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## Leveraging ChatGPT for Scoring Students' Subjective Tests

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## Leveraging ChatGPT for Scoring Students' Subjective Tests

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### Abstract

Assessing students' understanding of circle-related material through subjective tests is effective, though grading these tests can be challenging and often requires technological support. ChatGPT has shown promise in providing reliable and objective evaluations. Many teachers in Indonesia, however, continue to face difficulties integrating technology into assessments, highlighting the need for research on leveraging ChatGPT for scoring subjective tests. This study explores the potential of ChatGPT in mathematics education, specifically for evaluating students' answers on subjective tests related to circles. Using a qualitative case study approach, the research investigates how ChatGPT analyzes student responses. The findings reveal that ChatGPT effectively processes the answers of 15 vocational school students, delivering results that are logical and well-structured. ChatGPT aids teachers by offering a comprehensive evaluation focused on accuracy, clarity, completeness, and technical terminology. This approach supports effective feedback and objective assessment, making ChatGPT a valuable tool for understanding and addressing students' mathematical comprehension issues.

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### Introduction

The teaching and learning process is a fundamental part of the education system. The entire education system depends on the objectives of the teaching and learning process. In this process, evaluation is a crucial and mandatory component (Shinde, 2022). Learning evaluation is a process that involves measuring the achievement of learning goals, providing feedback for improvement, identifying individual student needs, enhancing teaching quality, and assessing and holding the education system accountable (Septiani et al., 2023). Evaluation plays a significant role in the teaching-learning process (Shinde, 2022) because it is essential for ensuring effective teaching, learning, and assessment methodologies. It measures the effectiveness of educational programs in relation to their objectives (Tripathi, 2018). There are two types of techniques for learning evaluation: tests and non-tests. A test is a technique or method used to carry out measurement activities, which includes various questions, statements, or a series of tasks that students must complete or answer to measure aspects of their behavior (Hayati et al., 2020). The learner's behavior can be professionally assessed by constructing a test through a sequence of steps, ensuring that the obtained marks are reliable and accurately reflect the learner's true level (Qudah, 2016).

Tests can be classified into two groups according to scoring or construction: objective tests and subjective tests. Objective tests are called objective because their scoring does not depend on the personal judgment or opinion of the scorer. In contrast, subjective tests are called subjective because their scoring depends on the scorer's personal judgment or opinion (Shaban, 2022). Techniques used in objective tests include multiple-choice items, true/false items, matching items, transformation sentences, rearrangement items, and fill-in-the-blanks or gap filling (Shaban, 2022). On the other hand, the techniques used in subjective tests include essay writing, composition writing, letter writing, reading aloud, completion-type, and answering questions. Furthermore, objective tests require much time and effort to write, as the examiner has to provide the answers as well as the questions. Therefore, objective tests require more careful preparation than subjective tests. However, in subjective tests, the examiner only needs to write a few questions without providing answers (Shaban, 2022). Objective tests are generally more reliable because they provide a stable score, while subjective tests are less reliable because they do not provide a stable score (Shaban, 2022). Another opinion states that objective tests (multiple choice) have deficiencies in measuring the level of understanding possessed by students because they have a higher incidence of cheating compared to other forms of tests, such as subjective tests (essays) (Surat & Darmayoga, 2018). Essay-type questions require students to recall and organize ideas or information they have learned, explaining or expressing those ideas in written form, which clearly reveals the students' understanding (Surat & Darmayoga, 2018). Based on these opinions, we can conclude that subjective tests are important for assessing students' understanding, but the challenge lies in reliably scoring subjective tests.

One of the test items that is appropriate to use subjective tests is mathematics material because the process of solving mathematical problems is very important for teachers to know in order to see how far students have achieved their learning. By understanding the progress of students' learning achievement, a teacher can give reinforcement or enrichment to students (Noor, 2019). The research found out that the use of multiple choice and essay test by teachers in posttests in teaching and learning activities ranges 81% for the essay test, fulfilling test (63.9%), and multiple choice (56.5%) (Noor, 2019). The finding revealed that teachers tend to use essay test for both formative and sumative tests more often. The essay test is also used by the Trends in International Mathematics and Science Study (TIMSS) and the programme for International Students Assessment (PISA) to measure students' competence in Mathematics, language, and science and most students find it difficult to do the essay test in Mathematics (Wahyuddin, 2016, Sulestry and Meliyana, 2018 in Noor, 2019). One of the weaknesses of essay test is the difficulty in setting up the scoring rubrics due to the different difficulty levels of the test items (Noor, 2019). So, we can conclude that subjective test on mathematics is good for reveal students' learning achievement, but there is difficulty in setting up the scoring student's answer.

One of the idea to solve that problem is by using AI. AI is a branch of computer science. AI systems use hardware, algorithms, and data to create "intelligence" to do things like make decisions, discover patterns, and perform some sort of action. AI is a general term and there are more specific terms used in the field of AI. AI systems can be built in different ways, two of the primary ways are: (1) through the use of rules provided by a human (rule-based systems); or (2) with machine learning algorithms (Kritandani et al., 2024). AI enabled educational systems will be desirable in part due to their ability to support more natural interactions during teaching and learning (Kritandani et al., 2024). AI uses mathematical logic to formalize commonsense knowledge in such a way that

common-sense problems can be solved by logical reasoning (McCarthy, 2022). AI models and AI-enabled systems may have potential to strengthen assessments. In one example, a question type that invites students to draw a graph or create a model can be analyzed with AI algorithms, and similar student models might be grouped for the teacher to interpret (Kritandani et al., 2024). Enhanced assessment may enable teachers to better respond to students' understanding of a concept like "rate of change" in a complex, real-world situation (Kritandani et al., 2024). AI can also give learners feedback on complex skills where no person is available to provide immediate feedback. Based on that opinion, we can use AI to giving assessment for the students. One tools of AI that can we use is ChatGPT.

In the end of 2022, ChatGPT application released by OpenAI company to the public and millions of people started using in the first month because of its unprecedented level of intelligence and complexity in addition to part of the community claiming it will be the new Google search engine (Dasari et al., 2024). ChatGPT is an emerging technology that provides educational researchers with the opportunity to explore the potential applications and benefits of AI technology (Davis & Lee, 2024). Two recent releases, ChatGPT-3.5, released in November 2022, and its subsequent upgrade, ChatGPT-4, in March 2023, have provided different access capabilities, both models demonstrated equivalent accuracy with respect to information output but noted nuanced variations in the way they defined certain terms (Davis & Lee, 2024). For example, ChatGPT-3.5 defined 'digital leadership' with an emphasis on the teaching-learning process, whereas ChatGPT-4 focused on the integration of digital leadership with school management (Davis & Lee, 2024). ChatGPT 3.5 is an emerging technology that provides educational researchers with the opportunity to explore the potential applications and benefits of AI technology (Davis & Lee, 2024). Due to the ability of ChatGPT 3.5 in generating human-like language and answering many questions in a logical manner even if these questions asking to prepare an assignment, quiz questions or any other academic task (Dasari et al., 2024). Many academics started using ChatGPT 3.5 and found it useful to save their time in teaching, assessment and research, so they can spend more time with students on other important activities (Dasari et al., 2024). The literature review indicates that while ChatGPT 3.5 has the potential to enhance personalized learning, feedback and assessment (Dasari et al., 2024). Therefore, ChatGPT 3.5 can help teacher giving feedback of the assessment like scoring student's subjective tests.

Although the use of ChatGPT 3.5 in analyzing student answers is still rare, including in subjects like mathematics, there have been several studies on its use in other subjects. For instance, research on chemistry has yielded the following results: " ChatGPT 3.5-generated responses to chemistry assessment questions were well-written. The quality of responses in this investigation varied, and ChatGPT 3.5 demonstrated limitations in addressing application and interpretation questions and non-text information" (Fergus et al., 2023). Other research results align with these findings. For example, in the study "Accuracy and Completeness of ChatGPT 3.5-Generated Information on Interceptive Orthodontics: A Multicenter Collaborative Study," the AI responses showed a high level of accuracy and completeness and a great ability to solve difficult clinical cases, although the answers were not 100% accurate and complete (Hatia et al., 2024). Similar results were shown in another study, which found that "While immediate deployment presents certain challenges, the performance exhibited by one-shot GPT justifies a more in-depth exploration across multiple dimensions. These avenues include investigating the impact of employing additional shots, enhancing question clarity, and providing the model with comprehensive

information, including grading criteria and reference answers" (Chang & Ginter, 2024). Several studies have demonstrated the validity of ChatGPT 3.5 in grading students' answers, including a study titled "Fine-tuning ChatGPT for Automatic Scoring," which found that fine-tuned GPT-3.5 is highly effective for automatic scoring of student responses in domain-specific educational data, with high accuracy (Latif & Zhai, 2024). This finding is supported by other research indicating that ChatGPT 3.5 has the potential to be a valuable tool for educational and research work. ChatGPT 3.5 is revolutionary in its ability to maintain human-like conversations and generate human-like text for any natural language query, making it nearly indistinguishable from human responses (Rahman & Watanobe, 2023). Therefore, it can be concluded that ChatGPT 3.5 is reliable for grading students' answers.

One of the mathematics sub-materials that often uses subjective tests is geometry because it involves pictures and analytical explanations. Students begin to understand geometry through direct interaction with their physical world (Faires, 2017). As the study of the physical attributes of the environment, geometry is relevant to every student. Students traditionally develop a greater respect and appreciation for mathematical methods through their study of this imaginative geometric material (Faires, 2017). A circle is a fundamental element in geometry that connects various concepts and theorems. A deep understanding of the properties of circles and their relationship to other geometric concepts allows students and professionals to apply mathematical principles in various fields of science and technology. By studying circles, we not only understand this basic shape but also open the door to further exploring many aspects of geometry and its applications. The theoretical importance of circles is reflected in the numerous and varied situations in science where circles are used to model physical phenomena (Arnigo et al., 2018). This highlights the importance of understanding mathematics, particularly circles, for all students, including vocational school students. A fundamental understanding that students need to master is the definition of a circle.

One way for teachers to gauge students' understanding of circle material is by administering tests, with subjective tests being particularly effective. This is due to the advantages of essay or subjective tests, which include: 1) This type of test is well-suited for measuring or assessing the results of a complex learning process that is difficult to evaluate with objective tests; 2) The use of essay tests provides students with the opportunity to construct their answers according to their own thought processes (Putri et al., 2022). Based on the discussion in the previous paragraph, assessing the definition of a circle is crucial because it can measure students' understanding of the fundamental concept of circles. Therefore, the most suitable type of test is a subjective test. However, as previously mentioned, grading subjective tests is not easy and requires technological assistance, specifically ChatGPT, which can provide reliable and objective evaluations. Thus, teachers can obtain well-justified data regarding students' understanding of the definition of a circle.

However, many teachers in Indonesia still find it challenging to conduct assessments using technology, as evidenced by research presented by Umiyati (2021). This reality makes the researcher feel it is crucial to conduct research about "Leveraging ChatGPT for Scoring Students' Subjective Tests" in addition to the lack of existing studies, the researcher also hopes that this research will motivate teachers to use technology for assessing circles, thereby facilitating their ability to obtain data on students' understanding of circles, particularly their

understanding of the definition of a circle, more effectively. This research aims to explore the potential use of ChatGPT 3.5 in mathematics education, especially leveraging ChatGPT 3.5 for scoring students' answer on subjective test, especially in circle material. Therefore, we propose the research questions that we will answer through this research "How can ChatGPT 3.5 assist teachers in analyzing students' test results on the understanding of the definition of a circle?"

## **Method**

Referring to the research question posed, this study adopts qualitative research approach. Qualitative research is a type of scientific research (Mack et al., 2005). Qualitative research is especially effective in obtaining culturally specific information about the values, opinions, behaviors, and social contexts of particular populations (Mack et al., 2005). One of approach in qualitative research is case study (Yin, 2011). Case study is an empirical inquiry that investigates the case or cases conforming to the abovementioned definition by addressing the "how" or "why" questions concerning the phenomenon of interest (Yin, 2011). Case studies can focus on various subjects, including specific situations, events, programs, and phenomena. This research use case study because this research aims to understand the complexities of students' answer of subjective test analyzed by ChatGPT.

A case study focuses on an in-depth exploration of a specific case within its real-life context. If we use a case study approach to analyze students' test answers with the help of AI, we will: 1) select one or several specific cases (e.g., test answers from students in a particular class or school); 2) analyze the specific context and conditions affecting students' answers; 3) use multiple data sources to gain a comprehensive understanding of the case. AI can assist by: 1) processing and analyzing various types of data (text, metadata, etc.) from students' answers; 2) identifying patterns and relationships in the data that might be relevant to the specific case context. Therefore, case study is suitable if the research goal is to thoroughly investigate a specific case, including the context and conditions influencing it like in this research.

Based on the meaning of a case study explained earlier, it is clear that the subject of the research becomes a crucial aspect in conducting a case study. The research objectives and the characteristics of the study population (such as size and diversity) determine who and how many people should be selected (Mack et al., 2005). This study employs purposive sampling, a common strategy that selects participants based on pre-established criteria relevant to the research question (Mack et al., 2005). The sample comprised 15 respondents from vocational school (SMK) students at a school in Central Java who had received mathematics instruction on circle material. Choosing vocational school (SMK) students for this research is crucial due to several reasons. Vocational students require precise and in-depth assessment of fundamental mathematical concepts, such as circles, which are directly related to their technical skills. Utilizing ChatGPT for analyzing subjective test results ensures a more objective and consistent evaluation, helping to uncover how these students understand the material in their specific educational context. This approach also demonstrates the application of advanced technology in vocational education, providing valuable insights into teaching effectiveness and curriculum development. By identifying challenges and improving assessment methods. Data collection methods in this research include observation and written essay tests, with the following instruments used:

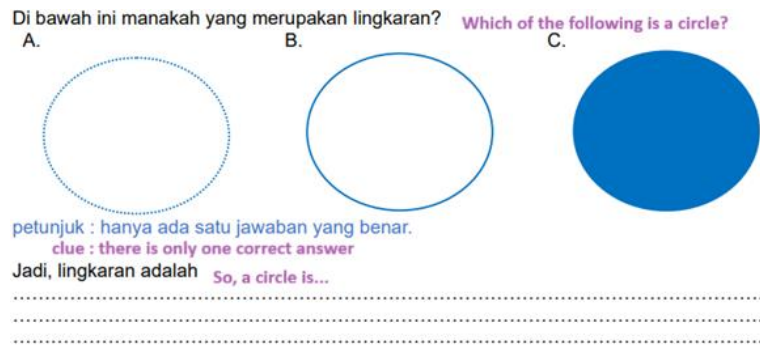


Figure 1. Written Circle Essay Test Given to Students

The step that needs to be taken in analyzing student answers using ChatGPT 3.5 is to compose a prompt. From the results of the work of 15 students, an analysis of the answers was carried out using ChatGPT 3.5, with the following prompt:

Give feedback for students answer below based on the question "what is the definition of circle"  
 [paste student assignment here]  
 If the feedback not clear enough, use the next instruction: "is it correct or not?"  
 from 1-10 give the score for students answer of student

Data analysis in this study used the Miles and Huberman model, carried out in three stages: (1) data collection, where the researchers recorded all student responses in answering questions related to the definition of circle; (2) data presentation, the researchers display the results of student answer analysis on ChatGPT 3.5; (3) drawing conclusions, where the researchers analyzed the results of student answer analysis given by ChatGPT 3.5 (Miles & Huberman, 1994).

## Results

After being given instructions, ChatGPT 3.5 provides responses to the 15 student answers entered. The responses given are according to the prompt, namely feedback with a description and quantity score for each student's answer, these results are displayed in Table 1:

Table 1. Analysis Results of Student Answers Given by ChatGPT

The instruction
Give feedback for students answer below based on the question "what is the definition of circle"
ChatGPT's response
Sure, let's review the student's answer: "The definition of circle is a shape that is round and has no corners." Feedback: Incomplete Definition: While the student mentions that a circle is round and has no corners, the definition lacks important details about the defining characteristics of a circle. Specifically, it doesn't mention that a

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circle is composed of all points in a plane that are equidistant from a fixed point called the center.

Lack of Technical Terms: The definition could benefit from including key terms such as "plane," "equidistant," and "center," which are essential for understanding the concept of a circle.

Precision: The statement "round and has no corners" is somewhat informal and doesn't capture the precision required in mathematical definitions. It's important to emphasize the geometric properties of circles, such as their curvature and symmetry.

Overall, while the student's answer shows some understanding of circles as round shapes, it could be improved by providing a more comprehensive and precise definition that incorporates the fundamental geometric properties of circles.

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The instruction

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Student1's Answer: "A circle is a flat area that is circular in shape"

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ChatGPT's response

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Feedback for Student1's answer:

**Clarity:** The answer is clear and concise, making it easy to understand.

**Correctness:** The statement accurately describes a circle as a flat, two-dimensional shape.

**Completeness:** While the definition correctly identifies a circle as a flat area, it could be enhanced by including additional details. Specifically, it could mention that a circle is formed by all points in a plane that are equidistant from a fixed point called the center.

**Technical Terminology:** The answer lacks technical terminology such as "plane," "equidistant," and "center," which are important for a precise definition of a circle.

**Improvement:** To improve the answer, the student could expand it to include these technical terms and provide a more comprehensive definition that captures the defining characteristics of a circle.

Overall, Student1's answer provides a basic understanding of a circle but could be enhanced by including additional details and technical terminology.

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The instruction

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is it correct or not?

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ChatGPT's response

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**Student1's answer is partially correct.** It accurately describes a circle as a flat area that is circular in shape, which is a fundamental aspect of what a circle is. However, it lacks some important details such as mentioning that a circle consists of all points in a plane that are equidistant from a fixed point called the center. Additionally, it could benefit from using more technical terminology to provide a more precise definition. Therefore, while the answer is somewhat correct in conveying the general idea of a circle, it could be improved to provide a more comprehensive definition.

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The instruction

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from 1-10 give the score for students answer of Student1

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ChatGPT's response

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Scoring the student answers on a scale of 1-10:

Accuracy: 7/10

Clarity: 8/10

Completeness: 6/10

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Technical Terminology: 5/10

**Overall Score: 6.5/10**

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The instruction

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Student2's Answer: "A circle is a line drawn without being cut so it is connected to form a circle"

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ChatGPT's response

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Feedback for Student2's answer:

**Accuracy:** The answer is incorrect. A circle is not simply a line drawn without being cut. It's a two-dimensional shape formed by all points equidistant from a central point, which gives it a circular shape.

**Misinterpretation:** The response seems to misunderstand the concept of a circle. It implies that a circle is formed by drawing a line without interruption, which doesn't accurately capture the geometric properties of a circle.

**Lack of Precision:** The answer lacks precision and technical accuracy in describing what constitutes a circle. It doesn't mention the key characteristic of a circle being formed by the set of all points equidistant from a central point.

**Improvement:** To improve, the student should provide a more accurate definition that includes the geometric properties of a circle, such as its curvature and the relationship between its points and the center.

Overall, **Student2's answer is incorrect** and could be improved by providing a more accurate and precise definition of a circle.

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The instruction

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from 1-10 give the score for students answer of Student2

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ChatGPT's response

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Scoring the student answers on a scale of 1-10:

Accuracy: 3/10

Clarity: 4/10

Completeness: 2/10

Technical Terminology: 2/10

**Overall Score: 2.75/10**

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The instruction

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Student3's Answer: "A circle is a collection of points connected to form an infinite line"

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ChatGPT's response

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Feedback for Student3's answer:

**Inaccuracy:** The answer is incorrect. A circle is not a collection of points connected to form an infinite line. Rather, it is a two-dimensional geometric shape formed by all points equidistant from a fixed point called the center.

**Misinterpretation:** The response misunderstands the concept of a circle by describing it as an infinite line formed by connecting points. This description does not accurately capture the defining characteristics of a circle.

**Lack of Precision:** The answer lacks precision and fails to mention key geometric properties such as the relationship between the points on the circle and the center.

**Improvement:** The student should provide a more accurate definition that includes the fundamental properties

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of a circle, such as its round shape and the equidistance of its points from the center.

Overall, **Student3's answer is incorrect** and would benefit from a better understanding of the geometric properties of circles.

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The instruction

from 1-10 give the score for students answer of Student3

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ChatGPT's response

Scoring the student answers on a scale of 1-10:

Accuracy: 3/10

Clarity: 4/10

Completeness: 2/10

Technical Terminology: 2/10

**Overall Score: 2.75/10**

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The instruction

Student4's Answer: "A circle is a two-dimensional flat shape formed from a collection of points at a constant/regular distance from a fixed point on a plane"

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ChatGPT's response

Feedback for Student4's answer:

**Accuracy:** The answer is mostly accurate. It correctly identifies a circle as a two-dimensional flat shape formed by a collection of points. It also mentions the key characteristic of these points being at a constant/regular distance from a fixed point, which is the center.

**Clarity:** The response is clear and easy to understand. It effectively communicates the essential properties of a circle.

**Completeness:** The answer could be improved by explicitly mentioning that these points are equidistant from the fixed point, which is essential to understanding the geometry of a circle.

**Technical Terminology:** The use of terms like "two-dimensional flat shape" and "constant/regular distance" demonstrates an understanding of geometric concepts, which adds clarity to the definition.

**Improvement:** Adding the term "equidistant" would enhance the completeness and precision of the answer.

Overall, Student4's answer provides a solid understanding of a circle but could be improved by explicitly mentioning that the points on the circle are equidistant from the fixed point.

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The instruction

for Student4's answer, it is correct or incorrect?

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ChatGPT's response

**Student4's answer is mostly correct.** It accurately describes a circle as a two-dimensional flat shape formed by a collection of points at a constant distance from a fixed point, which is the center. However, it could be slightly enhanced by explicitly mentioning that these points are equidistant from the center. Therefore, while it captures the essence of a circle, it could be improved for precision.

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The instruction

from 1-10 give the score for students answer of Student4

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ChatGPT's response

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Scoring the student answers on a scale of 1-10:

Accuracy: 8/10

Clarity: 9/10

Completeness: 7/10

Technical Terminology: 8/10

**Overall Score: 8/10**

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The instruction

Student5's Answer: "A circle is a collection of certain points, if these points are connected to each other they will form an endless curved line". Give feedback and score!

---

ChatGPT's response

Feedback for Student5's answer:

**Accuracy: 6/10** - The answer describes a circle as a collection of points forming an endless curved line when connected. While this captures the circular shape, it doesn't fully convey the concept of equidistance from a fixed point.

**Clarity: 7/10** - The answer is fairly clear in its description, but it could be improved by specifying that the collection of points is equidistant from a fixed point, enhancing clarity.

**Completeness: 5/10** - The answer lacks completeness as it does not mention the critical aspect of a circle, which is that the points are equidistant from a fixed point, forming a closed curve.

**Technical Terminology: 4/10** - There is a lack of technical terminology such as "equidistant" and "fixed point", which are crucial for a precise definition of a circle.

**Overall Score: 5.5/10** - While the answer captures some aspects of a circle, it could be improved by incorporating the concept of equidistance from a fixed point and using more technical terminology for precision.

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The instruction

is it correct or not?

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ChatGPT's response

**The answer provided by Student5 is partially correct.** It captures some aspects of a circle, such as its curved shape formed by connected points. However, it lacks completeness as it fails to mention the critical aspect of a circle, which is that the points are equidistant from a fixed point, forming a closed curve. Therefore, while it partially describes a circle, it is not entirely accurate.

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The instruction

Student6's Answer: "A circle is a geometric figure that has no vertices and has an infinite number of folds"

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ChatGPT's response

Feedback for Student6's answer:

**Accuracy: 2/10** - The answer is inaccurate. A circle does not have folds, as it is a smooth, continuous curve with no edges or corners. Additionally, a circle does not have vertices, which are points where edges meet in polygons.

**Clarity: 4/10** - The answer lacks clarity because it introduces the concept of "folds," which is not applicable to circles. This could lead to confusion about the nature of a circle.

**Completeness: 2/10** - The answer is incomplete as it does not accurately describe the defining characteristics

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of a circle. It does not mention that a circle is formed by all points equidistant from a fixed point called the center.

**Technical Terminology: 3/10** - The answer uses incorrect terminology ("folds") and fails to include key terms such as "equidistant" and "center," which are essential for understanding circles.

**Overall Score: 2.75/10** - **The answer is inaccurate**, lacks clarity, completeness, and appropriate technical terminology. Incorrect understanding of a circle, mentioning folds which are not applicable. Lacks clarity and completeness in describing the geometric properties of a circle. Encourage further understanding of circles as smooth, continuous curves with no vertices or folds. It would benefit from a clearer understanding of the geometric properties of circles.

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The instruction

Student7's Answer: "A circle is a geometric shape consisting of curved lines whose distance from the center point is the same"

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ChatGPT's response

Feedback for Student7's answer:

**Accuracy: 9/10** - The answer is highly accurate. It correctly identifies a circle as a geometric shape formed by curved lines, and importantly, it emphasizes that the distance from any point on the circle to the center point is the same. The only minor inaccuracy is the use of "lines" instead of "curve segments," but this doesn't significantly impact the accuracy of the statement.

**Clarity: 9/10** - The answer is clear and concise. It effectively communicates the essential properties of a circle, making it easy to understand.

**Completeness: 9/10** - The answer is nearly complete. It accurately describes the key characteristic of a circle, which is the equidistance of points from the center. However, it could be slightly enhanced by mentioning that a circle is formed by all points equidistant from the center.

**Technical Terminology: 8/10** - The answer uses appropriate terminology such as "geometric shape" and "center point." However, it could benefit from using "curve segments" instead of "lines" for precision.

**Overall Score: 8.75/10** - **Student7's answer is highly accurate**, clear, and nearly complete. It effectively describes the essential properties of a circle, with only minor room for improvement in technical terminology.

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The instruction

Student8's Answer: "A circle is a transverse line that forms a circle and has a radius"

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ChatGPT's response

Feedback for Student8's answer:

**Accuracy: 3/10** - The answer is not accurate. Describing a circle as a "transverse line" is incorrect. A circle is not a line but rather a two-dimensional shape formed by all points equidistant from a fixed point called the center. Additionally, while it mentions the radius, it doesn't fully describe the circle as a whole.

**Clarity: 4/10** - The answer lacks clarity due to the inaccurate description of a circle as a "transverse line." This could lead to confusion about the nature of a circle.

**Completeness: 3/10** - The answer is incomplete as it does not accurately describe the defining characteristics of a circle. It focuses only on the radius without providing a comprehensive understanding of the circle's shape and properties.

**Technical Terminology: 2/10** - The answer lacks appropriate technical terminology and incorrectly describes

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a circle as a "transverse line."

**Overall Score: 3/10 - Student8's answer is inaccurate**, unclear, incomplete, and lacks appropriate technical terminology. It would benefit from a clearer understanding of the geometric properties of circles.

The instruction

Student9's Answer: "A circle is a shape of space that has many sides or angles because all parts of the circle are angles"

ChatGPT's response

Feedback for Student9's answer:

**Accuracy: 2/10** - The answer is not accurate. Describing a circle as having "many sides or angles" is incorrect. A circle is a two-dimensional shape with no sides or angles. It is formed by all points equidistant from a fixed point called the center.

**Clarity: 3/10** - The answer lacks clarity due to the inaccurate description of a circle as having "many sides or angles." This could lead to confusion about the nature of a circle.

**Completeness: 1/10** - The answer is incomplete and does not accurately describe the defining characteristics of a circle. It incorrectly states that a circle has sides or angles, which is not true.

**Technical Terminology: 1/10** - The answer lacks appropriate technical terminology and misrepresents the geometric properties of a circle.

**Overall Score: 1.75/10 - Student9's answer is inaccurate**, unclear, incomplete, and lacks appropriate technical terminology. It requires a clearer understanding of the geometric properties of circles.

The instruction

Student10's Answer: "A circle is the locus of points that are the same distance from one point"

ChatGPT's response

Feedback for Student10's answer:

**Accuracy: 9/10** - The answer is highly accurate. It correctly identifies a circle as the locus of points that are equidistant from a fixed point called the center. This definition accurately captures the geometric essence of a circle.

**Clarity: 9/10** - The answer is clear and concise. It effectively communicates the essential property of a circle, making it easy to understand.

**Completeness: 9/10** - The answer is nearly complete. It accurately describes the key characteristic of a circle, which is the equidistance of points from the center. However, it could be slightly enhanced by explicitly mentioning that the distance is constant.

**Technical Terminology: 9/10** - The answer uses appropriate terminology such as "locus of points" and "equidistant," demonstrating a good understanding of geometric concepts.

**Overall Score: 9/10 - Student10's answer is highly accurate**, clear, and nearly complete. It effectively describes the essential property of a circle with appropriate technical terminology.

The instruction

Student11's Answer: "A circle is a flat shape that has a radius and only consists of one fold line"

ChatGPT's response

Feedback for Student11's answer:

**Accuracy: 4/10** - The answer is somewhat inaccurate. While it correctly identifies a circle as a flat shape with

a radius, the statement about it consisting of only one fold line is incorrect. Circles are smooth, continuous curves with no edges or folds.

**Clarity: 5/10** - The answer is somewhat clear, but the mention of a "fold line" could lead to confusion, as circles do not have fold lines. Additionally, the term "flat shape" might not fully capture the two-dimensional nature of a circle.

**Completeness: 4/10** - The answer is incomplete as it does not accurately describe the defining characteristics of a circle. It incorrectly mentions a "fold line" and does not mention that a circle is formed by all points equidistant from a fixed point called the center.

**Technical Terminology: 4/10** - The answer lacks technical terminology such as "equidistant" and "center," which are crucial for a precise definition of a circle.

**Overall Score: 4.25/10** - **Student11's answer is somewhat inaccurate**, lacks clarity, completeness, and appropriate technical terminology. It would benefit from a clearer understanding of the geometric properties of circles.

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The instruction

Student12's Answer: "A circle is a flat shape made up of curves and not straight lines so it does not form a polygon"

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ChatGPT's response

Feedback for Student12's answer:

**Accuracy: 7/10** - The answer is mostly accurate. It correctly identifies a circle as a flat shape made up of curves and emphasizes that it does not form a polygon, which is true. However, it could be clarified that a circle is a specific type of curve, namely one formed by all points equidistant from a fixed point called the center.

**Clarity: 8/10** - The answer is clear in its description of a circle as a flat shape made up of curves and emphasizing its distinction from polygons. However, it could be improved by providing more detail about the defining characteristic of a circle as being formed by all points equidistant from a fixed point.

**Completeness: 6/10** - The answer is somewhat incomplete as it does not explicitly mention the key characteristic of a circle being formed by all points equidistant from a fixed point. However, it correctly identifies that a circle does not form a polygon.

**Technical Terminology: 6/10** - The answer lacks technical terminology such as "equidistant" and "center," which are important for a precise definition of a circle.

**Overall Score: 6.75/10** - **Student12's answer is mostly accurate**, clear, and emphasizes the distinction between a circle and polygons. However, it could be improved by providing more detail about the defining characteristic of a circle and using appropriate technical terminology.

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The instruction

Student13's Answer: "A circle is a shape that has no corners. A circle is a collection of points on a plane line that are all the same distance from a certain point"

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ChatGPT's response

Feedback for Student13's answer:

**Accuracy: 7/10** - The answer is mostly accurate. It correctly identifies a circle as a shape with no corners, and it mentions that a circle is formed by a collection of points on a plane. However, it would be more accurate to

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say that the points are equidistant from a certain point (the center), rather than all being the same distance from a certain point.

**Clarity: 8/10** - The answer is clear in its description of a circle as a shape with no corners and a collection of points on a plane. However, the phrase "on a plane line" might be slightly misleading or unclear.

**Completeness: 7/10** - The answer is relatively complete. It accurately describes the lack of corners in a circle and the arrangement of points on a plane. However, it could be improved by explicitly mentioning that the points are equidistant from a certain point (the center).

**Technical Terminology: 6/10** - The answer lacks technical terminology such as "equidistant" and "center," which are important for a precise definition of a circle.

**Overall Score: 7/10 - Student13's answer is partially correct.** It accurately identifies a circle as a shape with no corners, and it mentions that a circle is formed by a collection of points on a plane. However, it could be more precise in stating that the points on the circle are equidistant from a certain point, which is the center. Overall, while it captures some aspects of a circle, it could be improved for accuracy and completeness.

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The instruction

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Student14's Answer: "A circle is a shape that does not have a central point at its base which is round or circular"

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ChatGPT's response

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Feedback for Student14's answer:

**Accuracy: 3/10** - The answer is inaccurate. It states that a circle does not have a central point at its base, which is incorrect. A circle does have a central point, known as the center, from which all points on the circle are equidistant.

**Clarity: 4/10** - The answer is somewhat unclear. The statement about a circle not having a central point at its base is confusing and doesn't accurately represent the geometry of a circle.

**Completeness: 3/10** - The answer is incomplete as it does not accurately describe the defining characteristics of a circle. It fails to mention the central point (the center) from which all points on the circle are equidistant.

**Technical Terminology: 2/10** - The answer lacks technical terminology such as "center" and "equidistant," which are important for a precise definition of a circle.

**Overall Score: 3/10 - Student14's answer is inaccurate,** unclear, incomplete, and lacks appropriate technical terminology. It would benefit from a clearer understanding of the geometric properties of circles.

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The instruction

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Student15's Answer: "A circle is a geometric shape formed by a collection of points that are the same distance apart"

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ChatGPT's response

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Feedback for Student15's answer:

**Accuracy: 9/10** - The answer is highly accurate. It correctly identifies a circle as a geometric shape formed by a collection of points that are the same distance apart. This accurately captures the defining characteristic of a circle.

**Clarity: 9/10** - The answer is clear and concise. It effectively communicates the essential property of a circle, making it easy to understand.

**Completeness: 9/10** - The answer is nearly complete. It accurately describes the key characteristic of a circle,

which is that all points on the circle are equidistant from a fixed point called the center. However, explicitly mentioning the center would enhance completeness.

**Technical Terminology: 8/10** - The answer uses appropriate terminology such as "geometric shape" and "equidistant," demonstrating a good understanding of geometric concepts. However, explicitly mentioning the "center" would improve technical precision.

**Overall Score: 8.75/10** - Student15's answer is **highly accurate**, clear, and nearly complete. It effectively describes the essential property of a circle with appropriate technical terminology, with only minor room for improvement in technical precision.

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Before discussing the results of the analysis of the answers given by ChatGPT 3.5, let's look at ChatGPT-3.5's answers to the questions given below:

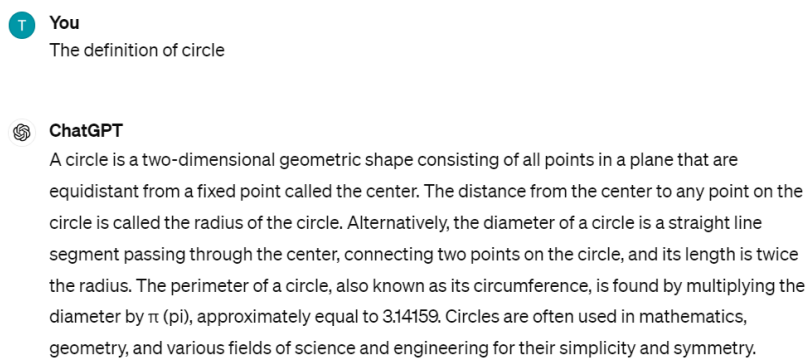


Figure 2. ChatGPT-3.5's Answer About Definition Of A Circle

Now, let's look at Euclid's definition of a circle below:

“A circle is a plane figure contained by a single line [which is called a circumference], (such that) all of the straight-lines radiating towards [the circumference] from one point amongst those lying inside the figure are equal to one another. And the point is called the center of the circle.” (Pereyra, 2022, p.6)

If we compare, the definition given by ChatGPT and the definition from Euclid are the same, so we can conclude that ChatGPT 3.5 has a good basic understanding of the definition of a circle. Next let's look at ChatGPT-3.5's response to the definition of a circle given by Euclid.

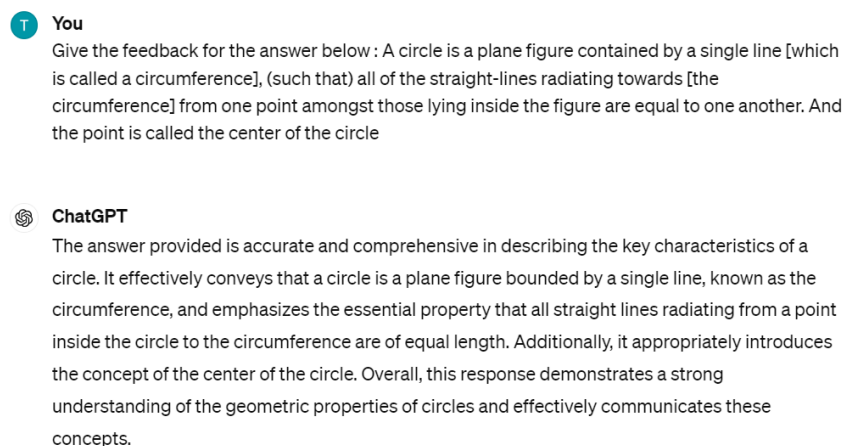


Figure 3. ChatGPT-3.5's Response to the Definition of a Circle Given by Euclid



From these responses, it can be concluded that the results of the analysis of student answers given by ChatGPT 3.5 are correct. Next, let's see how ChatGPT 3.5 provides analysis of student answers. From table 1, it can be seen that ChatGPT 3.5 analyzes student answers using 4 indicators, namely: *accuracy*, *clarity*, *completeness*, and *technical terminology*. Using multiple indicators allows for a more comprehensive evaluation of the student's answer. Here's why each indicator is important:

1. **Accuracy:** This indicator assesses the correctness of the information provided in the answer. It ensures that the student has a solid understanding of the topic and can convey accurate information.
2. **Clarity:** Clarity refers to how well the answer is expressed and how easily it can be understood by the reader. Clear communication is crucial for effective learning and comprehension.
3. **Completeness:** Completeness evaluates whether the answer covers all relevant aspects of the topic. It ensures that the student has provided a thorough response that addresses the main points or requirements of the question.
4. **Technical Terminology:** This indicator assesses the use of specialized vocabulary or terminology related to the topic. Using technical terms correctly demonstrates a deeper understanding of the subject matter and enhances the precision of the answer.

By considering these four indicators, ChatGPT 3.5 provide a well-rounded evaluation of the student's answer, taking into account accuracy, clarity, thoroughness, and technical proficiency. This approach helps ensure that the feedback is comprehensive and constructive, guiding the student towards a deeper understanding of the topic.

From an educational perspective, it is evident how greatly teachers are assisted by the analysis of student answers provided by ChatGPT 3.5. The question on the "definition of a circle" poses significant challenges for students, as it requires a solid understanding of the concept to formulate an appropriate definition. Not only do students struggle with this, but teachers also find it challenging to provide adequate feedback due to the variety of student responses and the difficulty of scoring essay-type questions. ChatGPT 3.5 can help teachers by offering both descriptive and quantitative feedback. This feedback aids in identifying and correcting misconceptions in each student's understanding. Additionally, instructing ChatGPT 3.5 is straightforward simply provide initial instructions and submit each student's answer, and ChatGPT 3.5 will generate the analysis without needing repeated instructions. Thus, leveraging AI, particularly ChatGPT 3.5, to provide feedback and scores on students' subjective test results is both feasible and efficient.

## **Discussion**

The research results effectively addressed the research question: " How can ChatGPT 3.5 assist teachers in analyzing students' test results on the understanding of the definition of a circle?" The results section demonstrates that ChatGPT can analyze the responses of 15 vocational school students based on the provided prompts. Teachers can use the prompts provided in this research as insights to instruct ChatGPT, specifically for analyzing students' subjective test answers. ChatGPT generates analysis results that are logical and structured, in line with the AI's characteristics. It evaluates answers by focusing on four indicators: accuracy, clarity, completeness, and technical terminology.

The aspect of accuracy is crucial in evaluating students' ability to define a circle, particularly in mathematics education. It helps measure how well students grasp the basic concept of a circle, with a precise definition indicating a solid understanding of its properties and characteristics. Accuracy also enables teachers to assess whether students use the correct terminology, ensuring they not only comprehend the concept but can also communicate it effectively.

In addition, accuracy in definitions allows teachers to identify any misunderstandings or misconceptions, providing an opportunity for more targeted feedback. It also aids in evaluating students' analytical skills, as a precise definition reflects their ability to analyze and organize information logically. Furthermore, accuracy serves as a foundation for more objective assessment, particularly in subjective evaluations like essays, ensuring fair grading based on the correctness of students' definitions. Overall, accuracy is an important tool for assessing the extent to which students understand and can clearly communicate the concept of a circle.

The use of the aspect of clarity in assessing students' ability to define a circle involves evaluating how clearly students can articulate the concept of a circle. Clarity ensures that students can communicate their understanding in a straightforward and unambiguous manner. It helps in assessing whether students express their definitions in a way that is easy to understand and free from vague or overly complex language. Emphasizing clarity allows teachers to avoid misinterpretation and verify that students have a precise understanding of the concept.

Furthermore, focusing on clarity provides opportunities for constructive feedback, enabling students to improve their communication skills and refine their explanations. This aspect also supports objective evaluation, particularly in subjective assessments, by focusing on the effectiveness of students' expressions. Overall, assessing clarity helps educators gauge students' ability to communicate mathematical concepts effectively, ensuring a comprehensive understanding of their conceptual and expressive skills.

The aspect of completeness is crucial in evaluating students' ability to define a circle because it ensures that students provide a thorough and detailed explanation of the concept. Completeness involves assessing whether students include all necessary components in their definition, such as the fundamental properties and characteristics of a circle. This aspect is important for ensuring that students have a comprehensive grasp of what constitutes a circle, covering key elements like the set of all points equidistant from a center point and any relevant mathematical properties. By focusing on completeness, educators can identify whether students omit critical details and ensure that their definitions encompass all essential information. A complete definition reflects a student's ability to integrate and synthesize various aspects of the concept, demonstrating an in-depth understanding.

Additionally, completeness facilitates accurate feedback, guiding students in refining their understanding and improving their responses. It also supports objective evaluation, providing a basis for assessing the quality of students' definitions and ensuring that all relevant information is included. Overall, completeness is essential for evaluating how well students understand and articulate the concept of a circle, ensuring their definitions are thorough and informative.

The use of the aspect of technical terminology in assessing students' ability to define a circle is crucial as it ensures that students employ precise and appropriate mathematical language in their definitions. Evaluating this aspect involves checking whether students correctly apply specific terms related to circles, such as "radius," "diameter," "circumference," and "center." Accurate use of these terms reflects students' understanding of the circle's mathematical properties and ensures that their definitions align with established concepts. Technical terminology facilitates clear and unambiguous communication, allowing students to convey their understanding effectively. Proper use of terms demonstrates conceptual mastery and integrates theoretical knowledge into practical explanations. Moreover, assessing technical terminology helps identify any misunderstandings or gaps in students' knowledge, guiding further instruction. It also provides a basis for objective evaluation, ensuring that student responses are assessed fairly and according to mathematical standards. Overall, focusing on technical terminology ensures that students' definitions of a circle are precise, clear, and consistent with mathematical conventions, offering a comprehensive evaluation of their understanding.

Accuracy ensures that students' definitions are precise and reflect a correct grasp of the circle's properties. Clarity assesses whether students can communicate their understanding effectively and unambiguously, avoiding confusion. Completeness evaluates whether students cover all essential aspects of the concept, providing a thorough explanation. Technical terminology ensures that students use appropriate mathematical language, demonstrating their conceptual mastery and aligning with mathematical standards. Together, these aspects offer a robust framework for evaluating students' definitions of a circle, highlighting their strengths and identifying areas for improvement. This multifaceted approach supports effective feedback and objective assessment, ultimately enhancing the accuracy and depth of students' mathematical understanding. In conclusion, the use of the aspects of accuracy, clarity, completeness, and technical terminology in assessing students' ability to define a circle provides a comprehensive evaluation of their understanding.

Assessment of mathematical understanding is crucial, as emphasized by The National Council of Teachers of Mathematics (NCTM), the National Association for the Education of Young Children (NAEYC), and the National Mathematics Advisory Panel (NMAP). Assessing mathematical understanding is intended to help teachers identify children who are at risk of not succeeding in mathematics and who may benefit from additional support (Education Northwest, 2011). Students will reach a certain depth of understanding of the concepts and acquire certain levels of fluency with the procedures by prescribed points in the curriculum, so further instruction can assume and build on this understanding and fluency (The National Council Of Teachers Of Mathematics, 2000). From this theory, it can be concluded that ChatGPT's ability, particularly ChatGPT 3.5, to analyze students' subjective test answers is very effective and can help teachers understand the mathematical comprehension issues that students face.

In addition to providing descriptive feedback, ChatGPT is also capable of assigning scores. This capability is particularly valuable given the difficulty teachers face in assigning objective scores to essay questions, such as those asking for definitions. All the results provided by ChatGPT in analyzing student answers and assigning scores offer accurate evaluation data regarding students' mathematical understanding. This data enables teachers to improve their instruction to address the specific mathematical comprehension issues each student experiences.

## Conclusion

One effective way for teachers to assess students' understanding of circle-related material is through tests, with subjective tests proving particularly useful. However, grading subjective tests can be challenging and often requires technological assistance. ChatGPT, especially ChatGPT 3.5, has shown promise in providing reliable and objective evaluations. Despite this, many teachers in Indonesia continue to struggle with integrating technology into assessments, as highlighted by recent research. This has underscored the importance of conducting research on "Leveraging ChatGPT for Scoring Students' Subjective Tests".

This study aimed to explore the potential use of ChatGPT 3.5 in mathematics education, specifically in scoring students' answers on subjective tests related to circle material. Employing a qualitative case study approach, the research delved into the complexities of analyzing students' subjective test responses with ChatGPT. The findings reveal that ChatGPT can effectively analyze the answers of 15 vocational school students using provided prompts, delivering results that are logical and structured. ChatGPT 3.5 aids teachers by providing a comprehensive evaluation of students' answers, focusing on accuracy, clarity, completeness, and technical terminology. Accuracy ensures that students' definitions are precise, clarity assesses their ability to communicate effectively, completeness evaluates their coverage of essential concepts, and technical terminology verifies their use of appropriate mathematical language. This multifaceted approach offers a robust framework for evaluating students' definitions of a circle, supporting effective feedback and objective assessment. Consequently, it can be concluded that ChatGPT 3.5 is highly effective in analyzing students' subjective test answers, assisting teachers in understanding and addressing the mathematical comprehension issues students encounter.

## Recommendations

ChatGPT has proven to be an AI that bridges technology with academic mathematics and can be used as a tool to assist teachers with measurements and assessments. However, it has not yet been proven that the ChatGPT approach is applicable to all school mathematics tests. This presents an opportunity for researchers interested in using AI in education, particularly in mathematics education assessment, to continue conducting studies and integrating AI into academic mathematics.

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