

ChatGPT and Assessment in Higher Education

**Jonna Lee (Director of Research in Education Innovation)
& Meryem Yilmaz Soylu (Research Scientist)**

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Introduction

Launched in November 2022, ChatGPT is an advanced large language model developed by OpenAI. This generative artificial intelligence (AI) chatbot was trained on massive amounts of text data from the internet using machine learning algorithms. ChatGPT is capable of answering prompts and invites users to interact in a conversational way—it can even answer follow-up questions.

To highlight some of its features, ChatGPT can provide step-by-step solutions to mathematical problems, write code, and generate various written output such as lesson plans, email drafts, stories, music lyrics, social media posts, and so on. Therefore, it is not surprising that many are excited about the potential positive influence of ChatGPT on productivity and efficiency. However, ChatGPT's ability to write college-level essays on any topic has triggered a lot of debate around integrity issues in higher education. The following figure shows an example conversation with ChatGPT that illustrates its essay writing feature, including what it can and cannot do.

The figure shows a chat interface with a user prompt and three AI responses. The user prompt asks for an essay on cognitive psychology. The first AI response provides a detailed paragraph on the concept of cognitive psychology. The second AI response provides a list of citations for further research. The third AI response explains that it cannot provide citations directly but can suggest sources.

User Prompt: Pretend that you are a psychology-major freshman. Respond to the following prompt: Define the concept of cognitive psychology within a paragraph. Explain and provide examples of how cognitive psychology helps us understand human memory and learning in three paragraphs. Finally, provide a conclusion paragraph with potential research questions to advance our knowledge in cognitive psychology.

AI Response 1: Cognitive psychology is the study of mental processes such as perception, attention, language, memory, and thinking. It seeks to understand how individuals process information, make decisions, and solve problems. This field of psychology explores the various ways in which humans acquire, process, store, and retrieve information.

Cognitive psychology has played an important role in our understanding of human memory and learning. Through various experiments and research, cognitive psychologists have discovered that memory can be divided into three stages: encoding, storage, and retrieval. Encoding involves transforming information into a form that can be stored in the brain, storage is the maintenance of the information over time, and retrieval is the process of accessing the stored information when it is needed. Cognitive psychologists have also discovered that memory can be affected by various factors such as attention, motivation, and emotional state.

Cognitive psychology has also explored how we learn and acquire new information. One influential theory in this area is the information-processing model which suggests that learning involves the processing of information in various stages including sensory input, attention, perception, and memory. Cognitive psychologists have also explored the role of attention in learning, finding that focused attention is essential for effective learning and that multitasking can negatively impact learning.

Overall, cognitive psychology has provided valuable insights into human memory and learning. However, there is still much to be explored in this field. Some potential research questions that could advance our knowledge in cognitive psychology include: How do emotions affect memory and learning? What role do individual differences such as age, gender, and culture play in cognitive processes? How can technology be used to enhance learning and memory? By continuing to explore these questions, we can deepen our understanding of cognitive psychology and its applications in various fields.

User Prompt: Include appropriate citations to your response above.

AI Response 2: I apologize, but as an AI language model, I am not able to provide citations in the same way that a human psychologist would. However, I can suggest some sources that you may find helpful in researching cognitive psychology:

- Goldstein, E. B. (2015). Cognitive psychology: Connecting mind, research, and everyday experience. Cengage Learning.
- Anderson, J. R. (2010). Cognitive psychology and its implications. Worth Publishers.
- Baddeley, A. D., Eysenck, M. W., & Anderson, M. C. (2015). Memory. Psychology Press.
- Mayer, R. E. (2014). Cognitive theory of multimedia learning. The Cambridge Handbook of Multimedia Learning, 43-71.

These sources provide comprehensive overviews of cognitive psychology, including its concepts, theories, and research findings. They may also provide citations to more specific studies and experiments in the field.

User Prompt: How did you find those sources?

AI Response 3: As an AI language model, I have access to a vast amount of digital resources including academic databases, online journals, and eBooks. In this case, I used my internal database of academic sources to find reputable textbooks and articles on cognitive psychology. I then selected sources that I deemed appropriate based on their relevance and authority in the field. If you have any specific questions or topics related to cognitive psychology, I can try to provide more specific sources that may be helpful to you.

Figure 1. Illustration of an essay writing feature of ChatGPT

While language models like ChatGPT can generate human-like text, it is important to note that the output can sometimes be misaligned with human expectations. As illustrated in Figure 1, ChatGPT is not able to provide citations within academic text output, though it can suggest some relevant sources based on access to an enormous number of digital resources. Another notable limitation of ChatGPT is that it was designed primarily to predict what word comes next in a sequence and therefore the information produced by this tool may not necessarily be factual. Further, when prompted to elaborate on its limitations of ChatGPT responds that it has limited understanding of context, can potentially generate offensive or harmful content, has limited ability to fact-check or verify information, lacks empathy, and has limited knowledge on certain topics (especially if the subject matter is complex).

In fact, ChatGPT is not the only generative AI model that impacts classrooms these days. There are other types of models such as DALL-E that can generate realistic art or image pieces based on text input. In this white paper, we mainly discuss the impact of generative language models on the assessment of students' learning in the higher education setting and provide example alternative or other transformative assessment methods that faculty can consider adopting in response to threats posed by ChatGPT. Next, we discuss ideas on how faculty should adapt to the emergence of AI language models like ChatGPT. To garner knowledge about transformations that are expected to happen within the classroom and beyond, we incorporate perspectives and insights from our interviews with the thought leaders of the Center for 21st Century Universities (C21U), Dr. Ashok Goel and Dr. Stephen Harmon. Goel is Chief Scientist at C21U, a Professor of Computer Science and Human-Centered Computing, and a Principal Investigator of the National Artificial Intelligence Institute in adult learning and online education (AI-ALOE). Harmon is Executive Director at C21U, Professor at the College of Design, and Associate Dean of Research in Georgia Tech Professional Education (GTPE). Finally, we conclude by offering a set of recommendations for enhancing assessment practices in the era of rapidly evolving AI technology.

Threats and Opportunities for Assessment in Higher Education

What are some potential threats that ChatGPT or other generative language models can pose to assessment practices in higher education? One of them would be causing academic integrity issues including plagiarism and cheating in and outside the classroom. As mentioned in the introduction, ChatGPT is capable of performing a range of academic writing tasks and often it is difficult to distinguish its performance from human performance. Thus, there has been growing concern about situations in which students rely on using such text-based AI models to complete their tasks, especially essay writing. As expected, when we asked ChatGPT whether it can tell us if a piece of writing was written by an AI language model, its response included the following comment:

“It is important to note that it can be difficult to determine with certainty if a piece of text was written by an AI language model or a human, as AI models are continually improving and becoming more sophisticated. Additionally, some AI models may have been fine-tuned on specific writing styles or topic, making it difficult to distinguish their output from that of a human.”

In light of the situation, it is not surprising that recently AI models specifically designed for plagiarism detection are being actively developed. However, whether these models are validated to be accurate and robust, this problem naturally leads to an increase in faculty workload to deal with challenges in detecting AI usage in their students' work. Also, beyond modifying their course syllabus, instructors will need to be trained on new assessment practices in response to students' exposure to and usage of ChatGPT. Yet, it is also true that AI technology continues to evolve rapidly, which adds another layer to the challenges. That is, policy implementation and adoption of new practices in higher education can be too slow to keep up with technological advancements. Nevertheless, we would like to invite readers to ponder opportunities that ChatGPT and other similar tools may bring to assessment and learning in higher education.

The release of ChatGPT has sparked in-depth discussions around opportunities for assessment and learning in the higher education community. In this section, we focus our discussion on how to adopt meaningful and innovative assessment methods for instructors while embracing the continuing advancement of language models like ChatGPT. Based on a synthesis of recently published papers and other web sources, we offer some practical suggestions and ideas on assessment that instructors can consider using in their courses.

First, given that ChatGPT tends to generate high-level and generic text output due to its training mechanism, we need to consider using authentic and personalized assessment methods in courses. These methods include using real-life examples and contextually specific situations that are meaningful to individual students. For instance, instructors may ask students to include their personal experience or perspectives in their writing. Students can

also be asked to conduct analysis that draws on specific class discussions. Another way to promote this type of assessment method is to give students complex instructions that involve long texts that do not fit a typical ChatGPT prompt or to ask students to write about the most recent events that are not necessarily reflected in the data used to train the language model.

Next, alternatives to essay-based assessment need to be further explored. These methods can include using (impromptu) video presentations for assessments or using other digital forms such as animations. Also, through self-assessment or reflective writing, students could discuss their writing or thinking process. Additionally, peer evaluations or interactive assessment activities could be integrated into grading by engaging students in group discussions or other activities such as research and analysis in which students are expected to co-construct knowledge and apply certain skills. Another possibility is to place an emphasis on assessing the process of learning rather than the outcome. Instead of grading a final writing product alone, instructors could grade multiple drafts and assess how a student's writing improved. However, a major drawback of this approach is that it requires carefully designed evaluation criteria and can be time-consuming to instructors.

In addition to its ability to write college-level essays, ChatGPT allows students to quite easily find answers (not necessarily accurate) to coding assignments and physics problems etc., which may possibly affect more technical skill-oriented classes. Thus, assessments that are formulaic need to be avoided. Instead, instructors could use assessments that are open-ended or encourage students to demonstrate originality and creativity in their performance. Creating original ideas or research questions can be one such example. As mentioned by Dr. Chris Dede, who is a senior research fellow at the Harvard Graduate School of Education and a co-principal investigator of AI-ALOE, the existence of Chat AI "raises the bar for human performance." Considering these aspects, it is crucial to find ways to assess students' deep, sophisticated, and critical thinking skills. Some example assessment methods include asking students to critique papers or build logical arguments with appropriate reasoning skills, answer scenario-based or situational problem-solving questions, and create a concept map or diagram to demonstrate a deep understanding of a topic and its knowledge structure.

Conducting experiments for using ChatGPT as a tool for students' learning may create opportunities for innovative assessment in higher education. One of the limitations of the current version of ChatGPT is that it does not provide appropriate sources and quotations in its text output. Instructors may use this as an opportunity to engage students in writing practices focused on correcting factual errors and locating accurate data sources. Students can also be asked to cite and reference the work of others accurately and properly by using in-text citations or including bibliography at the end of their writing product. Beyond learning the mechanics of writing, instructors could ask students to critique a piece of writing generated from ChatGPT by analyzing and interpreting how it conveys an idea and assessing its strengths and weaknesses in terms of readability, credibility, comprehensiveness, accuracy, and so on.

On the other hand, instructors can utilize ChatGPT as a supplemental tool for designing various assessment activities. As illustrated in examples from the University of Sydney (Liu et al., January 2023), instructors may ask detailed and specific prompts to ChatGPT to generate a rubric for grading students' knowledge and skills, create multiple-choice quiz questions, or come up with group discussion questions about course topics. However, when using these sources, it would be important to ensure they are accurate and check how the information presented can be interpreted or if it contains any biased views.

How Should Faculty Adapt? Transformations within and beyond the Classroom

In the previous section, we explored various assessment ideas and methods to test students' knowledge, considering the rising concerns about ChatGPT's ability to pass exams or write essays on various topics. However, AI technologies are fast evolving, and thus it is possible that some of the ideas that we introduced

earlier may no longer be useful. Then, how should faculty adapt to the fast-paced technological environment? In this section, we focus on addressing this question by sharing future directions that the two leaders from C21U, Dr. Stephen Harmon and Dr. Ashok Goel, provided during our interview sessions.

Harmon pointed out that with the introduction of these tools, it is essential for both instructors and students to adopt flexibility of thinking as part of their skills. Especially, for instructors, flexibility of thinking would be a skill that may be essential to teaching and evaluating the students as they tend to get caught up in a very traditional mindset where their mental adaptability to new tools takes a long time to adjust. Harmon mentioned that one aspect that may need to be rethought with the introduction of ChatGPT is assessment testability. A student's ability to do prompt engineering, the ability to define prompts and generate good results from ChatGPT, would make it harder to assess students based on essay responses. This would lead to instructors having to rethink the existing and possible assessments for students. That is, they need to consider where and how to assess learning as well as creating types of assessment situations where it does not matter if ChatGPT was used or not. At the same time, it may be useful to include prompt engineering as a part of the curriculum.

Likewise, Goel explained that one of the things that all these technologies do is force the teacher to reflect on his or her role. Teachers become accustomed to a particular role—they go and teach the same way every day, and then technology comes and it makes the teacher rethink their role. If such assignments as essay writing can now be done with ChatGPT's help, the teacher has to think harder about better ways to assess students' learning in a way that can measure and enhance active and individualized learning.

Another important aspect of adapting to AI technologies would be to identify areas where these technologies can be most successful in supporting students' learning. Harmon mentioned that there are two different perspectives we can take on ChatGPT. You can see it as an autonomous conversation agent whose behavior in some ways resembles a human, not the cognition of a human. We can also view it as a very specific tool for a very specific task. Much of the attention has been on ChatGPT as a conversational agent, and that is potentially where many problems and issues arise. However, in the long term, we should consider its role as a tool for very specific learning purposes.

This second use-case, which has not received much attention, can be interesting and exciting, according to Harmon. For instance, AI contains a component of "theory of mind" where it develops a theory of the interacting individuals and similarly, instructors in a regular class setting also develop theories of minds of the students who can be driven by different motivations or be fast/slow learners. As more interactions occur with each student and AI, it is assumed that individualized ways to approach students from AI's perspective would naturally be built through development of theory of minds. If one person was to learn something new, and the AI develops a theory of mind where it realizes how the person enjoys humor and is very responsive, it can accommodate a person's natural behavior and likings. In fact, according to Benjamin Bloom's two sigma problem, this theory of mind and individualization can be very beneficial as Bloom initially discovered how one to one mentoring method was two standard deviations more effective than any other type of learning for the students. Although this cannot be done at scale with current educational practices because one to one teaching is not very cost effective, the use of ChatGPT can bring this idea to the table as individualization can be more possible for students.

When it comes to using these new AI language models, it seems also critical to view these technologies as a double-edged sword and understand both positive and negative sides. On one side, it appears as if they might improve curiosity and creativity in the sense that a student can now write an essay or get ChatGPT's help to write an essay about almost any topic. On the other hand, the fact that ChatGPT can write an essay when earlier the student would have had to do that research also indicates that it perhaps is going to act against curiosity and

creativity because ChatGPT will be doing the work on behalf of the student. Nevertheless, simply putting one word after the other without understanding what the text means does not necessarily make one very creative.

Additionally, faculty need to be aware that bias can exist in the model output and these kinds of models are only as good as the data they are trained on. Goel mentioned that there is no simple solution, and in some sense, it is a cycle. We already have implicit biases within society. A result of this is that we collect data in a biased way, such that representation between groups is skewed (based on income, for example). Thus, algorithms and the results they produce are biased. We also have human analysts who read and interpret the results of the algorithms with their own biases. This feeds back into the system's bias, which continues to grow.

Goel further pointed out that what people need to understand is how ChatGPT derives its answers. ChatGPT does not provide factual answers, rather it provides likely or word choice probable answers based on the questions asked. Thus, it is important that people get a grasp of how ChatGPT processes the question and provides an answer to it. Much of the focus right now is on building technologies, but we do not understand how they work. Even AI scientists only have an approximate understanding because the representations within the neural network are not interpretable. The technology seems to work, but when we inspect it, we cannot always make sense of what exactly the representations are. Goel added that though these tools might be engineering marvels, releasing these technologies without conducting social impact studies is deeply concerning.

To imagine how ChatGPT and other generative language tools will change or reshape the general landscape of assessment in the near future, it is crucial to reflect on the current hype around such tools and critically view how to make sense of this phenomenon where AI models are constantly evolving. Harmon explained that technology growth sometimes follows an exponential curve where after the elapse of a certain amount of time, we tend to spot a progression and evolvment double compared to the previous time frame. We are near a point where the concept of "singularity," where AI is generating and inventing new AI, will result in unpredictable outcomes. Both Goel and Harmon agreed that it is difficult to predict the next 5-10 years. Goel provided examples of IBM Watson and Wolfram Alpha in which people thought that these tools would revolutionize learning and mathematics education when they first came out but this has not happened as expected. Goel mentioned that ChatGPT could be a different beast altogether, or it could just be another bump in the constantly evolving world of technology. Nevertheless, based on the comments from these experts, we anticipate that these generative models like ChatGPT or DALL-E probably will not be a step function in education that fundamentally changes the way we learn or teach. Rather, they will become new tools in our expanding arsenal of tools.

Takeaways and Final Recommendations

After obtaining valuable insights from the experts and reviews of various articles, we have identified some key takeaways and practical implications for the use of generative AI systems, specifically ChatGPT, in higher education settings. As highlighted by Harmon, both instructors and students need to adopt a flexible mindset to optimize educational practices. Instructors in particular should cultivate the ability to think flexibly as traditional teaching methods can delay their mental adaptability to new tools. With flexibility of thinking in mind, instructors should re-evaluate the concept of authentic assessment to determine what they want to measure in a test (content validity) and if the assessment approach accurately reflects this (construct validity). While instructors are generally adept at creating tests or assignments with high content validity, how to ensure high construct validity and how to improve it has become a salient issue since the introduction of tools like ChatGPT. Therefore, to overcome this issue, instructors should critically evaluate whether exams or quizzes can measure what they are supposed to measure. For instance, given that ChatGPT can easily write up college-level essay pieces without truly understanding the content it produced, we need to find out what kinds of assessment

methods other than essay writing would enable us to capture the skills that we want our students to learn and improve (e.g., comprehension, thought processes, problem-solving)

Ongoing discussions about rethinking assessment methods in response to the growing influence of generative AI like ChatGPT remind us of adopting more student-centric assessments that can create meaningful learning opportunities for individual students. As Goel mentioned above, AI is good at generating output based on sophisticated predictions, but that does not mean that AI understands what it says. Existing learning theories suggest that one of the main differences between expert and novice learners is the quality of knowledge organization, that is, how much learners can make deep connections between concepts. Thus, it would be important to design assessments that can provide students with ample opportunities to deepen their knowledge by applying skills to critically analyze and evaluate ideas and to integrate and synthesize concepts. Also, beyond assessing these cognitive skills, how to incorporate assessments of non-cognitive skills such as collaboration, communication, and leadership into classroom learning needs further discussion. That is, instead of emphasizing skills that are traditionally measured by standardized or psychometric tests on which AI can perform very well, we should emphasize skills that are useful and meaningful for human learning and performance and even employability.

Despite many helpful publications and discussions about the use of ChatGPT in educational settings, there are and will be instances where it is used in extreme and inappropriate ways. It is important to consider the potential for misuse of ChatGPT, but it's equally important to recognize its potential benefits as a tool for learning and communication. As we continue to use and adapt to this technology, we can discover innovative ways to integrate it into educational settings. Moreover, given that ChatGPT is constantly evolving, we must understand that there will always be progress and change. For instance, experts started to discuss the design of an AI with the "theory of mind." This development and adaptation cycle will continue, and in the future, it is likely that instructors will utilize ChatGPT in a similar way to how they adapted to the use of calculators in teaching mathematics. This means that users must have a basic understanding of the subject matter before utilizing ChatGPT to aid in their learning.

It is critical to remember that tools like ChatGPT do not necessarily generate factual information. Rather, they produce pieces based on the potential relationships between words. Depending on the questions asked, the outputs generated by ChatGPT may be incorrect, outdated, or illogical. In such case, instructors must caution students about the limitations of such tools and encourage them to compare the outputs with other reliable sources to prevent the spread of misinformation and misconceptions. Also, serendipitous learning experiences can be created if the instructors can open and facilitate discussions on the ChatGPT outputs. It would be beneficial to educate students on AI literacy by encouraging them to discuss the benefits and limits of using text-generator models in learning and teaching them how to use AI tools responsibly to foster meaningful and personalized learning process. Furthermore, given that AI systems are constantly learning and adapting, it would be increasingly important for both instructors and students to learn how to create and engineer prompts to elicit high quality output from generative AI in different situations.

As a final takeaway from this white paper, we would like to recommend educators become knowledgeable about what generative AI can and cannot do in order to envision what we should teach in the fast-paced technological world. According to Dede et al. (2021), we need to shift our attention from AI toward IA, or intelligence augmentation, which focuses on educating people on what AI cannot do well and how humans can collaborate with AI to produce better decision-making outcomes. In other words, IA occurs when "AI and humans engage in a complementary partnership in which a human-and-AI team's overall performance is greater than their individual capacity." Dede pointed out that what AI can do well is "reckoning" based on calculative prediction and formulaic decision-making while what humans can uniquely do is "judgment" that is cultivated

through culture, ethics, biological nature, and so on. Drawing on this notion of IA, as AI takes over tasks that are “routine and predictable” in the classroom, it would free up educators’ time and energy to focus on nurturing personalized learning and bring in the cultural and equity dimensions that AI may not necessarily be able to assist humans with.

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Appendix. Illustration of How ChatGPT Produce Grading Rubrics Based on Different Prompts

Prompt 1 with Less Specific Instructions



You are going to ask undergraduate students to write a short essay about the concept of data-driven education and how data-driven education could impact daily lives of students and teachers. Create a rubric for grading this writing assignment.



Rubric for Data-Driven Education Short Essay Assignment



| Criteria | Excellent (5) | Good (4) | Satisfactory (3) | Needs Improvement (2) | Poor (1) |
|--|---|---|---|--|---|
| Understanding of Data-Driven Education | Student demonstrates a clear understanding of data-driven education, and is able to define the concept with relevant examples | Student demonstrates a good understanding of data-driven education, and is able to provide a definition with some examples | Student demonstrates a satisfactory understanding of data-driven education, but may have some misconceptions or incomplete explanation | Student's understanding of data-driven education is limited or inaccurate | Student does not demonstrate an understanding of data-driven education |
| Impact on Daily Lives | Student provides a clear and insightful analysis of how data-driven education can impact daily lives of students and teachers, with specific examples and relevant evidence | Student provides a good analysis of how data-driven education can impact daily lives of students and teachers, but may lack specificity or depth in examples and evidence | Student provides a satisfactory analysis of how data-driven education can impact daily lives of students and teachers, but may have some inaccuracies or lack of clarity in examples and evidence | Student's analysis of how data-driven education can impact daily lives of students and teachers is limited or irrelevant | Student does not provide an analysis of how data-driven education can impact daily lives of students and teachers |
| Organization and Clarity | Student's essay is well-organized and easy to follow, with clear and concise language that is free of grammatical errors | Student's essay is mostly well-organized and easy to follow, with some errors in clarity or grammar | Student's essay lacks organization and clarity, making it difficult to follow or understand, with several grammatical errors | Student's essay is poorly organized and difficult to follow, with frequent grammatical errors | Student's essay is very poorly organized, with significant errors in clarity and grammar that make it difficult to understand |
| Use of Evidence | Student effectively incorporates relevant evidence to support their analysis and arguments, with proper citations and references | Student incorporates some relevant evidence to support their analysis and arguments, but may lack proper citations or references | Student's use of evidence is limited or inaccurate, or lacks relevance to the analysis and arguments | Student's use of evidence is inaccurate or missing | Student does not incorporate any evidence to support their analysis and arguments |
| Overall | Student demonstrates exceptional understanding and analysis of data-driven education and effectively addresses all aspects of the assignment | Student demonstrates solid understanding and analysis of data-driven education and addresses most aspects of the assignment | Student demonstrates some understanding and analysis of data-driven education, but fails to fully address all aspects of the assignment | Student's understanding and analysis of data-driven education is limited or inaccurate, and fails to address several aspects of the assignment | Student's essay is significantly flawed and fails to address most aspects of the assignment |

Prompt 2 with More Specific Instructions



You are going to assign a 3-page essay task to undergraduate students who are enrolled in a course titled as Data-Driven Education. In this task, students will be asked to write general definition of data-driven education, provide at least 3 important research topics in data-driven education, elaborate on some key challenges and issues in data-driven education research, and include a conclusion about how data-driven education practices can benefit learning and teaching practices. Create a rubric for grading this writing assignment.

|  Rubric for Data-Driven Education Essay Assignment   | | | | | |
|--|---|--|--|---|---|
| Criteria | Excellent (5) | Good (4) | Satisfactory (3) | Needs Improvement (2) | Poor (1) |
| Definition of Data-Driven Education | Student provides a clear and comprehensive definition of data-driven education, supported with relevant examples | Student provides a definition of data-driven education, but it lacks clarity or depth | Student provides a definition of data-driven education, but it is unclear or irrelevant | Student's definition is inaccurate or missing | Student did not attempt to provide a definition |
| Research Topics | Student identifies at least 3 significant research topics in data-driven education and provides a detailed explanation for each, supported by relevant literature | Student identifies 3 research topics in data-driven education and provides a brief explanation for each, supported by some literature | Student identifies fewer than 3 research topics in data-driven education, or explanations lack depth or relevance | Student's identified topics lack relevance or are not related to data-driven education research | Student did not attempt to identify research topics |
| Challenges and Issues | Student identifies and discusses at least 3 significant challenges and issues in data-driven education research, with clear and insightful analysis, supported by relevant literature | Student identifies and discusses 3 challenges and issues in data-driven education research, but analysis is not as insightful or literature is not as relevant | Student identifies fewer than 3 challenges and issues in data-driven education research, or analysis is not clear or lacks depth or relevance | Student's identified challenges and issues lack relevance or are not related to data-driven education research | Student did not attempt to identify challenges and issues |
| Conclusion | Student provides a well-supported conclusion that summarizes the benefits of data-driven education practices for learning and teaching, and offers insightful reflections | Student provides a conclusion that summarizes the benefits of data-driven education practices, but lacks depth or relevance | Student provides a conclusion that lacks clarity or relevance, or does not fully summarize the benefits of data-driven education practices | Student's conclusion is inaccurate or unsupported | Student did not attempt to provide a conclusion |
| Organization and Clarity | Student's essay is well-organized and easy to follow, with clear and concise language that is free of grammatical errors | Student's essay is mostly well-organized and easy to follow, with some errors in clarity or grammar | Student's essay lacks organization and clarity, making it difficult to follow or understand, with several grammatical errors | Student's essay is poorly organized and difficult to follow, with frequent grammatical errors | Student's essay is very poorly organized, with significant errors in clarity and grammar that make it difficult to understand |
| Overall | Student demonstrates exceptional understanding and analysis of data-driven education research and effectively addresses all aspects of the assignment | Student demonstrates solid understanding and analysis of data-driven education research and addresses most aspects of the assignment | Student demonstrates some understanding and analysis of data-driven education research, but fails to fully address all aspects of the assignment | Student's understanding and analysis of data-driven education research is limited or inaccurate, and fails to address several aspects of the assignment | Student's essay is significantly flawed and fails to address most aspects of the assignment |