

## ARTICLE

# *Geography's*<sup>1</sup> interpretation of topographic maps and orthophotographs, adoption prediction, and learning activities to promote responsible use of this chatbot in classrooms

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## ABSTRACT

*Learners find it challenging to interpret topographic maps and orthophotographs. Although the chatbot, Geography, might be useful for this purpose, no research is available regarding its abilities and limitations. Thus, the aim of this multi-phase mixed methods research was threefold, namely (a) to explore Geography's topographic map and orthophotograph interpretation skills, (b) to determine the factors which can drive its adoption, and (c) to suggest learning activities to promote responsible usage in geography classrooms. During the first phase, an explorative case revealed that Geography can be useful to interpret topographic maps and orthophotographs, but it can also fabricate facts. During the second phase, the high adoption prediction score (six out of nine), indicated a need for responsible usage. Thus, learning activities were designed during the last phase to promote responsible use in geography classrooms.*

**Keywords:** Chatbot; *Geography*, Geography education; Orthophotographs; Topographic maps

1 A chatbot developed to serve as geography expert. To mitigate instances for confusion, the title of this chatbot is italicized throughout this paper.



## INTRODUCTION

Topographic maps and orthophotographs encapsulate the complex elevation of the Earth's surface in an accessible visual format and are therefore fundamental teaching media in the Geography classroom. South African learners are exposed to these media from grade 9 onwards (DBE, 2011) to learn how to extract meaningful insights from complex spatial data. Learners must develop comprehensive mapwork content knowledge and technical skills (Larangeira & Van der Merwe, 2016). They must calculate heights, distances and areas, recognise and use map symbols and understand how contour lines are used to represent the continuous elevation of the Earth's surface on a flat surface (Ory et al., 2015; Atit et al., 2016). The importance of these skills cannot be overstated (Xu & Tao, 2024), but the development thereof entails many challenges (Larangeira & Van der Merwe, 2016; Hsu et al., 2018).

There are indications that many of these skills are not fully developed at school level as South African first year Geography student teachers found it challenging to draw and interpret cross-sections, calculate distances, areas, magnetic declination, gradient, and vertical exaggeration and interpret topographic maps (Larangeira & Van der Merwe, 2016). A similar challenge is experienced in the Japanese context where students also grapple with understanding how contour lines represent the elevation of the Earth's surface (Hsu et al., 2018).

Educators have explored various tools, for example Google Earth, to demonstrate the continuous elevations of the Earth and to facilitate learning of map work competencies. However, until the 25th of September 2023, when OpenAI (2023) announced that the GPT-4 architecture was enabled to read and understand visual inputs, no tools could read and interpret topographic maps and orthophotographs on behalf of their users. Since then, it was found that ChatGPT-4V(ision) can interpret aerial photographs and that its successor, ChatGPT-4o, can interpret contour maps (Van Staden, 2024, 2025). However, none of OpenAI's chatbots were trained to serve as Geography experts. Gen-AI addressed this gap by further training an instance of the GPT-4 architecture to serve as geography expert and titled the newly developed chatbot, *Geography*<sup>2</sup>. Little is known regarding the capabilities and limitations of this new chatbot.

The purpose of this research was threefold, namely (a) to explore *Geography's* topographic map and orthophotograph interpretation skills, (b) to identify the factors which can drive the adoption of *Geography* for this purpose, and (c) to suggest learning activities to promote responsible use of this chatbot in classrooms. This paper introduces *Geography*, which is followed by a review of the current literature, discussion of the overarching multiphase mixed methods framework, results, and learning activities to promote responsible use in classrooms. The paper concludes with the significance of the research, limitations and ideas for further research.

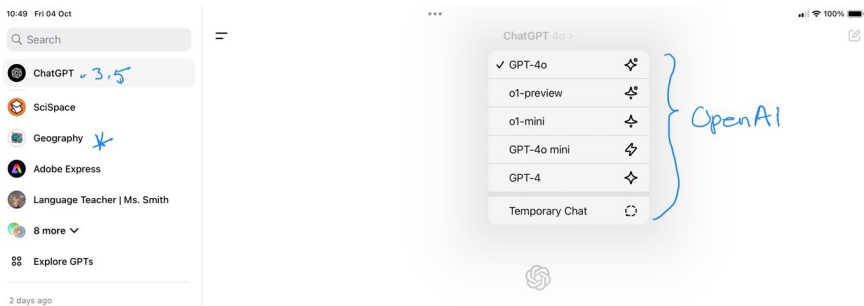
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2 The title of the chatbot is italicized throughout the rest of the paper to mitigate confusion. Where the word Geography is not italicized, this refers to the academic school subject.

## The chatbot Geography

As AI-Gen based *Geography* on the GPT-4 architecture, this chatbot is only accessible via OpenAI's Pro subscription (\$20 per month). The chatbot is described here, as educators might be unfamiliar with it. When users visit the website, <https://chatgpt.com>, they can click on the left pane of the user interface on *Explore GPTs* to explore more GPTs. As soon as the user clicks on *Geography*, the chatbot will be available in the left pane, as can be seen in this screenshot of the home page of the ChatGPT application (Figure 1).

**Figure 1. User interface of OpenAI's Pro subscription.**



When prompted, *Geography* responded that it was 'fine-tuned to focus specifically on geography' (see Supplementary Figures for *Geography's* responses). It was also confident that it is 'well-equipped to explain geographic phenomena, answer questions about maps, help with geographic data analysis and many more.' As *Geography* uses reinforcement learning (A1), it can use users' feedback to improve its responses (Gill & Kaur, 2023). However, a chatbot can only provide correct responses if the necessary information is available in its training data. Although it can access the internet to find answers, the searching skills of its stall mates (ChatGPT-4V and ChatGPT-4o) are limited (Van Staden, 2024, 2025).

During the initial chats, *Geography* could define a topographic map (see Supplementary Figure A2) and provided six reasons why it is useful to interpret topographic maps (Supplementary Figure A3). It could also discuss four ways in which a terrain can be read on a topographic map. As mentioned, no literature was available to support these responses.

## LITERATURE REVIEW

### ***Topographic map and orthophoto interpretation skills of chatbots***

Although no research was available regarding *Geography's* ability to interpret topographic maps or orthophotographs, literature regarding the abilities and limitations of its stall

mates, ChatGPT-4V and ChatGPT-4o, provided useful insights as both are also based on the GPT-4 architecture. Hochmair et al. (2023) compared ChatGPT-4 (OpenAI), Gemini (Google), Claude-3 (Anthropic) and Copilot (Microsoft, built on GPT-4 architecture) and found their spatial literacy and knowledge of Geographic Information Systems (GIS) good, but their mapwork skills limited. According to Mooney et al. (2023) ChatGPT-4's knowledge of GIS and basic mapwork (88.3%) is better than those of ChatGPT-3 (63.3%). Xu & Tao (2024) explored ChatGPT-4 (with vision) and reported that it could interpret various types of maps and performed basic map analysis but lagged human expertise in more nuanced or detailed map interpretation. None of these studies explored abilities and limitations regarding topographic map or orthophoto interpretation.

Two recent studies provide insight in the possibility that a chatbot may be useful to interpret topographic maps and orthophotographs. According to Van Staden (2024), who explored ChatGPT-4V(ision), this chatbot could interpret aerial photographs to a certain extent. It is assumed that *Geography* might be useful in interpreting orthophotographs and topographic maps as ChatGPT-4o ('o' for 'omni'), launched on the 13th of March 2024 (OpenAI, 2024), could interpret contour maps to a certain extent (Van Staden, 2025). As both studies reported that the chatbots fabricated facts convincingly (Van Staden, 2024, 2025), it may be assumed that *Geography* might also hallucinate.

### ***Factors impacting the adoption of AI in classrooms***

Van Staden (2023) developed an artificial-intelligence-adoption-prediction-model (AIAPM) which requires three actions from users, namely (a) to explore if an AI can perform specific tasks, (b) to identify the adoption driving factors, and (c) to design strategies and policies to promote responsible use if one or more of the factors could drive the adoption decision. Nine driving factors, posed as questions with 'yes' or 'no' answers, are integrated in the AIAPM. Eight of these factors, namely, advantage above status quo, low input needed, high output, easy to use, usefulness, trialability, observability of results and compatibility with needs of users, are based on a solid knowledge base (Van Staden, 2023). The ninth, humanlike interaction, was integrated as it drove the quick adoption of ChatGPT. The AIAPM also suggests that an AI should be explored after each update to ensure that it still cannot perform certain tasks.

The AIAPM has been applied in three studies (see Van Staden, 2023, 2024, 2025). During the first study, it was found useful to predict that all factors could drive the adoption of ChatGPT-3.5 to write, justify, and analyse English poems (Van Staden, 2023). During the second study, the AIAPM was quantified to calculate an adoption prediction score (APS). This score is determined by adding '1' point for each positive answer (Van Staden, 2024). Based on an APS of 8 (out of 9), Van Staden (2024) could predict that ChatGPT-4(V) would be adopted in geography classrooms to analyse and interpret aerial photographs. This scoring system was further improved during the third study by introducing '½' points as Van Staden (2025) found that some of the questions did not have a definite 'yes' or 'no' answer. All three studies regarded the AIAPM as an effective model to better understand how responsible use of the respective AI tools could be improved.

## METHODOLOGY

### *Multi-phase mixed method frameworks*

Multi-phase mixed method frameworks are useful in sequential research as the results of the one phase serve as a starting point for the next (Creswell & Plano Clark, 2011). It allows researchers (a) to use elements of various methods during phases, (b) to reach the long-term goal through more than one study and (c) to answer new research questions which might develop along the way due to entering a novice study terrain (Creswell & Plano Clark, 2011). It fits pragmatic research well as problems faced in practice can be investigated and solved in a single study (Van Staden, 2012). This research was conducted in three phases.

### *Phase 1: An explorative case study*

An explorative case study was conducted during phase 1 to collect quantitative data to explore *Geography's* topographic map and orthophotograph interpretation skills (objective 1). For this research, a topographic map and an orthophotograph was selected from two South African National Senior Certificate (NSC) papers written recently by Independent Examination Board (IEB, 2024) candidates (see Supplementary Figures), namely:

- 3217 *Paternoster*, a topographic map used in Paper 2, May 2024.
- Olifantsnek, an orthophotograph used in Paper 2, November 2023.

These are referred to in the rest of the paper as IEB1 (May 2024) and IEB2 (November 2023). Two approaches were followed to design prompts to explore *Geography's* topographic map and orthophotograph interpretation skills. The first is the knowledge, skills and techniques to be developed in South African classrooms (DBE, 2011) (Table 1). The second is purposefully selected IEB examination questions which specifically focused on the knowledge, skills and techniques listed in Table 1. This approach enables comparison between *Geography's* responses with those expected from recent IEB candidates.

**Table 1. Media to explore *Geography's* interpretation skills**

	<b>Skills (DBE, 2011)</b>	<b>Relevant media (see Supplementary Figure A)</b>
1	Use scale to calculate distances	Topographic map 3217DD Paternoster, (IEB1)
2	Use grid references to describe location of features on map	
3	Recognise symbols and signs	
4	Draw and interpret cross sections	
5	Discuss intervisibility	

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	Skills (DBE, 2011)	Relevant media (see Supplementary Figure B)
6	Calculate vertical exaggeration	Orthophoto Olifantsnek (IEB2)
7	Recognise contours and landforms	
8	Determine direction from one point to another on map	
9	Determine gradient of a slope or landscape	

The media used, are identified in Table 1. As *Geography* can remember, two chats were planned, one for the topographic map and one for the orthophotograph. However, more chats were created during the research based on limitations of *Geography*. If a response was correct, it was then prompted to improve the responses to further explore its abilities and limitations. If not, clues were provided until it was clear that it could, or could not, fulfil a task.

### ***Phase 2: Quantitative study***

During phase 2, the AIAPM was applied to identify the factors which can drive adoption of *Geography* to interpret topographic maps and orthophotographs (objective 2).

### ***Phase 3: Design-based research***

During the last phase, design-based research was conducted to design learning activities to promote responsible use of this chatbot during interpretation of topographic maps and orthophotographs (objective 3).

### ***Ethical issues***

Ethical clearance for this research was granted by the General/Human Research Ethics Committee of the University of the Free State (Ethical clearance number: UFS-HSD2023/2243. The research was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. As no humans were investigated, no other documents are applicable.


## **RESULTS AND DISCUSSION**

The results are discussed under three headings, namely interpretation of the topographic map, interpretation of the orthophotograph, and factors which can drive the adoption of *Geography* in classrooms.


## Geography's *interpretation of the topographic map*

*Geography's* response is provided in the text, or in the Supplementary Figures. The responses are placed in text boxes as illustrated below.

When the topographic map was uploaded, *Geography* responded:

 I now have access to the topographic map you uploaded, titled "Paternoster 3217DD Topographic Map," with a scale of 1:50,000 and a contour interval of 20 meters. You can go ahead and ask your specific questions regarding the map, and I'll help you with the information you need!

The first prompt (2.1.1, IEB1) required *Geography* to calculate the distance of the hiking trail between the school in E6 and Groot Paternoster-punt in A4. Instead of providing the distance, it provided steps to fulfil the task. It also asked for assistance in measuring the map distance (B1). When ChatGPT-4o was asked calculate the distance, it hallucinated that the distance was 4 km (B2). After the measured map distance was provided (16.8 cm) as found in the memorandum, *Geography* read the scale from the uploaded topographic map, and provided the correct answer, namely 8.4 km:

 The distance of the hiking trail between the school in Paternoster and Groot Paternoster-punt, based on a map distance of 16.8 centimeters, is approximately **8.4 kilometers**. [[<\\_](#)]

It also provided a link ([\[<\\_\]](#)) to the Python code used to calculate the distance (Figure 2).

**Figure 2. The Python code *Geography* created to calculate the distance**

```
python Copy

# Given the map distance is 16.8 cm and the scale is 1:50,000
map_distance_cm = 16.8

# Conversion factor from centimeters on the map to real-world meters
conversion_factor = 500 # 1 cm = 500 meters in reality

# Calculating real-world distance in meters
real_world_distance_m = map_distance_cm * conversion_factor

# Convert to kilometers
real_world_distance_km = real_world_distance_m / 1000

real_world_distance_km

Result
8.4
```

The second prompt (2.1.2, IEB1) assessed its ability to identify natural features along the hiking trail. *Geography* identified a coastline and beaches, rocky outcrops, dunes and vegetation (B3). If human, it could have scored two out of three marks for the question. However, dunes and vegetation can also be accepted as correct answers.

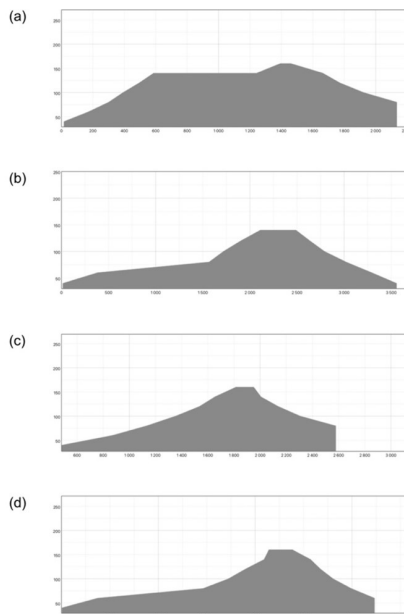
The third prompt (2.1.3, IEB1) required *Geography* to determine if the lighthouse on the western side of Seal Island would be visible from Groot Paternoster-punt. It knew which factors to consider, assumed that the lighthouse would be visible, but did not provide a definite answer (B4). Although the memorandum (IEB1) did not consider distance, it is a factor that must also be considered. A clue was provided, namely, to look at the contour lines to determine intervisibility. *Geography* hallucinated the distance between the two points (29.8 km), regarded the lighthouse as visible and instructed to check the map to confirm the response (B5).

The fourth prompt (2.1.4, IEB1) required calculation of bearing from the school (grid E4) to Groot Paternoster-punt (grid E4). *Geography* hallucinated the steps convincingly, indicated that magnetic declination should be used to 'adjust' the answer but fabricated (270 degrees, westward) the bearing (B6). It could also not determine the direction from the school to Groot Paternoster-punt (B7).

The fifth prompt (2.2.2, IEB1) required *Geography* to choose the correct cross-section for the line A-B on the topographic map (Supplementary Figures). Unfortunately, the question at the top of the cross-sections was not deleted prior to input (Figure 3).


**Figure 3. Cross sections, IEB Paper 2, May 2024 examination (source: IEB, 2024).**

- 2.2.2 Use the topographic map of Kasteelberg (E7). Which of the cross sections below best suits the line A-B in Figure 5 on page 10? Mark the correct answer.





Before a specific prompt could be typed, *Geography* responded:

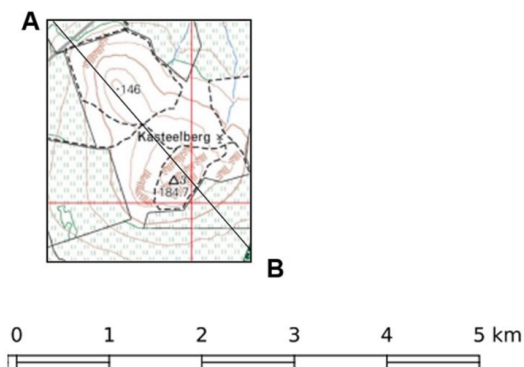
 To assist you in choosing the correct cross-section that best matches the line A–B on the topographic map of Kasteelberg (E7), I will need to access the topographic map or Figure 5 from page 10, as referenced in your image. Since I cannot view that directly, you can provide details about the contour lines or the general shape of the terrain along the A–B line from the map.

If you provide the map, I can help you determine the correct answer. Alternatively, you can describe the contour pattern along the A–B line.


As the topographic map was already uploaded, *Geography* was referred to the map. However, *Geography* insisted that 'figure 5 on page 10' (see question Figure 3) was provided. As soon as a screenshot of the requested figure was uploaded (Figure 4), it chose the correct cross-section.

**Figure 4. Topographic map, Kasteelberg (source: IEB, 2024) with the original figure number from IEB (2024).**

**Figure 5 – Kasteelberg**



*Geography's* response to this interactive process was impressive:

 Thank you for providing the image of Figure 5 from Kasteelberg. Based on this figure, I can now help you determine which of the cross sections (a, b, c, or d) best suits the line A–B.

**Observations from the map:**

The line A–B crosses over Kasteelberg, with the elevation reaching a peak (indicated by the contour lines forming closed loops).

The elevation at the highest point, near the center of the line A–B, appears to be around **1847 [184.7] meters** (as indicated by the trigonometrical beacon).

The contour lines suggest a steady slope leading up to the peak and a similar slope down on the opposite side.

**Matching with the cross sections:**


The cross section should show a gradual increase in elevation, followed by a peak and then a gradual descent.

Given the shape of the mountain, the cross section should not have a steep, sharp peak but rather a more rounded top. Looking at the options provided: **Option (a)** seems to represent the terrain well, with a gradual increase in elevation, a rounded peak, and a gradual descent on the other side. The other cross sections either show a steeper peak (like in option c) or do not match the general slope pattern.


**Conclusion:**  
The best match for the cross section along the line A–B is option (a), as it closely resembles the terrain's gradual ascent, rounded peak, and descent shown in Figure 5.

*Geography* did not read the height of the trigonometric beacon correctly (1874 instead of 187.4), but this was not needed to answer the question. The motivation for the choice was good.


The last prompt consisted of a set of self-designed prompts to assess its ability to recognise and use map symbols. Although it recognised the trigonometric beacon on Soetlandskop, it fabricated the height of the beacon convincingly:

 The height of **trigonometric meter 6** on **Soetlandskop** in grid **A8** is marked at **259 meters** above sea level, as indicated by the trigonometrical point (triangle symbol) on the topographic map.

*Geography* could not be guided to read the height correctly (B8). *Geography* could also not define the red star on the map without 'specific map legends' (B9). However, when a screenshot of the map legend was uploaded (IEB1) and it was prompted to use this legend to identify the 'red star in grid F2', *Geography's* response was impressive. It could even provide the name of the lighthouse:

 Using the legend you provided, the **red star** symbol on the topographic map represents a **lighthouse or marine light**. Therefore, the red star in grid F2 on the contour map indicates the location of a **lighthouse**, which in this case is **Cape Columbine Lighthouse**.

*Geography* could use these map symbols to describe the area covered by the map as urban or rural. It also substantiated its response:

 The area covered by this map can be described as predominantly **rural**. Here are the key reasons supporting this classification:


1. **Sparse Settlements:** The map shows a limited number of buildings and settlements, such as Paternoster, which is a small coastal town. The absence of densely packed infrastructure and buildings typically associated with urban areas indicates a rural character.
2. **Natural Features Dominating the Landscape:** The map highlights a significant amount of natural terrain, such as coastal features (e.g., Groot Paternoster-punt), rocky outcrops, and natural vegetation. Rural areas are often characterized by the prominence of natural features over built-up areas.
3. **Agricultural and Open Land:** The map likely includes large expanses of open land and possibly areas used for agriculture or conservation. This further aligns with a rural landscape, where land use is often less intensive compared to urban environments.

**4. Lack of Major Infrastructure:** There are no indications of extensive infrastructure like highways, large industrial areas, or high-density residential zones, which are typical of urban areas.

Overall, the combination of natural landscapes, sparse settlements, and limited infrastructure suggests that this is a rural area.

### Geography's interpretation of the orthophotograph

The provided orthophotograph (Supplementary Figures) was augmented by adding slopes and landforms to be identified. *Geography* was not prompted to draw a cross-section (2.1.1, IEB2) or to indicate features on the cross section (2.1.2, IEB2). Instead the cross-section was uploaded, as provided in the memorandum of this paper (Supplementary Figure C), and *Geography* was that the vertical scale was: 1 cm = 40 m. The first prompt (2.1.3, IEB2) required *Geography* to determine the vertical scale of the cross-section. The response was correct, it was 1:4000 (C1). The second prompt (2.1.4, IEB2) required *Geography* to calculate the vertical exaggeration of the provided cross section (Supplementary Figure C). It did not need any more information as it read the vertical scale from the orthophoto already uploaded (Supplementary Figure B), and provided the correct answer, namely 5 times.

 To calculate the vertical exaggeration (VE) of the cross section, you need to compare the **vertical scale** and the **horizontal scale**. **Given Information:**

- **Vertical scale:** 1:4000 (from your previous information where 1 cm = 40 meters)
- **Horizontal scale:** The map you uploaded has a horizontal scale of **1:20,000**.

**Formula for Vertical Exaggeration:**

$$VE = \frac{\text{Horizontal Scale}}{\text{Vertical Scale}}$$


Substitute the values into the formula:

$$VE = \frac{20,000}{4,000} = 5$$

**Conclusion:** The vertical exaggeration of the cross section is **5**. This means the vertical distances in the cross section are exaggerated by a factor of 5 compared to the horizontal distances.

The third prompt (2.2.3a, IEB2) required *Geography* to calculate the difference in height between the starting and ending points of the provided cross section (Supplementary Figures). It could read the start height (1651.1 m) and estimated the end height (1220 m) based on the cross-section (C2). Although the memorandum (IEB2) estimated the end height between 1221 and 1230 m, *Geography's* response can be accepted as reasonable. The fourth prompt (2.2.3b, IEB2) required *Geography* to calculate the gradient of the slope, if the distance between the two points is 2220 m (as provided in the examination question). *Geography* could calculate the gradient but provided the response as a percentage, namely 19.4% (C3). When requested to provide the answer as a ratio (scale), it provided the correct answer, namely 1:5.16, and a motivation for the answer (C4). The fifth set of prompts was self-designed and assessed *Geography's* ability to name the

slopes labelled A, B, and C on the augmented orthophotograph (Supplementary Figures). However, it stated that the PDF did not contain labels (C5). On being informed that the labels were added in yellow ink, it responded that it 'currently do[es] not have the ability to visually inspect images or marked content in PDF files' (C6). As ChatGPT-4o could successfully interpret an image of a contour map (Van Staden, 2025), a screenshot of the orthophotograph was uploaded and the prompt was repeated. At this point *Geography* could identify only one of the slopes, namely A (gentle slope), and motivated the answer well.

 To name the slopes marked A, B, and C, we need to understand their orientation and type based on the contour lines.

1. **Slope A** seems to follow a gradual incline where the contour lines are somewhat spaced apart. This would likely be classified as a gentle slope [correct] due to the wider spacing of the contour lines, indicating a less steep rise in elevation.
2. **Slope B** shows a more consistent and significant elevation change over a shorter distance (contour lines are closer together). This suggests that Slope B is a steep slope, as the tightly packed contour lines indicate a sharp change in elevation over a small horizontal distance.
3. **Slope C** is likely somewhere between the two, with contour lines not as close together as Slope B but also not as widely spaced as Slope A. This could be categorized as a moderate slope, representing a moderate incline where the elevation change is noticeable but not as dramatic as Slope B.

Would you like further clarification or an analysis of specific measurements from the map?

When informed to look specifically at the distance between the contour lines near the top and bottom of the slope, it stated incorrectly that it was a concave slope (C7). It could be concluded that *Geography* did not perform better than ChatGPT-4o, which could also not distinguish between concave and convex slopes (Van Staden, 2025). When told that the correct answer was the opposite of the response, *Geography* provided the correct answer, namely a convex slope (C.8). It could only identify slope C after being told that the contour lines were paired (C9). Based on these responses, *Geography* did not perform better than ChatGPT-4o, which could identify more slopes correctly, but on self-drawn contour maps (Van Staden, 2025).

The last set of prompts were self-designed, and assessed *Geography's* ability to identify landforms marked D, E and F (Supplementary Figures). However, this time it was prompted to identify the marked landforms one by one. *Geography* identified landform D correctly as a dam or reservoir (C10). It hallucinated that E was a spur (C11) but could use a clue to improve the response (hilltop, C12). It hallucinated that landform F represented a valley or re-entrant (C13) but used a clue to improve the response (saddle, C14). *Geography* did not only provide answers, it motivated them as well. Based on the responses, *Geography* can to a certain extent be useful in classroom situations (Table 2). The factors which could drive the adoption of this tool were also explored.

**Table 2. *Geography's* map reading and interpretation skills.**

	<b>Skills (DBO, 2011)</b>	<b><i>Geography's</i> capabilities and limitations</b>
1	Use scale to calculate distances	Yes, if the user provides the map distance
2	Use grid references to identify features	Yes
3	Recognise symbols and signs	Yes, if legend is uploaded as well
4	Draw and interpret cross sections	Partially, cannot draw the cross sections, but can interpret it
5	Discuss intervisibility	Yes, and it cautions the user to ensure that it is not too far away to see it
6	Calculate vertical exaggeration	Yes, if a well-labelled cross section is provided
7	Recognise contours and landform	A few, hallucinated, but could use clues to identify the slope or landform
8	Determine direction or bearing from one point to another	No
9	Determine gradient of a slope or landscape	Yes, only need a well-labelled cross section, map distance, and the orthophotograph to calculate the gradient

### ***Factors which can drive the adoption of Geography***

The AIAPM was used to identify the factors which can drive the adoption of *Geography*. The results are presented in Table 3.

**Table 3. The APS for *Geography* as a tool to be used to interpret topographical maps.**

<b>Factors which can drive the adoption of <i>Geography</i></b>	<b>APS</b>
Advantage above status quo	1
Low input	½
High quality output	1
Humanlike interaction	1
Easy to use	1
Useful	½
Trialable	½
Observable results	½
Compatible with needs of users	1
<b>APS</b>	<b>7</b>

Five of the factors (full points) could drive the adoption of *Geography*, while the rest (half points) could not be excluded (Table 3). If learners use *Geography* to perform certain tasks (limited usefulness), carefully design prompts (higher input), and can afford the

subscription fee (limited trialability and limited observability), these four factors can also drive the adoption of *Geography*. Based on the high APS (7 out of 9), it was necessary to design learning activities to promote responsible use of *Geography*.

### ***Learning activities to promote responsible use of Geography***

The activities were based on a learning-oriented approach to assessment. Learning oriented assessment is based on three pillars, namely, to design learning tasks rather than assessment tasks, to provide quick feedback, and to involve learners as peer assessors. As *Geography* provides quick feedback, it can promote learning, but learners must be cautioned that it hallucinates convincingly. They must understand that the responses cannot be accepted without being critically evaluated. Learners can be involved as peer assessors, requested to provide feedback, and use it to improve their learning tasks, if they agree with the feedback.

Although *Geography* can be used to create rich learning activities, it is also important to note that chatbots can undermine academic integrity if used to perform academic tasks on behalf of learners (Anders, 2023; Engineering & Technology, 2023; Khalil & Er, 2023; King & ChatGPT, 2023). Therefore, learning activities were designed to promote responsible use of *Geography*. The learning activities presented in this section, were designed from a learning-oriented approach to assessment (Carless, 2007, 2015) and are based on the knowledge, skills, and techniques South African grade 7 to 12 Geography learners must develop (Table 1) (DBE, 2011).

Firstly, learners can be requested to instruct *Geography* to calculate distances and scale based on uploaded topographical maps or orthophotographs. They must follow its instructions, such as providing more information to enable it to fulfil the task. As *Geography* does not only provide answers but also substantiates the responses, the learners must evaluate the answers. This learning activity can promote development of geographical knowledge, skills and techniques, but also critical thinking skills whenever learners are using the chatbot.

Secondly, learners can be required to instruct *Geography* to determine intervisibility as it refrains from providing a definite answer. It rather instructs the user to ensure that no obstructions are found between two points on a map, which can impact visibility. As it regards distance as a factor, but cannot measure map distance, learners can be requested to determine and provide the distance between the two mentioned locations. This activity can facilitate the development of critical learning skills. Thirdly, learners can be instructed to draw well-labelled cross-sections, upload it, and instruct *Geography* to calculate gradient and vertical exaggeration. They can also be required to instruct *Geography* to determine if their cross sections are correct. This learning activity can help learners to better understand how chatbots can be used, and why the responses cannot be accepted without critical evaluation. Fourthly, learners can be required to instruct *Geography* to recognise and use map symbols, without providing the legend. They must follow its instructions and evaluate the responses to better understand the limitations of

chatbots. Lastly, learners can be required to instruct *Geography* to identify slopes and landforms on topographic maps and orthophotographs, to evaluate the responses, and to provide clues to guide the chatbot to improve answers. This activity can help learners to identify the limitations of chatbots.

The list of activities is not extensive, it should rather serve as starting point for designing learning activities to promote learning, while responsible use of technology is also promoted, as required by the South African Qualifications Authority (1997). Currently responsible use is more important than ever to mitigate opportunities for AI plagiarism.

## CONCLUSIONS

Previous studies show that Geography learners find it challenging to interpret topographical maps and orthophotographs. Therefore, a chatbot which can perform this task on behalf of its users have important implications for practice. The results of phase 1 of this multiphase mixed methods research shows that the chatbot *Geography* can be useful to develop topographic map and orthophotograph interpretation skills, but learners must be cautioned that it hallucinates convincingly. The high adoption prediction score (seven) determined during the second phase, indicates that *Geography* might be adopted in classrooms. The five learning activities developed during the last phase of the research might promote responsible use of this chatbot.

Chatbots which can interpret visual inputs are still in their infancy. It can be expected that they will make errors, but they are rapidly updated and improved to mitigate faulty responses. Furthermore, better chatbots are being launched at an increasing rate, without findings published regarding their capabilities and limitations. Educators must be aware of new chatbots and their abilities and limitations to understand how these tools can be used to develop topographic map and orthophotograph interpretation skills, without promoting AI plagiarism.

This research is significant as it is the first research focusing on *Geography's* ability to interpret topographical maps and orthophotographs, adopting driving factors and strategies to promote responsible use of this chatbot in classrooms. As only one topographic map and one orthophoto was used, more research must be conducted to explore its capabilities and limitations. The list of learning tasks was not tried in classrooms and must be further investigated. As ChatGPT-4o performed better than *Geography* in identifying slopes and landforms, the capabilities of these two chatbots should also be compared in future research.

*Geography* can perform certain tasks, but it can also hallucinate convincingly. Therefore, learners must be provided with sufficient opportunities to learn from own experience that chatbots cannot be trusted to complete their assignments.

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