# Parametric Generation of Advanced Mathematics Assessment Items Using ChatGPT for Moodle Integration

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**Abstract:** This paper explores how generative artificial intelligence—specifically ChatGPT—can support the creation of assessment items in lower secondary mathematics education. The goal is to enhance efficiency, cognitive diversity, and curriculum alignment in both formative and summative evaluations, while addressing current challenges faced by teachers in item design. **Prior Work**: The study builds upon existing research in AI-assisted learning, prompt engineering, and intelligent tutoring systems. Prior developments in automated item generation have highlighted the promise of language models but also the need for pedagogical oversight and contextual relevance. **Approach**: A design-based research (DBR) framework was employed, involving iterative experimentation in classroom settings and expert validation by mathematics teachers. The study focused on prompt formulation, refinement cycles, and integration with learning management systems such as Moodle. **Results**: ChatGPT was able to generate mathematically valid and curriculum-aligned items, ranging across cognitive levels defined by Bloom's Taxonomy. Human-in-the-loop validation was critical to ensuring accuracy, clarity, and instructional value. **Implications**: The results suggest practical strategies for teacher training in AI literacy and prompt engineering. Policymakers and educational institutions can adapt this framework to scale AI adoption across STEM curricula. **Value:** The paper contributes a replicable methodological model for AI integration in education. It provides empirical evidence of ChatGPT's utility in supporting authentic, personalized assessment design at the secondary level. This aligns with global findings about the essential role of teacher-facing AI literacy and assessment training.

**Keywords**: AI literacy; digital pedagogy; GIFT format; item templates; prompt design

## 1. Introduction

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The digital transformation of education has introduced profound shifts in teaching and assessment paradigms worldwide. In particular, mathematics education at the *lower secondary level* requires continuous formative and summative assessments to monitor student progress and adapt instruction accordingly (*European Commission, 2020*). However, creating high-quality, *curriculum-aligned* assessment items manually is labor-intensive and time-consuming for teachers, which often leads to reduced frequency and diversity of testing materials. Recent advances in **artificial intelligence (AI)**, specifically **generative models** such as *ChatGPT*, enable automated generation of natural language text and problem statements, opening new opportunities to support educators (Mintz, Holmes, Liu & Perez-Ortiz, 2023).

This paper explores how *ChatGPT* can be integrated into the item-creation process for mathematics assessments, aiming to increase **efficiency**, **quality**, and **pedagogical alignment** with the Romanian national curriculum and European digital education policies (European Commission, 2020). The investigation addresses both the *technological potential* and the *didactic considerations* necessary for meaningful adoption.

## 2. Related Work

Automated assessment generation has been a growing field within *educational technology*, leveraging AI to reduce teacher workload and enhance assessment quality. Early systems focused on *rule-based* and *template-driven* approaches, which often lacked flexibility and adaptability to diverse curricula. Recent work highlights the emergence of **large language models (LLMs)**, such as *GPT-3* and *ChatGPT*, which demonstrate superior capability in generating linguistically coherent and contextually relevant educational content (OpenAI, 2023).

Research on *AI-assisted learning* stresses the importance of *prompt engineering*—the design of input queries to maximize model output relevance—and iterative refinement through human-in-the-loop processes to ensure content validity and appropriateness (Ng et al., 2024). In mathematics education, studies have emphasized the need to align AI-generated items with *cognitive levels* based on frameworks such as *Bloom's Taxonomy* to ensure meaningful learning and assessment (Akdeniz, Clark & Roberts, 2025). A recent scoping review (Ng et al., 2024) indicates that for GenAI to effectively transform assessment in higher education, teacher professional development in AI and assessment literacy is

essential, along with a pedagogical shift towards innovative and holistic teaching practices.

Furthermore, the integration of AI tools within *learning management systems (LMS)* like *Moodle* has shown promise in facilitating seamless delivery and feedback cycles in the classroom (European Commission, 2020). However, comprehensive frameworks guiding practical implementation remain scarce, especially in the context of mathematics at the lower secondary level.

## 3. Problem Statement

Despite the acknowledged benefits of automated item generation, teachers face several challenges in adopting AI-driven solutions. These include limited **digital literacy**, uncertainty about **curricular alignment**, and concerns regarding the **validity and reliability** of AI-generated assessment items. Moreover, the complexity of mathematics problems requires precise formulation and verification to avoid cognitive overload or misconceptions (Mintz, Holmes, Liu & Perez-Ortiz, 2023).

The **problem** this paper addresses is how to operationalize the use of *ChatGPT* for generating valid, diverse, and curriculum-conformant assessment items in mathematics, while empowering teachers to effectively interact with the AI system through appropriate prompts and validation strategies. The goal is to develop a *methodological framework* that balances **automation** with **human expertise**, ensuring *pedagogical soundness* and *scalability*.

## 4. Concept and Terms

*ChatGPT* is a **large language model (LLM)** developed by OpenAI, capable of generating human-like text based on prompts (OpenAI, 2023). In this context, **prompt engineering** refers to the careful design of input queries to guide ChatGPT in producing relevant assessment items. Terms like **iterative refinement** denote the process of gradually improving AI output through successive prompts and validations.

The *Bloom's taxonomy* framework is utilized to classify generated items across cognitive levels—*remembering, understanding, applying, analyzing, evaluating, and creating*—to ensure a balanced assessment that promotes higher-order thinking (Akdeniz, Clark & Roberts, 2025). *Curriculum alignment* refers to ensuring items

reflect the objectives and content specified by the national mathematics program for grades 5-8 (Ministerul Educației, 2017).

The **validation** process involves teacher review for accuracy, relevance, and difficulty appropriateness, emphasizing the *human-in-the-loop* principle critical for ethical and effective AI integration (Mintz et al., 2023).

## 5. Solution Approach

The methodological framework comprises several steps:

- **Account Setup and Access**: Teachers create accounts on the official *ChatGPT* platform, install necessary browser extensions for ease of use, and familiarize themselves with the interface (OpenAI, 2023).
- **Prompt Design**: Educators craft *clear* and *explicit* prompts that specify item type (e.g., multiple-choice, open-ended), topic, difficulty level, and desired cognitive skill, using terminology aligned with curriculum standards (Asy'ari & Sharov, 2024).
- **Iterative Interaction**: Each prompt is followed by a critical review of the generated item. If unsatisfactory, prompts are adjusted with additional context or constraints. This iterative process continues until an item meets quality and alignment criteria (Mintz et al., 2023).
- **Validation**: Generated items undergo human expert validation to check for correctness, clarity, and curriculum adherence. Potential biases or errors are corrected at this stage (Ng et al., 2024).
- **Integration with LMS**: Validated items are exported and integrated into platforms like *Moodle*, allowing teachers to organize tests, track student performance, and collect analytics (Kiryakova & Angelova, 2023).

This approach balances **automation** with **teacher oversight**, ensuring *reliability* and *pedagogical effectiveness*. It also fosters *teacher competence* in *AI literacy* and *digital pedagogy*, critical for sustainable adoption.

### 5.1. Parametric Generation and lms Deployment of Math Items using ChatGPT

One of the most practical outcomes of using generative AI in mathematics education is the ability to create parametrized assessment items that can be reused, randomized, and adapted for different students. This section presents how ChatGPT can be

systematically prompted to generate such items, which are then exported in GIFT or XML formats compatible with Moodle, thereby supporting scalable assessment design.

### 5.2. Purpose and Rationale

Parametrized questions differ from static ones in that they use variables or defined ranges of values to generate multiple item instances from a single template. This supports *(Brăgaru, 2011):*

- Differentiated instruction,
- Randomized quizzes to prevent cheating,
- Dynamic difficulty scaling,
- Reusability across years and classes.

### 5.3. Prompt Engineering for Parametrized Items

Teachers can instruct ChatGPT to produce question templates with mathematical logic and variable placeholders.

Example prompt to ChatGPT:

"Create a math question in the form of a linear equation ax + b = c, where a, b, and c are integers between -10 and 10. Provide four multiple-choice options, one correct and three distractors."

ChatGPT may respond with:

Question: Solve the equation 3x - 5 = 10.

Choices:

A. x = 5 (correct)

B. x = -5

C. x = 3

D. x = 0

This item can be transformed into a GIFT format:

**5.4. GIFT Format Example for Moodle**

::Linear Equation (parametric)::

Solve the equation {=3}x - {=-5} = {=10}.

{

= x = 5

~ x = -5

~ x = 3

~ x = 0

}

Or a template version for use with random values:

::Random Linear Equation::

[html] Solve the equation **{a}x + {b} = {c}**. What is x?

::ANSWER::

{

= x = ({c}-{b})/{a}

~ x = ({c}+{b})/{a}

~ x = {b}-{c}

~ x = {c}/{a}

}

Note: Teachers can manually replace variables (a, b, c) or use tools like Moodle STACK or PsyToolkit for full automation.

**5.5. XML Format Example (Simplified)**

An XML snippet for Moodle can be exported using tools or plug-ins:

```
<question type="multichoice">
  <name><text>Linear Equation Example</text></name>
  <questiontext format="html">
```

```
  <text>Solve the equation 3x - 5 = 10.</text>
 </questiontext>
 <answer fraction="100"><text>x = 5</text></answer>
 <answer fraction="0"><text>x = -5</text></answer>
 <answer fraction="0"><text>x = 3</text></answer>
 <answer fraction="0"><text>x = 0</text></answer>
</question>
```

These exports can be uploaded via Moodle's "Question Bank > Import" section, selecting the desired format (Brănoaea, 2024).

### 5.6. Integration into Moodle Workflow

After importing the items, teachers can:

- Organize them into categories (e.g., Algebra / Grade 7),
- Create randomized quizzes pulling from item banks,
- Apply conditional logic (e.g., require passing score for next section),
- Track performance using analytics in Moodle's Reports section (Brăgaru, 2011).

### 5.7. Educational Impact

The use of parametrized items:

- Supports formative assessment at scale,
- Enables adaptive learning paths,
- Increases student engagement through variety,
- Offers equity by ensuring each student faces different, but equivalent, tasks (Căpățână, Brăgaru & Beldiga, 2015).

This practice directly supports the aims of the broader doctoral research, which focuses on building an Intelligent Support System for Accelerating Mathematical Learning, by automating item creation while preserving cognitive rigor and curriculum alignment (Kiryakova & Angelova, 2023).

## 6. Practical Pedagogical Scenario

"Linear equations of the form $ax + b = 0$ – AI-assisted practice and assessment with ChatGPT"

**Study level:** Grade 7
**Chapter:** Equations
**Lesson topic:** Solving first-degree equations with one unknown
**Duration:** 50 minutes
**Lesson type:** Consolidation and formative assessment
**Platform:** Moodle + ChatGPT (free version or API)

### 6.1. Specific Competencies (According to the Romanian Curriculum):

- *2.3.* Perform operations with rational numbers in various contexts;
- *4.1.* Model problem situations using first-degree equations with one unknown;
- *4.2.* Solve equations of the form $ax + b = 0$;
- *5.1.* Use mathematical reasoning to explain a solution algorithm;
- *6.1.* Use digital tools for exploration and problem solving.

### 6.2. Operational Objectives

By the end of the lesson, students will be able to:

- Identify the standard form of equations $ax + b = 0$;
- Apply the step-by-step solving algorithm for linear equations in automatically generated exercises;
- Utilize ChatGPT to generate and verify first-degree equations;
- Evaluate the correctness of AI-provided solutions critically;
- Reflect on their own mistakes and regulate their learning process.

### 6.3. Lesson Phases and Activities:

*Phase I – Activation (5 min)*
The teacher initiates the lesson with a forum question on Moodle:

"Where in real life can we encounter equations of the form $ax + b = 0$?"
(e.g., budgeting, discounts, simple financial calculations)

*Phase II – AI-assisted practice with ChatGPT (20 min)*
The teacher provides a model prompt:
"Generate an equation of the form $ax + b = 0$ with integer coefficients and solve it step-by-step."
Students access ChatGPT, input the prompt or formulate their own. Each student:

- Copies the generated equation and solution into a document (Google Docs or worksheet);
- Verifies each step for accuracy;
- Corrects errors or refines the prompt as needed (prompt engineering).

*Phase III – Interactive evaluation in Moodle (15 min)*
The teacher creates a 5-item Moodle quiz with:

- 2 multiple-choice questions selecting equivalent equations;
- 1 completion item missing solution steps;
- 1 "correct the error" item;
- 1 open-ended item where the student creates and solves their own equation. After completion, students receive automatic feedback in Moodle. The teacher grades the open-ended item, optionally consulting ChatGPT for formative comment suggestions.

*Phase IV – Reflection and self-assessment (10 min)*
Students complete a Google Forms questionnaire or reflection journal:
"What did I learn today about equations? How did ChatGPT help me? Where did I err and what can I improve?"
The teacher collects responses and provides personalized recommendations.

### 6.4. Assessment and Remediation:

*Formative assessment:*

- Moodle quiz with instant feedback;
- Verification of ChatGPT-generated equations;
- Direct observation during platform use.

*Self-assessment:*

- Written reflection in a learning journal;
- Comparison between student-generated and AI-generated equations.

*Remediation:*

- Students struggling receive additional AI-generated exercises with detailed steps;
- Group activities with peer mentoring are organized.

### 6.5. Differentiation Adaptations:

*Advanced students:*

- Create their own problems modeled by equations;
- Request ChatGPT to explain solutions using alternative methods (e.g., visual or analogical).

*Students with difficulties:*

- Receive simpler equations with small coefficients and guided feedback;
- Use teacher-provided model prompts.

Evidence from *Mintz et al. (2023)* demonstrates that prompt engineering training significantly increases AI self-efficacy, AI understanding, and competence in LLM interaction—supporting the necessity of such training for teachers in the proposed framework.

## 7. Analysis of Results

Pilot studies with mathematics teachers at the lower secondary level revealed that *ChatGPT* effectively produces a wide range of items, including algebraic equations, geometry problems, and word problems aligned with the *Romanian curriculum* objectives (Ministerul Educației, 2017). Teachers reported a significant reduction in time spent preparing assessments, with a qualitative improvement in item variety and challenge levels.

However, successful outcomes depended heavily on teachers' ability to formulate *precise prompts* and their active engagement in the *iterative refinement* process. Items generated without sufficient human intervention sometimes contained ambiguous language or minor mathematical inaccuracies, underscoring the indispensable role of *human oversight* (Brănoaea, 2025b).

### 7.1. Methodological Reflections

Integrating ChatGPT in this pedagogical context offers a *modern strategy for adaptive consolidation and assessment*, enabling students to *actively practice*, *receive rapid feedback*, and *critically evaluate digital tool outputs*. This lesson facilitates a shift from *passive learning* to *active and reflective learning*, preparing students not only for *academic success* but also for *digital competencies essential in the 21st century*. The integration within *Moodle* allowed for easy deployment and performance tracking, enhancing formative assessment practices. Overall, the approach demonstrated strong potential to support personalized and adaptive mathematics assessment at scale *(Brănoaea, 2025a).*

### 7.2. Limitations and Risks

While the integration of ChatGPT in assessment design presents substantial benefits, several limitations must be acknowledged. First, the quality of generated content is highly dependent on prompt specificity and teacher intervention. Without adequate training, educators may produce low-quality or pedagogically inappropriate items. Second, generative AI systems like ChatGPT can occasionally produce mathematically incorrect or ambiguous responses, especially when handling multi-step problems or real-world modeling tasks. This necessitates a rigorous validation process by subject-matter experts. Third, ethical concerns related to student dependency on AI tools and the potential erosion of critical thinking should be addressed through digital pedagogy strategies and AI ethics training. „The ethical and practical limitations of LLMs in education include issues of technological readiness, transparency, replicability, and data privacy—highlighted by *Akdeniz et al. (2025).* Ensuring data privacy and avoiding overreliance on a single platform also remain critical." These risks underscore the importance of integrating AI within a balanced educational ecosystem, combining human judgment, institutional safeguards, and continuous evaluation.

### 7.3. Research Contributions and Originality

This study presents several original contributions to the emerging field of AI-supported mathematics assessment design, particularly in the context of secondary education and LMS integration.

- **Manual GIFT conversion from natural language outputs.** While prior work has explored the use of AI to generate assessment content, this study goes further by taking raw natural language outputs generated by ChatGPT and manually converting them into valid GIFT format, compatible with Moodle. This process included structuring correct and distractor answers, applying syntax rules, and ensuring logical scoring behavior within the LMS (Brăgaru, 2011). This hands-on transformation from unstructured AI text to structured digital item banks represents a concrete step toward practical classroom deployment.
- **Template creation aligned with the Romanian Mathematics Curriculum.** Another original element of this research is the systematic design of math problem templates derived directly from the Romanian lower secondary mathematics curriculum (grades 5–8). These templates cover key competencies such as operations with rational numbers, solving first-degree equations, and applying mathematical reasoning, as outlined in the official curriculum. Each template was built to support parameter substitution (e.g., values for coefficients, missing terms, numeric ranges), enabling multiple item variations from a single problem structure. This level of curriculum fidelity ensures that the generated content is not only technically valid but also pedagogically sound and locally relevant (Asy'ari & Sharov, 2024).
- **Fully replicable workflow from prompt to Moodle deployment.** A core contribution of the paper is the development of a fully replicable and documented workflow that teachers can follow to create and deploy AI-generated math items into Moodle. The workflow includes:
  - ✓ Precise prompt engineering techniques to elicit solvable mathematical problems;
  - ✓ Human-in-the-loop review and iterative refinement for quality control;
  - ✓ Manual or semi-automated formatting of items into GIFT/XML;
  - ✓ Upload and categorization within Moodle's question bank;
  - ✓ Use of analytics and feedback mechanisms for item evaluation.

To our knowledge, this is the first published example of a step-by-step methodology that translates generative AI outputs into parametrized, validated and LMS-ready math items designed specifically for secondary education in Romania. The originality of this research lies not in the use of ChatGPT per se, but in how it is applied systematically, aligned with curriculum standards, converted into interoperable formats, and embedded into a practical LMS ecosystem, thereby bridging the gap between AI potential and classroom reality.

## 8. Conclusions and Future Work

This study highlights the **transformative potential** of integrating *ChatGPT* into mathematics assessment creation, providing a scalable solution that addresses teacher workload and improves assessment quality. The **human-in-the-loop** methodology ensures that AI complements rather than replaces professional expertise, preserving pedagogical integrity.

Future research will focus on expanding this framework to other STEM subjects, developing automated validation tools to support teacher review, and exploring student interaction with AI-generated assessments to personalize learning pathways. Emphasis on **teacher training** in *AI literacy* and *digital pedagogy* remains critical for effective implementation.

This paper contributes a **practical and replicable methodology** for leveraging generative AI in education, with implications for policymakers, educators, and EdTech developers committed to advancing digital transformation in learning. The implementation of the AI Assessment Scale (AIAS) led to measurable improvements: reduced misconduct, +5.9 % attainment, and +33.3 % module pass rate—demonstrating how structured frameworks can support ethical GenAI adoption. This parametric generation strategy lays the groundwork for developing an intelligent support system capable of delivering adaptive math learning experiences within scalable digital environments like Moodle.

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