Michel & Van Hentenryck, 2025). This confirms that the future of AI integration in schools lies not in the use of open chatbots, but in curated closed systems. The product's ability to automate complex curriculum components into a standard table format provides an appropriate solution to the dilemma of teachers' administrative burden, ensuring technological efficiency in line with compliance with national regulatory standards.

Ecological Validity and Market Acceptance Evidence Within the Design-Based Research (DBR) framework, the highest indicator of product success lies in ecological validity, which is the sustainability of its use in real-world situations outside the laboratory. Implementation data recording 141 verified lifetime orders on the digital distribution platform by the end of 2025 provides strong empirical evidence for this indicator. The high adoption rate, accompanied by consistent daily access traffic, indicates that the product has practical value relevant to current education market needs.

In addition, this product has been proven to operate within the scope of formal school administration, not merely as a personal tool. This is evidenced by user feedback urging the adjustment of the Student Worksheet feature in image form to comply with school supervisor inspection standards. This finding highlights the generator's ability to produce documents that meet academic supervision bureaucratic standards. The developers' responsiveness in accommodating field-based regulatory feature requests confirms the position of this research

as an adaptive, solution-oriented technological intervention to the real dynamics in schools.

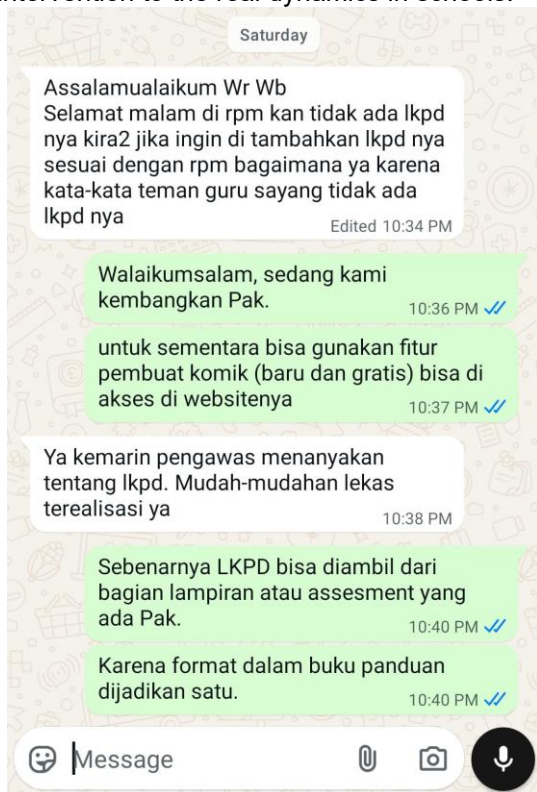


Figure 4. User's Feedback

Ultimately, the successful deployment, high user adoption, and positive ecological validation of this multimodal Gen-AI generator confirm its efficacy in bridging the gap between advanced artificial intelligence capabilities and the rigid administrative demands of the national curriculum. By providing a highly practical, scalable, and compliant technological solution, this study affirms that the integration of visual prototyping and constraint-based prompting successfully achieves its primary objective: significantly reducing teachers' administrative burdens while maintaining strict adherence to formal educational bureaucracy.

## CONCLUSION

This study concludes that technical barriers in educational software development can be effectively bridged through a multimodal design approach. The integration of visual interface design and Generative AI coding capabilities has proven to empower education practitioners to independently develop functional digital products without absolute dependence on conventional programming skills. Furthermore, the application of constraint-based prompting strategies using structured data templates and knowledge base injection from official guidelines from the Ministry of Primary and Secondary Education

successfully overcame the issue of AI hallucinations, resulting in precise planning documents that comply with National Curriculum standards.

In practical terms, this study provides strong empirical evidence regarding the ecological validity of the product in a real educational ecosystem. The adoption rate demonstrated by 141 verified access transactions, as well as confirmation of the use of system output documents in the formal monitoring process by school supervisors, proves that this product has high utility value. These findings indicate that technological solutions designed with school bureaucratic rigidity in mind have a much greater chance of acceptance than general AI tools.

Based on these findings, further research is recommended to not only focus on time efficiency in administrative preparation, but also to begin evaluating the impact of this product's use on the quality of learning interactions in the classroom. In addition, future feature development needs to be directed towards more adaptive personalization capabilities to support differentiated learning, to ensure that administrative automation continues to lead to improved quality of educational services for students.

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