

# Argumentative Essay Writing Tutor

QIANQI YAN\* and JIYU CHEN\*, University of Michigan, USA

We design a tutoring system to teach novices about argumentative essay writing in this project. We also do an experimental design and analysis to evaluate the feasibility of our tutoring system.

CCS Concepts: • **Human-centered computing** → **Human computer interaction (HCI)**.

Additional Key Words and Phrases: cognitive tutor, cognitive task analysis, experimental design and analysis

## ACM Reference Format:

Qianqi Yan and Jiyu Chen. 2022. Argumentative Essay Writing Tutor. 1, 1 (May 2022), 8 pages. <https://doi.org/10.1145/nnnnnnn.nnnnnnn>

## 1 INTRODUCTION

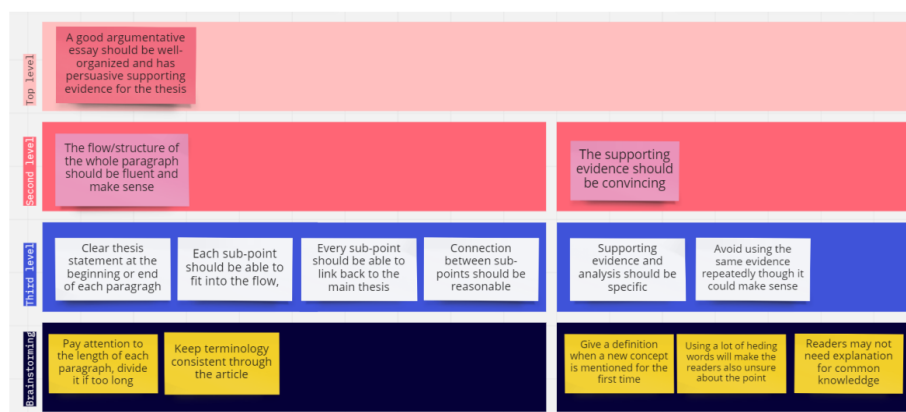


Fig. 1. Affinity Diagram from the cognitive task analysis.

Above is the affinity diagram summarizing the challenges that novice has and points they has to pay attention to become experts during our cognitive task analysis. The top-level theme is a summary of what characterizes a good argumentative essay - good structure and persuasive supporting evidence.

From that of experts: "I definitely see a clear topic sentence, which is good", "there's evidence and there's also analysis of the quotes, which is good" and similar quotes form the second level. Also, the experts do point out room for improvements, such as "I'm not sure if it's exactly needed, like considering the audience of the essay. Because I feel like most people know what the Great Depression is", which gets summarized into "Readers may not need explanation for

\*Both authors contributed equally to this research.

Authors' address: Qianqi Yan, qianqi@umich.edu; Jiyu Chen, jiyuchen@umich.edu, University of Michigan, Ann Arbor, Michigan, USA, 48105.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from [permissions@acm.org](mailto:permissions@acm.org).

© 2022 Association for Computing Machinery.

Manuscript submitted to ACM

Manuscript submitted to ACM

common knowledge”, and “I feel like in terms of like, looking at the flow of the essay, I don’t think it fits that well” which goes into “Each sub-point should be able to fit into the flow”.

For the hierarchy of themes, we begin with a general point “A good argumentative essay should be well-organized and has persuasive supporting evidence for the thesis” which further extends to flow/structure thing and the supporting evidence part. Then the former gets further divided into requirements for clear thesis and connections between subpoints. The latter gets extended into requirements for specific and unrepeatable evidence. The last layer contains more detailed brainstorming notes on what exactly should be pay attention to, for example, “Pay attention to the length of each paragraph, divide it if too long”, “Give a definition when a new concept is mentioned for the first time” etc.

Based on the above challenges, we focus on the structural aspect when deploying our tutor (the left part on the diagram), namely well-organized overall structure, fluent flow, and connection between sub-thesis and supporting evidence. We leave rest more semantic part (the right part on the diagram), such as judgement of strong/weak supporting evidence as a future integral part since this would require some advanced NLP techniques.

## 2 TUTORING SYSTEM

We choose TOEFL sample essays from <https://www.toeflresources.com/sample-toefl-essays/>. They have relatively fixed structure and short length, which enables us to apply various essays to a uniform tutor system. We wrote a script to preprocess the essays so that each sentence is parsed and enumerated within its own paragraph to make the overall structure clearer for novice to approach. An example of the structure is shown in Fig. 2.

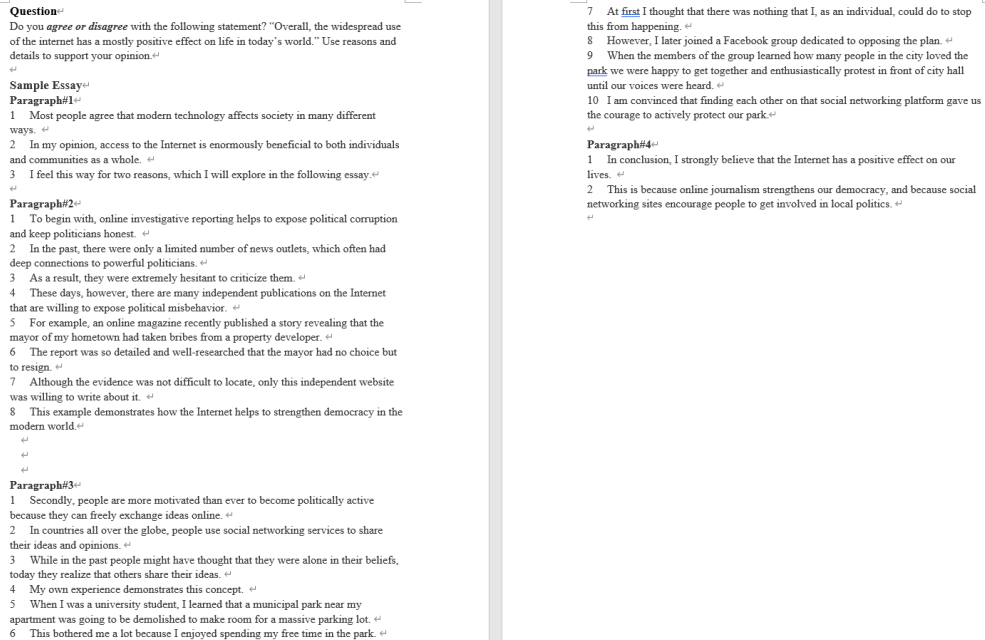


Fig. 2. Sample Essay used in the tutor.

The above figure shows one of the interfaces of our tutor system. The workflow is designed from top to bottom: Identify the location of main thesis - Identify the location of sub-thesis (paragraph 1) - Identify the category and content

Argumentative Essay Tutor v 1.2.2

---

***Argumentative Essay Writing: Sample Essay Evaluation***

Now you agree or disagree with the following statement: *When doing research, it's better to rely on printed material such as books and articles than it is to use the Internet. Use scientific research techniques to support your position.*

Think about the topic first. Then read the sample essay and answer the following questions.

Link: <https://www.cuny.edu/academic-resources/writing-center/sample-essays/>  
Download: <https://tinyurl.com/yw6d9mde>

Where is the author's main thesis?      Paragraph # \_\_\_\_\_ Line # \_\_\_\_\_

**Paragraph(s)**

What kind of evidence does the author use for this paragraph?

☐ Examples                  ☒ Citations                  ☐ Statistics

What is the corresponding sentence in original essay for this evidence?

\_\_\_\_\_

**Paragraph(s)**

What kind of evidence does the author use for this paragraph?

☐ Examples                  ☒ Citations                  ☐ Statistics

What is the corresponding sentence in original essay for this evidence?

\_\_\_\_\_

Where is the author's conclusion?      Paragraph # \_\_\_\_\_ Line # \_\_\_\_\_

How to write an argumentative essay? Arrange the following steps in a reasonable order:

1. Think of supporting evidence for each sub-thesis statements.  
2. Construct the sub-thesis statements.  
3. Construct the conclusion paragraph.  
4. Construct the main thesis statement.  
5. Put pieces together and construct the whole essay.  
6. Check grammar errors in the paper before submitting.

Step 1    Step 2    Step 3    Step 4    Step 5    Step 6

Enter your reflections and thoughts after evaluating this sample essay.

Question mark icon    Green checkmark icon

(b)

(c)

of supporting evidence used in the sub-thesis - Identify the location of sub-thesis (paragraph 2) - Identify the category and content of supporting evidence used in the sub-thesis - Identify the location of the conclusion - Make a general summarization of the steps to construct a well-formulated argumentative essay - Leave any thoughts and comments. The interface is highly generalizable since different problem interfaces only differ from each other regarding the top two boxes (title and sample essay link).

Also, the tutor system offers specific hints based on different sample essay. For example, in Fig. 5, where the author justifies their sub-thesis by the sentence "For example, an online magazine recently published a story revealing that the mayor of my hometown had taken bribes from a property developer.", the tutor offers hint to the novice to identify the location by the phrase "for example" as a strong indicator.

Argumentative Essay Tutor: 1 2 3

**Argumentative Essay Writing: Sample Essay Evaluation**

Topic: Do you agree or disagree with the following statement? "Overall, the widespread use of the Internet has a mostly positive effect on life in today's world." Use reasons and details to support your position.

Think about the topic first. Then read the sample essay and answer the following questions.

Link: <https://docs.google.com/document/d/1eTcy0R8PjSDwG5D9C-ksdM5bW5AD0VQg/edit#heading=h.6q3aaf10v4de>

Where is the author's main thesis? Paragraph #  Line #

**Paragraph2** Where is the author's thesis for this paragraph? Line #

What kind of evidence does the author use to support this thesis?  
☐ Example ☐ Citations ☐ Statistics

What is the corresponding sentence in original essay for this evidence?

**Paragraph3** Where is the author's thesis for this paragraph? Line #

What kind of evidence does the author use to support this thesis?  
☐ Example ☐ Citations ☐ Statistics

What is the corresponding sentence in original essay for this evidence?

Where is the author's conclusion? Paragraph #  Line #

How to write an argumentative essay? Arrange the following steps in a reasonable order.  
 1. Think of supporting evidences for each sub-thesis statements.  
 2. Polish the whole essay.  
 3. Construct the sub-thesis statements.  
 4. Construct the conclusion paragraph.  
 5. Construct the main thesis statement.  
 6. Put pieces together and construct the whole essay.

Put pieces together in the correct order. Step1 Step2 Step3 Step4 Step5 Step6

Enter your reflections and thoughts after evaluating this sample essay.

This is a demo of correct solution.

(a) Correct solution of the tutor system.

Argumentative Essay Tutor: 1 2 3

**Argumentative Essay Writing: Sample Essay Evaluation**

Topic: Do you agree or disagree with the following statement? "Overall, the widespread use of the Internet has a mostly positive effect on life in today's world." Use reasons and details to support your position.

Think about the topic first. Then read the sample essay and answer the following questions.

Link: <https://docs.google.com/document/d/1eTcy0R8PjSDwG5D9C-ksdM5bW5AD0VQg/edit#heading=h.6q3aaf10v4de>

Where is the author's main thesis? Paragraph #  Line #

**Paragraph2** Where is the author's thesis for this paragraph? Line #

What kind of evidence does the author use to support this thesis?  
☐ Example ☐ Citations ☐ Statistics

What is the corresponding sentence in original essay for this evidence?

**Paragraph3** Where is the author's thesis for this paragraph? Line #

What kind of evidence does the author use to support this thesis?  
☐ Example ☐ Citations ☐ Statistics

What is the corresponding sentence in original essay for this evidence?

Where is the author's conclusion? Paragraph #  Line #

How to write an argumentative essay? Arrange the following steps in a reasonable order.  
 1. Think of supporting evidences for each sub-thesis statements.  
 2. Polish the whole essay.  
 3. Construct the sub-thesis statements.  
 4. Construct the conclusion paragraph.  
 5. Construct the main thesis statement.  
 6. Put pieces together and construct the whole essay.

Put pieces together in the correct order. Step1 Step2 Step3 Step4 Step5 Step6

Enter your reflections and thoughts after evaluating this sample essay.

(b) Incorrect solution of the tutor system.

Argumentative Essay Tutor: 1 2 3

**Argumentative Essay Writing: Sample Essay Evaluation**

Topic: Do you agree or disagree with the following statement? "Overall, the widespread use of the Internet has a mostly positive effect on life in today's world." Use reasons and details to support your position.

Think about the topic first. Then read the sample essay and answer the following questions.

Link: <https://docs.google.com/document/d/1eTcy0R8PjSDwG5D9C-ksdM5bW5AD0VQg/edit#heading=h.6q3aaf10v4de>

Where is the author's main thesis? Paragraph #  Line #

**Paragraph2** Where is the author's thesis for this paragraph? Line #

What kind of evidence does the author use to support this thesis?  
☐ Example ☐ Citations ☐ Statistics

What is the corresponding sentence in original essay for this evidence?

**Paragraph3** Where is the author's thesis for this paragraph? Line #

What kind of evidence does the author use to support this thesis?  
☐ Example ☐ Citations ☐ Statistics

What is the corresponding sentence in original essay for this evidence?

Where is the author's conclusion? Paragraph #  Line #

How to write an argumentative essay? Arrange the following steps in a reasonable order.  
 1. Think of supporting evidences for each sub-thesis statements.  
 2. Polish the whole essay.  
 3. Construct the sub-thesis statements.  
 4. Construct the conclusion paragraph.  
 5. Construct the main thesis statement.  
 6. Put pieces together and construct the whole essay.

Put pieces together in the correct order. Step1 Step2 Step3 Step4 Step5 Step6

Enter your reflections and thoughts after evaluating this sample essay.

(c) Another incorrect solution of the tutor system.

Fig. 4. Solutions of the tutor system.

One of the unique features that we designed in our tutoring system is that the students don't have to enter the exact same sentence as the golden answer in the filling-blank type question.

```

1 function overlap(s, t) {
2   var list_s = s.split(/\b\s+(?!$)/);
3   var list_t = t.split(/\b\s+(?!$)/);
4   var overlap = list_s.filter(value => list_t.includes(value));
5   return overlap.length / list_t.length;
6 }

```

Listing 1. The function that uses regex to calculate the overlap between student answer and golden answer.

Later, one of the customized production rules set the threshold for the student's answer to be accepted.

Manuscript submitted to ACM

Argumentative Essay Tutor: 1 2 3

**Argumentative Essay Writing: Sample Essay Evaluation**

Topic: Do you agree or disagree with the following statement? "Overall, the widespread use of the internet has a mostly positive effect on life in today's world." Use reasons and details to support your opinion.

Think about the topic first. Then read the sample essay and answer the following questions.

Link: <https://docs.google.com/document/d/1e9ycIM9U-Daw5GV9c-abKMddbw5Q4XIB0Y-QESoiaF0/edit>

---

Where is the author's main thesis? Paragraph #  Line #

**Paragraph#2**  
Where is the author's thesis for this paragraph? Line #

What kind of evidences does the author use to support this thesis?  
☐ Example ☐ Citatations ☐ Statistics

What is the corresponding sentence in original essay for this evidence?

**Paragraph#3**  
Where is the author's thesis for this paragraph? Line #

What kind of evidences does the author use to support this thesis?  
☐ Example ☐ Citatations ☐ Statistics

What is the corresponding sentence in original essay for this evidence?

---

Where is the author's conclusion? Paragraph #  Line #

How to write an argumentative essay? Arrange the following steps in a reasonable order.

1. Think of supporting evidences for each sub-thesis statements.
2. Polish the whole essay.
3. Construct the sub-thesis statements
4. Construct the conclusion paragraph.
5. Construct the main thesis statement.
6. Put pieces together and construct the whole essay.

Put numeric numbers in the answer boxes.

Step1  Step2  Step3  Step4  Step5  Step6

---

Enter your reflections and thoughts after evaluating this sample essay.

The word 'for example' shows that the author uses example as supporting evidence.

Fig. 5. Specified hint message.

```

1 let predictedSAI = {selection: sel, action: "UpdateTextField", input : sentence2_ans};
2   if (checkSAI(predictedSAI, function(s,t) {
3     if (s.selection == t.selection && s.action == t.action && (overlap(s.input, t.input) >= 0.8))
4       {
5         t.input = s.input;
6         return true;
7       } else {
8         return false;
9       }
10    }))) {
11      modify(ie, "value", predictedSAI.input);
12      halt();
13    }
14  assert(new Hint(hint2));

```

Listing 2. Production rule that sets the threshold for the student's answer to be accepted.

### 3 EXPERIMENTAL DESIGN AND ANALYSIS PLAN

The research question we aim to answer in our experimental design and analysis plan is that, whether our tutoring system can improve novice students' understanding of writing a specific type of argumentative essay. We will measure this by measuring the students' performances on writing this specific type of argumentative essay using hand-graded scores by specialists.

The type of argumentative essays used in our experiments will be of the same type as that used in our tutoring system. We will call this type "agree-or-disagree" essays. An example of the essay question of this "agree-or-disagree" type of essays is shown in Figure 6. Also, you can view an entire example here [https://docs.google.com/document/d/1e9yclM9U-DAw5GV9c-abKMddbW5Q4XIB0Y\\_QESojaE0/edit?usp=sharing](https://docs.google.com/document/d/1e9yclM9U-DAw5GV9c-abKMddbW5Q4XIB0Y_QESojaE0/edit?usp=sharing).

#### Question

Do you *agree or disagree* with the following statement? "Overall, the widespread use of the internet has a mostly positive effect on life in today's world." Use reasons and details to support your opinion.

Fig. 6. Sample "agree-or-disagree" essay question.

We design experiments to investigate the effects of our tutoring system in the novices' learning process to learn the "agree-or-disagree" argumentative essay writing. Below, we give a detailed introduction and explanation of our experimental design and analysis plan.

**Step1: Choose 160 test subjects as incoming freshmen students from different universities with different majors.**

Here, because our tutoring system aims at teaching novices about argumentative essay writing, we will choose our test subjects as incoming freshmen university students to make sure that they have not taken formal argumentative essay writing classes.

Also, we will choose these students from different universities, and also make sure that they have different majors. For example, they can come from private liberal arts colleges, or public universities. They can be engineering students, science students, or art students. This is because students from different universities or from different majors, will probably have different previous understanding of argumentative essay writing. We do this to help to improve the external validity and generalizability of our experimental design.

We choose 160 as the number of test subjects in our experiments, because too many subjects will be too expensive, and too little subjects will decrease the reliability of our experiments.

**Step2: Randomly assign the participants into two groups, Group A and Group B. Make sure that both Group A and Group B have 80 participants.**

We will randomly assign our participants into to two groups. This randomization process helps to improve the internal validity in our experiments. Also, we make sure that these two groups are of the same size.

**Step3: Group A will be given the tutor. Group B will be given the materials along with the tutoring system but not the tutor.**

We will give the Group A the tutoring system and ask them to finish the problems in our tutoring system. To make sure that the only difference between the treatment of Group A and Group B is the tutoring system our designed, we

will also give our Group B the materials used in our tutoring system, that is, the sample essay questions and the sample essays, but do not give them our tutoring system. This helps to improve the internal validity.

**Step4: Both Group A and Group B will write and submit argumentative essays answering the same essay question.**

After Step3, we will ask both Group A and Group B to write argumentative essays on the same essay question. This essay question will be of “agree-or-disagree” type, so that it is consistent with that used in our tutoring system.

**Step5: Essays are randomly shuffled, and four human specialists will give ratings for every essay submitted.**

Then we will randomly shuffle the essays submitted by both Group A and Group B, to make sure that when these essays are handed over to human specialists, they do not know whether the essay comes from a student with tutoring system or not. This also helps to improve the internal validity as it tries to eliminate the bias in grading process.

We will design a detailed grading rubric for the specialists. The four specialists should give each essay a rating from 1 to 5, where 5 means that the student shows a good understanding of writing argumentative essay, and 1 means that the student does not know much about how to write an argumentative essay. After that, we will have four scores for every essay. We will take the average of these four scores to get the final score for an essay.

**Step6: Do exploratory data analysis (such as t-test) to figure out whether there is a difference between the essay scores of Group A and Group B.**

After each essay receives a score, we will do exploratory data analysis to find out whether there is a difference between the essay scores of Group A and Group B. For example, we can do a t-test, with null hypothesis being that there is no difference in Group A and Group B’s performance in terms of scores. After getting the p-value, if we can reject the null hypothesis, we will be able to conclude that our tutoring system does make a difference in the novices’ learning process.

Above are the six steps in our experimental design and analysis plan.

As seen from above, the target learners in our tutoring system are novices, i.e., incoming freshmen university students. The control group in our experiments is Group B, and the treatment group is Group A. Group A will be given the tutor, while Group B will be given the materials along with the tutoring system but not the tutor. How would Group A and Group B differ from each other? Basically we are expecting Group A to have a better understanding of writing “agree-or-disagree” type argumentative essay, and we will evaluate this in EDA.

We quantify the outcome variables by giving each essay submitted by Group A and Group B a hand-graded score by human specialists. This score will range from 1 to 5, where 5 means the essay is quite good and 1 means that the student does not know much about how to write an argumentative essay.

To ensure external validity in our experiments, we choose our test subjects from different universities and from different majors. This makes sure that there is more diversity in our test subjects, and therefore improves its generalizability.

## 4 WRAP-UP

### 4.1 Reflections

We reflect on the whole process of designing this tutoring system and summarize the pros and cons of our tutor here.

#### 4.1.1 Pros.

- Focus on a specific and well-defined subdomain of argumentative essay writing. Argumentative essay writing is a complicated topic with many considerations, and novices may feel overwhelmed if we present them the

whole view all at once. Hence we choose to focus on one specific type of argumentative essay writing in our tutoring system, i.e., “agree-or-disagree” type, and this will help novices to get to know this area.

- Break a complex problem into smaller sub-problems and conquer it step by step. In our tutoring system, we break the complicated essay writing problem into several sub-problems. We start with identifying the main thesis, then identifying the first sub-thesis and the supporting evidences associated with it. Then we come to the second sub-thesis and the supporting evidences, and finally the conclusion.
- Break a long essay into paragraphs and break paragraphs into sentences. It might be hard for novices to comprehend a long essay all at once, so breaking them into pieces may be a good way to help beginners digest things.

#### 4.1.2 Cons.

- After identifying a certain step is correct, giving some additional information about why this step is correct may be useful. For example, before we ask the learner to identify the location of the main thesis, we can give some additional information such as the definition of main thesis, and properties of a good thesis statement.
- In practice, problems may be too easy, all three problems are very similar and have similar answers. This is a problem pointed out by our users. Although I consider repetitive work to be necessary in novices’ learning process, I do agree that we can choose more various problems and sample essays in our tutoring system.

## 4.2 Challenges

We also met some challenges in our design process. The major challenge is that to better understand the student’s writing, we need some natural language processing technologies. For now, we can not evaluate answers to open-ended questions well without NLP technologies. Besides, we now emphasize on the general structure of argumentative essays in our tutor, for example, where the main thesis should be put. But it is possible that students may just memorize these structures as formulas without truly understand the essence of argumentative essay writing.

## ACKNOWLEDGMENTS

To Xu Wang and Tanya Lai, for helpful suggestions and patient instructions in the designing process of our tutoring system and experiments.

## REFERENCES

TOEFL Writing Questions (2022 edition) – Sample Essays and Questions <https://www.toeflresources.com/sample-toefl-essays/>

EECS 498-003 L16 slides - overview of experimental design , Xu Wang <https://umich.instructure.com/courses/490859/assignments/syllabus>