ENHANCING STUDENT WRITING SKILLS THROUGH GAMIFICATION: EVALUATING THE EFFECTIVENESS OF TEXTOPIA, AN AI-DRIVEN PLATFORM FOR PERSONALIZED WRITING PROMPTS AND FEEDBACK

Yiting Min[1], Moddwyn Andaya[2]

[1]Fairmont Preparatory Academy, 2200 W Sequoia Ave, Anaheim, CA 92801
[2]Computer Science Department, California State Polytechnic University, Pomona, CA 91768

ABSTRACT

Textopia is an inventive platform addressing the decline in writing skills among students by combining writing with gaming to make learning enjoyable [1]. It leverages OpenAI's API for generating personalized writing prompts and provides instant feedback on writings to enhance students' skills [2]. The system includes components like PromptManager for prompt generation and FeedbackManager for offering constructive feedback and grammatical corrections. Moreover, Textopia integrates a gaming element where progress in writing unlocks new gaming features, linking educational achievements with gaming rewards. This approach aims to motivate students, making writing a rewarding activity. An experiment within the research illustrates significant improvement in writing quality through iterative feedback and writing exercises, suggesting Textopia's effectiveness in fostering writing skills [3]. By transforming writing from a chore into an engaging experience, Textopia addresses educational challenges, rekindles students' passion for writing, and opens avenues for academic and personal growth. This innovative blend of writing and gaming in education offers a promising solution to enhance student engagement and writing proficiency.

KEYWORDS

Inventive Platform, OpenAI, Education, AI Writing

1. INTRODUCTION

Nowadays, the avoidance and decline in writing skills among students has emerged as a critical educational challenge, especially from lower-grade students. “While around 72% children enjoy writing when they start school, this drops to only 26.4% by the age of 16.” These situations were caused by the dullness and anxiety students experienced in school, where teachers often have high expectations of literary skills and demand a substantial amount of work from students. The pressure, coupled with a lack of engaging and supportive instruction, eventually obliterates students’ passion for writing. This issue could be found in most schools, from kindergarten to high school. As Bernoff notes, “Poor writing creates a drag on everything you do.” The inability to express thoughts clearly and effectively in writing can limit one’s understandings and

David C. Wyld et al. (Eds): AdNLP, CDKP, NCO, SAI, MLT, Signal, SOFT, ICAITA, CMC - 2024
pp. 225-234, 2024. CS & IT - CSCP 2024 DOI: 10.5121/csit.2024.141020

perspectives not only in literary pieces but also the way they perceive the world; devastating to self-esteem, diminished academic and professional opportunities, as well as communications in ways both interpersonal and intrapersonal. Let us aware that this issue is not confined to a small group; every single child has the potential to be affected by the matter. It has become a severe educational challenge in our modern society, waiting for an efficient solution to twist the environment.

Recent research highlights different ways AI and gamification can enhance writing education. A 2019 study from Mazhar Bal Akdeniz University discussed how digital games could boost students' motivation for writing [4]. The study suggests that adding an AI tool like Textopia, which provides AI-generated feedback, could further improve learning outcomes by helping students recognize their strengths and weaknesses [5]. In 2023, Thomas Arnett noted that ChatGPT acts as a versatile writing assistant, offering real-time guidance. Textopia builds on this by integrating ChatGPT's features with gaming elements to make writing more interactive and engaging for students. This approach not only draws students in but also makes the writing process more enjoyable and rewarding. Nermin Punar Özçelik also emphasized ChatGPT's role in enhancing writing skills through instant support [6]. However, Textopia enhances this by adding gamification, encouraging active participation and transforming writing education into a dynamic experience, as opposed to ChatGPT's more simple, direct interaction.

While you're engaged in writing, you'll also improve your ability to write. This method utilizes this aspect by blending the process of writing with the engaging elements of gaming. By offering a space where writing tasks are intertwined with interactive gaming, Textopia aims to transform writing from a perceived chore into an enjoyable and rewarding experience. As students' progress in their writing, they unlock new features in a building game, directly linking their effort and creativity in writing to tangible rewards within the game [7]. This linkage not only motivates students but also reduces the anxiety and pressure associated with writing tasks. Moreover, Textopia provides immediate, constructive feedback on students' writing, including grammatical corrections, positive reinforcement of their strengths, and suggestions for improvements. By fixing their mistakes, users could also earn rewards for improving their essays, which not only makes them acknowledge their disadvantages but also encourages them to strengthen their writing skills. Ultimately, by making writing an engaging, interactive, and rewarding activity, Textopia aims to counteract the decline in writing skills among students, enhancing their ability to express thoughts clearly and effectively, and reigniting their passion for writing.

Firstly, the PromptManager component's capability to generate a wide range of creative and engaging prompts is affirmed, leveraging the OpenAI API to cater to diverse interests and writing levels [8]. This ensures that users receive relevant and varied content to explore and write about, addressing concerns about the AI's ability to produce engaging and diverse prompts. Secondly, the reliability and accuracy of AI-generated feedback on creative writing are discussed [9]. Despite the subjective nature of creative writing, Textopia's implementation of ChatGPT is noted for its ability to analyze various genres and prompts at any writing level, providing dependable feedback. Lastly, the integration of gaming elements into the writing improvement process is defended. The design of these game mechanics is such that they reward writing progress, with game features being unlocked as direct results of the user's writing achievements. This approach aims to motivate users to improve their writing skills, ensuring that the gaming aspect enhances rather than distracts from the educational goal.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Genre/Prompt Writing

Sample Skeptical Question: “Can the AI truly generate prompts that are engaging and diverse enough to cater to all users' interests and writing levels?”

Sample Response: “Absolutely, the PromptManager component leverages the capabilities of the OpenAI API to create a broad spectrum of creative and engaging prompts. The PromptManager component utilizes the OpenAI API to generate a wide array of creative and engaging prompts tailored to users' specified genres or interests that they choose to customize and write about, ensuring relevance and variety.The user can freely write any prompt including instructions to help the AI create the most detailed prompts to your needs.”

2.2. ChatGPT AI Feedback

Sample Skeptical Question:”How reliable and accurate can the AI-generated feedback be, considering the complexity and subjective nature of creative writing?”

Sample Response: “Textopia's integration of ChatGPT offers a high level of reliability and accuracy in providing feedback on creative writing. The system is designed to understand and analyze a wide array of writing genres and styles, tailored to the user's specific needs and skill levels. ChatGPT can interpret nuances in text and offer constructive criticism that mirrors human insight. This capability ensures that feedback is not only precise but also deeply relevant to the user’s creative process, thereby enhancing the quality and depth of the writing experience for all users, regardless of their proficiency.”

2.3. Building

Sample Skeptical Question: “With the integration of gaming elements, isn't there a risk that users might become more focused on gaming than improving their writing skills?”

Sample Response: “While integrating gaming elements poses a risk of distraction, the design within our platform strategically aligns these elements to support writing development. Game mechanics are crafted to reinforce and reward writing progress, not just gameplay. For instance, unlocking new game features and rewards is directly contingent upon achieving specific writing milestones. This ensures that the gaming aspect serves as a strong motivator for users to enhance their writing skills. By doing so, it promotes a balanced engagement where the excitement of gaming fuels the discipline of writing, ensuring that improvements in writing remain the central focus.”

3. SOLUTION

Textopia offers a comprehensive environment for young writers, seeking not only to improve their writing skills but also to refine their work to a better state. Textopia combines games and writing together to pique interest and motivate students to write. Textopia allows you to write essays, stories, and other papers with the assistance of providing feedbacks for your writings, ranges from simple feedbacks of incorrect grammar and spelling error; to positive feedback of the strength and advantage, encouraging writers to maintain and further develop these elements and suggestions on the aspects that the writing is lacking that require improvement or further development [15]. Aside from the writings, Textopia also includes a building game in which the players could build their town according to their preferences. By integrating the game, it offers a unique incentive for engagement. As sets progress in their writing endeavors, they unlock new features for their game, establishing a link between writing excellence and in-game rewards. Upon accessing the game's main page, users are presented with the option to dive straight into gameplay or navigate to the prompt screen to select a topic for their writing. Once a prompt is chosen, the user is seamlessly directed to the essay writer. By opting to receive feedback, the game utilizes ChatGPT to analyze the user's writing and provides generated feedback. This tailored feedback encompasses everything from grammatical corrections to positive reinforcement on the writing's strengths, as well as constructive suggestions for areas requiring improvement. From the essay writer and the feedback, the app also allows users to direct straight to the game, if they chose to relax after writing for a while.

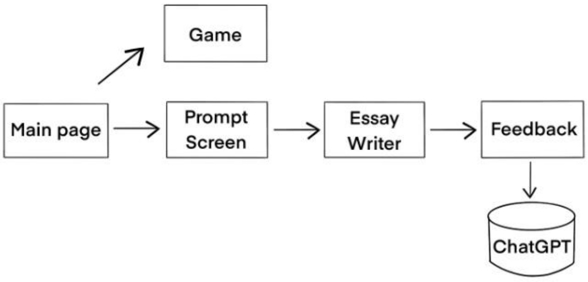
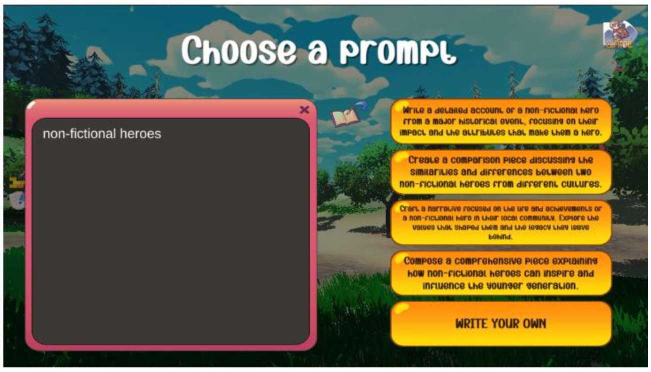


Figure 1. Overview of the system

One of the most important components in the project is the PromptManager. This manager handles the generations, using the OpenAI API (or most commonly known as ChatGPT), of AI generated prompt ideas for you to write about related to the genre you have specified. The prompt manager also allows you to write your own customized prompt.



non-fictional heroes

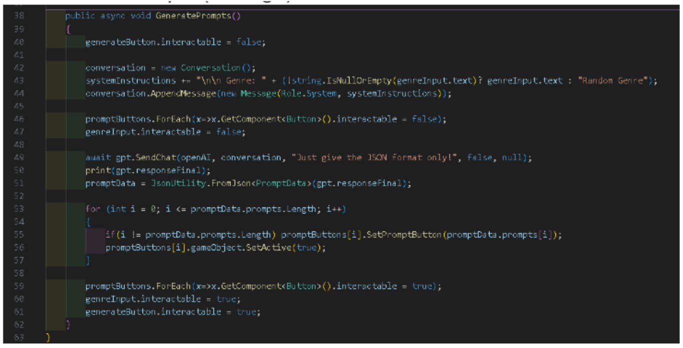
Write a detailed account of a non-fictional hero from a major historical event, focusing on their impact and the attributes that make them a hero.

Create a comparison piece discussing the similarities and differences between two non-fictional heroes from different cultures.

Craft a narrative focused on the life and achievements of a non-fictional hero in their local community. Explore the values that shaped them and the legacy they leave behind.

Compose a comprehensive piece explaining how non-fictional heroes can inspire and influence the younger generation.

Figure 2. Screenshot of the PrompyManager

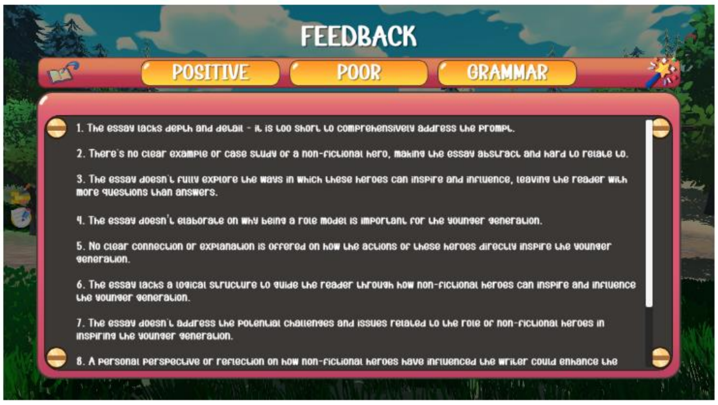


```
38      public async void GeneratePrompts()
39      {
40          generateButton.interactable = false;
41
42          conversation = new Conversation();
43          systemInstructions += "\n\n Genre: " + (!string.IsNullOrEmpty(genreInput.text)? genreInput.text : "Random Genre");
44          conversation.AppendMessage(new Message(Role.System, systemInstructions));
45
46          promptButtons.ForEach(x=>x.GetComponent<Button>().interactable = false);
47          genreInput.interactable = false;
48
49          await gpt.SendChat(openAI, conversation, "Just give the JSON format only!", false, null);
50          print(gpt.responseFinal);
51          promptData = JsonUtility.FromJson<PromptData>(gpt.responseFinal);
52
53          for (int i = 0; i <= promptData.prompts.Length; i++)
54          {
55              if(i != promptData.prompts.Length) promptButtons[i].SetPromptButton(promptData.prompts[i]);
56              promptButtons[i].gameObject.SetActive(true);
57          }
58
59          promptButtons.ForEach(x=>x.GetComponent<Button>().interactable = true);
60          genreInput.interactable = true;
61          generateButton.interactable = true;
62      }
63  }
```

Figure 3. Screenshot of code 1

GeneratePrompts() function is called when a UI button has been pressed (a book and quill button). This functions creates a new conversation with the AI and give it the instructions to generate prompts in JSON format. On the left side of the ‘Choose a prompt’ screen ,you can type in any genre you would like or some kind of topic to generate 4 prompts out of it. Line 43 of the code takes that genre input as part of its instruction or if the user input is empty, the AI will generate 4 prompts of random genre. Line 49-51 passes in the instructions to the AI and start generating it then once it finishes, pass the JSON formatted string into a class that our code can access easily. The rest of the function spawns 4 prompt button UI on the screen with the generated prompts from the AI that the user can now choose and write about.

The most important component of the project is FeedbackManager. This manager takes in the written essay that the user has typed in and processes it into 3 different feedback categories. The positive feedback tells the user things they did well on their writing, poor tells the user things they can work on, and grammar tells the user spelling and grammar errors the user can fix.



1. The essay lacks depth and detail - it is too short to comprehensively address the prompt.

2. There's no clear example or case study of a non-fictional hero, making the essay abstract and hard to relate to.

3. The essay doesn't fully explore the ways in which these heroes can inspire and influence, leaving the reader with more questions than answers.

4. The essay doesn't elaborate on why being a role model is important for the younger generation.

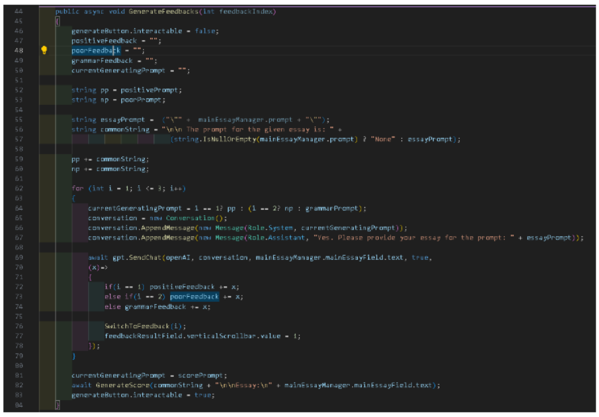
5. No clear connection or explanation is offered on how the actions of these heroes directly inspire the younger generation.

6. The essay lacks a logical structure to guide the reader through how non-fictional heroes can inspire and influence the younger generation.

7. The essay doesn't address the potential challenges and issues related to the role of non-fictional heroes in inspiring the younger generation.

8. A personal perspective or reflection on how non-fictional heroes have influenced the writer could enhance the

Figure 4. Screenshot of the feedback



```
44  public async void GenerateFeedbacks(int feedbackIndex)
45  {
46      generateButton.interactable = false;
47      positiveFeedback = "";
48      poorFeedback = "";
49      grammarFeedback = "";
50      currentGeneratingPrompt = "";
51
52      string pp = positivePrompt;
53      string np = poorPrompt;
54
55      string essayPrompt =  ("\"" +  mainEssayManager.prompt + "\"");
56      string commonString = "\n\n The prompt for the given essay is: " +
57                              (string.IsNullOrEmpty(mainEssayManager.prompt) ? "None" : essayPrompt);
58
59      pp += commonString;
60      np += commonString;
61
62      for (int i = 1; i <= 3; i++)
63      {
64          currentGeneratingPrompt = i == 1? pp : (i == 2? np : grammarPrompt);
65          conversation = new Conversation();
66          conversation.AppendMessage(new Message(Role.System, currentGeneratingPrompt));
67          conversation.AppendMessage(new Message(Role.Assistant, "Yes. Please provide your essay for the prompt: " + essayPrompt));
68
69          await gpt.SendChat(openAI, conversation, mainEssayManager.mainEssayField.text, true,
70          (x)=>
71          {
72              if(i == 1) positiveFeedback += x;
73              else if(i == 2) poorFeedback += x;
74              else grammarFeedback += x;
75
76              SwitchToFeedback(i);
77              feedbackResultField.verticalScrollbar.value = 1;
78          });
79      }
80
81      currentGeneratingPrompt = scorePrompt;
82      await GenerateScore(commonString + "\n\nEssay:\n" + mainEssayManager.mainEssayField.text);
83      generateButton.interactable = true;
84  }
```

Figure 5. Screenshot of code 2

The Generate Feedbacks (int feedbackIndex) function generates one of the 3 feedback categories based on the feedbackIndex. FeedbackIndex 1 is the positive, 2 is the poor, 3 is the grammar feedback. From line 47 to 67 formats a string to get the proper instructions that the AI needs to follow aka the positive, negative or the grammar instructions. These instructions tell the AI what kind of feedback it should give and the format it should write it. Line 69 to 78 starts the feedback generation of the AI and also allows the user to be able to see the live generation of this feedback (rather than loading and waiting till generated). On line 76, this makes sure that as we are generating one of the prompt categories, the screen shows which feedback category panel we are viewing. And finally on line 82, based on the overall quality of the essay, the AI will provide a score out of 100. This will be later used for many use cases like rewards or coins received for the game aspect of the project.

One of the ways we make the project interesting is to add a game to this essay analysis part of the project. This adds an interesting aspect to the project of fun and creativity. The players can build structures, buildings, and props on a 3D world [10]. Placeable objects are obtained through a shop using coins earned from writing quality essays.

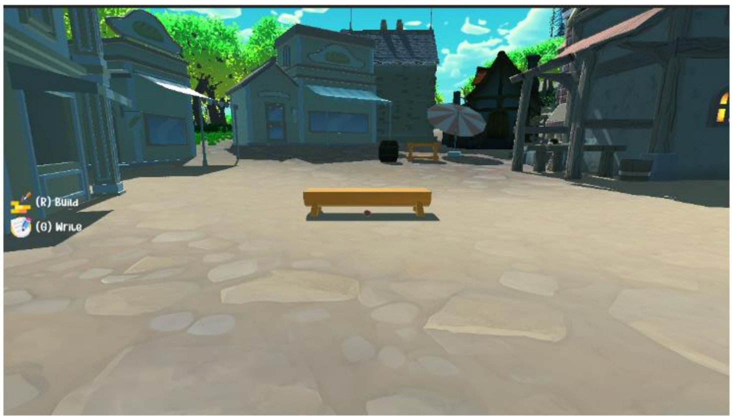
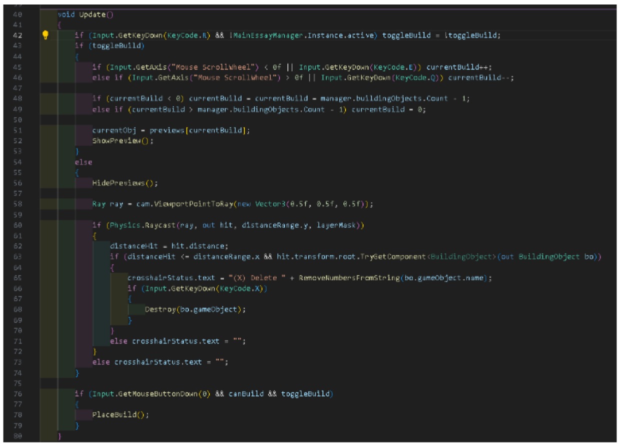


Figure 6. Screenshot of the game



```
40  void Update()
41  {
42      if (Input.GetKeyDown(KeyCode.R) && !MainEssayManager.Instance.active) toggleBuild = !toggleBuild;
43      if (toggleBuild)
44      {
45          if (Input.GetAxis("Mouse ScrollWheel") < 0f || Input.GetKeyDown(KeyCode.E)) currentBuild++;
46          else if (Input.GetAxis("Mouse ScrollWheel") > 0f || Input.GetKeyDown(KeyCode.Q)) currentBuild--;
47
48          if (currentBuild < 0) currentBuild = currentBuild = manager.buildingObjects.Count - 1;
49          else if (currentBuild > manager.buildingObjects.Count - 1) currentBuild = 0;
50
51          currentObj = previews[currentBuild];
52          ShowPreview();
53      }
54      else
55      {
56          HidePreviews();
57
58          Ray ray = cam.ViewportPointToRay(new Vector3(0.5f, 0.5f, 0.5f));
59
60          if (Physics.Raycast(ray, out hit, distanceRange.y, layerMask))
61          {
62              distanceHit = hit.distance;
63              if (distanceHit <= distanceRange.x && hit.transform.root.TryGetComponent<BuildingObject>(out BuildingObject bo))
64              {
65                  crosshairStatus.text = "(X) Delete " + RemoveNumbersFromString(bo.gameObject.name);
66                  if (Input.GetKeyDown(KeyCode.X))
67                  {
68                      Destroy(bo.gameObject);
69                  }
70              }
71              else crosshairStatus.text = "";
72          }
73          else crosshairStatus.text = "";
74      }
75
76      if (Input.GetMouseButtonDown(0) && canBuild && toggleBuild)
77      {
78          PlaceBuild();
79      }
80  }
```

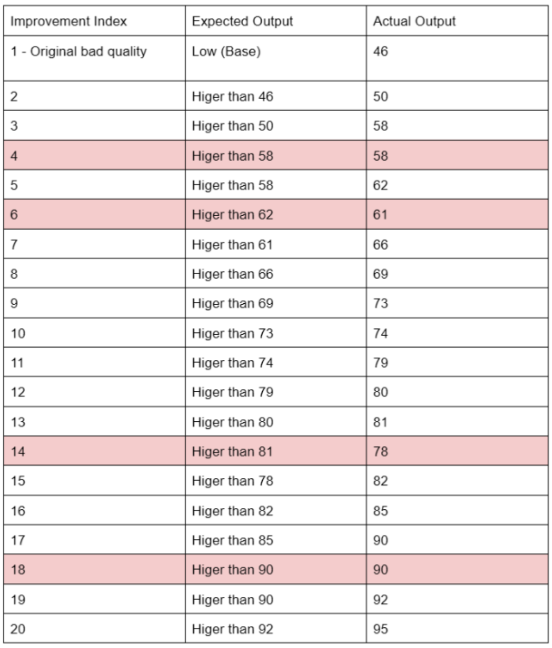
Figure 7. Screenshot of code 3

In the ObjectPlacer script, during Update(), we are allowing the user to build by just a keybind. Pressing R on your keyboard toggles building. When building is toggled, there are multiple things that you can now do. Seen from line 43 to 49, we are able to scroll through a catalog of building objects that we want to place down. And from line 51-52, we are showing what we call 'previews' on the world. These previews show the object you want to place down on the world right where your crosshair is aiming at. These previews show the positions and rotations to see how you want your build to be placed, and to get a feel of the scale it has. Line 76 to 79 simply allows you to place down the preview onto the world as you like it. Additionally, from line 56 to 74, where toggle build is off, you have the option to press keybind X, while looking at the built object using Raycast, and be able to delete it from the world.

4. EXPERIMENT

Now we have the overall function of the app and how it could improve our writing by giving feedback according to the essays it receives. But we can not determine whether or not the analysis and feedback are valid upon the writing. So we want to test out and determine how good the feedback is. In order to decide the accuracy, we decided to design an experiment.

In order to determine the accuracy and reliability of Textopia's scoring and feedback section. For example, a deliberately flawed essay serves as the input (the one on the x-axis in the graph), this initial version is filled with errors, both in grammar and delivery, waiting to establish enhancement. Then by using the app, check the feedback it provided and the quality score, and put it as the output (on y-axis in the graph). After receiving the score, improve the essay by removing 2 grammar or spelling errors and two poor feedback proposed according to the app's descriptions. Then repeat the procedure 20 times to determine the results.



Improvement Index	Expected Output	Actual Output
1 - Original bad quality	Low (Base)	46
2	Higer than 46	50
3	Higer than 50	58
4	Higer than 58	58
5	Higer than 58	62
6	Higer than 62	61
7	Higer than 61	66
8	Higer than 66	69
9	Higer than 69	73
10	Higer than 73	74
11	Higer than 74	79
12	Higer than 79	80
13	Higer than 80	81
14	Higer than 81	78
15	Higer than 78	82
16	Higer than 82	85
17	Higer than 85	90
18	Higer than 90	90
19	Higer than 90	92
20	Higer than 92	95

Figure 8. Expected and actual output

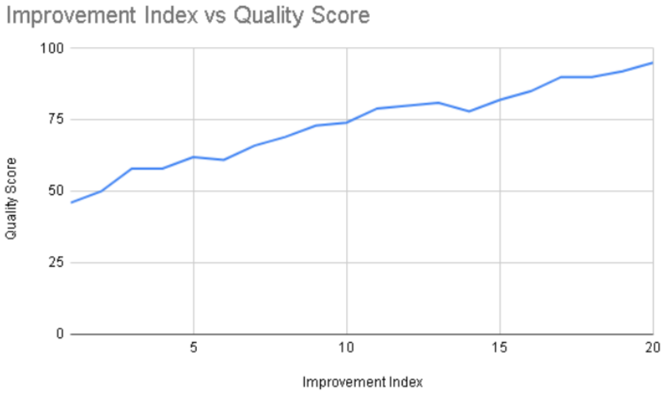


Figure 9. Improvement index vs quality score

Looking at this data, we can see a visible upwards trend. About 4 of the inputs didn't get the expected output making it 16/20 or 80% accurate. A common unexpected output was having our actual output no more than 3 score below the expected output or equal score to the previous input. I believe that most or all of the analysis went wrong during improvement is due to the possibility that fixing multiple errors on a sentence or two can lead to new existing errors. Mostly in grammar, fixing a spelling in a sentence doesn't fully make the grammar correct because a different word might fit the sentence better. Getting a lower score than the previous check won't necessarily mean your essay got worse but now just have another problem to fix. Same with getting an equal score compared to your previous check since a new error could have the same quality issue.

5. Related Work

The 2019 research paper "Use of Digital Games in Writing Education: An Action Research on Gamification" from Mazhar Bal Akdeniz University in Turkey investigated the integration of gaming into writing lessons [11]. It highlighted how games could enhance student motivation and passion for writing. Despite these benefits, the use of an AI tool like Textopia could further enhance learning outcomes. Textopia offers AI-generated feedback, enabling students to identify their strengths and weaknesses, thereby significantly improving their writing skills. This combination of gamification and tailored AI feedback represents a powerful approach to modernizing education and making learning more engaging and effective.

The article, How AI Could Save–or Sink–Creative Writing in School, written by Thomas Arnett in 2023, claims that ChatGPT stands out as a versatile assistant, offering real-time guidance and suggestions to writers, it talks about how ChatGPT helps and guides writers for the better [12]. But Textopia not only combined ChatGPT's advantages, it also combined gaming to learning for students in the pursuit of writing, it allows students to feel more drawn to activities and engage in writing. These game mechanics can make the process of writing more engaging by transforming it into a more dynamic and rewarding experience. In contrast, the traditional ChatGPT interface focuses more on simplicity and functionality, providing a straightforward, text-based interaction that appeals to those who prefer a minimalist and direct approach.

Cultivating writing skills: the role of ChatGPT as a learning assistant—a case study, written by Nermin Punar Özçelik, explained how ChatGPT could assist students in learning and help students engage [13]. ChatGPT is widely recognized as a flexible tool that offers instant guidance and advice to writers, enhancing their skills through real-time interaction. However, Textopia takes this a step further by integrating the benefits of ChatGPT with gamification elements, thereby making the learning process more engaging for students. By incorporating games into writing activities, Textopia attracts students and encourages them to participate more actively. These gaming elements transform writing from a static task into a dynamic and enjoyable experience. In contrast, the traditional ChatGPT interface prioritizes simplicity and practicality, offering a clean, text-based format that suits those who favor a straightforward and unembellished approach to learning and writing.

6. Conclusions

While Textopia presents a novel approach to enhancing writing skills through gamification and interactive feedback, there are areas within the platform that require further refinement for optimal effectiveness. A notable challenge lies in the AI-generated responses, particularly concerning the scoring of essays. The current mechanism, which lacks a standardized scoring rubric, may yield scores that are not only highly variable but also potentially misleading. This inaccuracy in scoring could lead to confusion among users, undermining their confidence in the feedback provided and, by extension, their engagement with the platform.

To address this, the development team should consider integrating a more robust and transparent scoring system. This system could be based on established educational standards, incorporating a range of criteria such as clarity of argument, coherence, grammar, and creativity. By doing so, Textopia can offer users scores that are not only more accurate but also more meaningful, providing clear indications of where improvements are needed and where strengths lie.

In conclusion, while Textopia offers a promising approach to tackling the decline in writing skills among students, its effectiveness could be significantly enhanced by addressing the limitations in its scoring and feedback mechanisms. By implementing a standardized scoring rubric, expanding feedback types, collaborating with educators, and actively engaging with user feedback, Textopia can become an even more powerful tool in fostering writing excellence and enthusiasm among students.

Firstly, the PromptManager component's capability to generate a wide range of creative and engaging prompts is affirmed, leveraging the OpenAI API to cater to diverse interests and writing levels. This ensures that users receive relevant and varied content to explore and write about, addressing concerns about the AI's ability to produce engaging and diverse prompts. Secondly, the reliability and accuracy of AI-generated feedback on creative writing are discussed. Despite the subjective nature of creative writing, Textopia's implementation of ChatGPT is noted for its ability to analyze various genres and prompts at any writing level, providing dependable feedback [14]. Lastly, the integration of gaming elements into the writing improvement process is defended. The design of these game mechanics is such that they reward writing progress, with game features being unlocked as direct results of the user's writing achievements. This approach aims to motivate users to improve their writing skills, ensuring that the gaming aspect enhances rather than distracts from the educational goal.

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