Plotting Your Course

Session Time: Two, 50-minute sessions

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

Comprehensive preflight planning is an integral (and regulatory) component of safety for all flights.

Pilots have been flying in their local area and around the globe with just a chart, compass, and watch since the early days of flight. Navigation by flying visually from landmark to landmark is possible. Adding precision with compass headings and timing has helped many pilots arrive at their destinations safely.

ESSENTIAL QUESTIONS

1. How do pilots navigate from one location to another without complex electronic devices?

LEARNING GOALS

Students Will Know

- What pilotage is.
- What dead reckoning is.
- How to begin plotting a course for a flight that will use pilotage and dead reckoning for navigation.

Students Will Be Able To

- *Synthesize* information from aeronautical charts, weather reports, and mathematical calculations to plot and plan a cross-country flight in visual conditions. [DOK-L4]

ASSESSMENT EVIDENCE

Warm-up
Students will learn about Charles Lindbergh and hypothesize how he achieved his transatlantic flight without modern navigation equipment. They will then watch a video introducing the concepts of pilotage and dead reckoning.

Formative Assessment
Students will complete an activity in which they plan a cross-country flight between two airports.

Summative Assessment
Students will evaluate their routes and other choices from the **Formative Assessment.**

LESSON PREPARATION

MATERIALS/RESOURCES

- Plotting Your Course Presentation
- Plotting Your Course Student Activity 1
- Plotting Your Course Student Activity 2
- Plotting Your Course Teacher Notes 1
- Plotting Your Course Teacher Notes 2
- VFR Navigation Log
- **Sectional aeronautical chart (any area is suitable, but one covering the local area is preferable)**
- **Plotter**
- **E6-B flight computer**

LESSON SUMMARY

Lesson 1: Plotting Your Course
Lesson 2: Helpful Documents
Lesson 3: VOR and GPS Navigation

The lesson will begin with a brief discussion about how Charles Lindbergh used the concepts of pilotage and dead reckoning to navigate non-stop across the Atlantic Ocean. A video will then be shown defining and outlining the terms "pilotage" and "dead reckoning."

During the next part of the lesson, students will learn more about how pilots use pilotage and dead reckoning to navigate. They will then be walked through the process of completing each part of a VFR Navigation Log.

Finally, students will work in small groups to complete an activity in which they use the concepts of pilotage and dead reckoning to plan a cross-country flight. They will use the VFR Navigation Log to document their flight plan. Following the exercise, the students will review the Private Pilot Knowledge Test questions and evaluate their flight plan.

BACKGROUND

As with any mode of travel, getting from point A to point B in the most efficient way possible is the goal of most air travel. VFR pilots have traditionally used two techniques to plot and fly a course that accomplishes this goal.

- Pilotage is the most basic technique, though it is not necessarily the most efficient. It normally involves flying at lower altitudes, seeking out prominent visual checkpoints, and making many turns.

- Dead reckoning is when a pilot navigates by means of computations based on airspeed, ground speed, heading, wind velocity, and time.

A useful resource is the Smithsonian Institute, whose website highlights types of historic air navigation, including dead reckoning: https://timeandnavigation.si.edu/navigating-air/early-air-navigators.

MISCONCEPTIONS

Many modern pilots believe that with modern technology (computers, tablets and apps like ForeFlight, Garmin Pilot and WingX) aviators don't need to demonstrate mastery of the concepts of pilotage and dead reckoning. While technology certainly aids in flight planning, not all of the navigation computations that a pilot needs can be done with electronics. Batteries die and programming formulas are sometimes incorrect. Manual means of making navigation calculations do not rely upon batteries, so being proficient with tools such as the E6-B ensures the pilot has a backup plan. Remind students that during a flight test, an examiner is entitled to ask a private pilot candidate to compute something without an electronic device (and they normally do).

DIFFERENTIATION

To support student comprehension during the **EXPLAIN** phase of the lesson, give students a copy of the VFR Navigation Log. Give students an opportunity to participate in the demonstration by quizzing them on the information that should be captured in the log.

Encourage collaborative learning by having students conduct a peer review of **Student Activity 1** and **Student Activity 2.**

LEARNING PLAN

ENGAGE

Teacher Material: [Plotting Your Course Presentation]

Session 1

Slides 1-3: Introduce the topic and learning objectives of the lesson.

Slide 4-6: Conduct the **Warm-Up.**

Warm-Up

Open the lesson by showing the following video, about Charles Lindbergh's nonstop transatlantic flight from New York to Paris, France. Emphasize that Lindbergh used the relatively simple techniques of pilotage and dead reckoning not only to achieve his goal but to arrive within 3 miles of his intended destination. He was doing this in an effort to win a $20,000 prize. Several other pilots had gone missing attempting the same feat.

- "Charles Lindbergh" (Length 1:07)
  https://video.link/w/mCRz

For teachers unable to access Safe YouTube links, the video is also available here: https://www.youtube.com/watch?v=Mvt-4Lr6TzE

The main focus of this warm-up is that, even back in 1927, the relatively simple concepts that students are about to learn can be used to navigate effectively. Ask the class: What techniques might Lindbergh have used to plan and navigate on his flight?

Student responses will vary. They will likely not yet know about the concepts of pilotage and dead reckoning, but they may suggest extensive planning, knowledge of winds, luck, and studying the attempts of other pilots as possible factors in Lindbergh's success.

Then show the video "Pilotage and Dead Reckoning." This will define the terms for the students and allow for follow-up discussion.

- "Pilotage and Dead Reckoning" (Length 8:50)
  http://video.link/w/ePdx

For teachers unable to access Safe YouTube links, the video is also available here: https://www.youtube.com/watch?time_continue=5&v=u6AU5DfG8A0&feature=emb_logo

Ask the class: What is the difference between pilotage and dead reckoning?

After watching the video, students should be able to state that pilotage is navigating using landmarks such as roads, prominent land features, and human-made objects. Dead reckoning is using various calculations to fly a more accurate route to the destination. Some students may combine the two terms into one definition, so it's advisable to clarify that they are two separate techniques.

For now, don't tell students the correct answer; use this discussion as a baseline for the remainder of the lesson, when students will learn the answer.

EXPLORE

Teacher Material: Plotting Your Course Presentation

Slide 7: Following the video, use this slide to enhance the students' understanding of pilotage and dead reckoning. These definitions are taken from the FAA's Pilot's Handbook of Aeronautical Knowledge (Chapter 16).

- Pilotage is navigating by reference to landmarks or checkpoints. It is often used in conjunction with dead reckoning and VFR radio navigation.
- Dead reckoning is navigation solely by means of computations based on time, airspeed, distance, and direction.

Slide 8: This slide discusses what makes an adequate checkpoint for pilotage. A good practice is to select checkpoints that are close enough so that when passing over one checkpoint, the pilot is able to see the next checkpoint ahead. This often means checkpoints are about 5 to 10 NM apart.

If a road is used, it should be well traveled and easily discernible from other roadways. If a tower or an antenna is used, ensure that the planned altitude is no lower than 500 feet above the tallest structure. Tower and antennas are often stabilized by guidewires that are virtually invisible when flying. Cruising altitude should always be considered as checkpoints may or may not be easily visible depending on the aircraft's height above the checkpoint.

Questions

What makes a good checkpoint?

Good checkpoints are prominent from the sky and easily identifiable. An excellent checkpoint may combine several landmarks: for example, train tracks crossing a river.

What are good examples of checkpoints? (Think of natural or human-made features that are easily identifiable from the air.)

lakes, rivers, water towers, large cities, airports, large stadiums

Slide 9: This slide shows an example of a good checkpoint: Lake Waccamaw in North Carolina. The images are from a VFR sectional aeronautical chart and Google Earth. If you wish to elaborate further, use SkyVector (www.skyvector.com) and Google Earth (www.googleearth.com) to show additional examples. Pick out checkpoints that look adequate on a VFR sectional aeronautical chart, then compare what is seen on the sectional chart with the imagery on Google Earth.

Slides 10-11: Students will now apply what they have learned to the following scenario, using the map provided on the slide. The Perry Warsaw Airport (01G) is in the northwest corner, and the Elmira Corning Airport (KELM) is in the southeast corner. To access this map online, students should go to www.skyvector.com and select the Detroit Sectional Aeronautical Chart; this activity focuses on the upper-right part of the chart, below Lake Ontario. Alternatively, using SkyVector (not in sectional chart mode), students may search for either airport, and the correct region will appear.

Tell students to imagine they have just purchased a vintage aircraft and will fly from KELM to 01G using only what they can see out the window: the most advanced navigation tool their aircraft has is a compass.

Questions

How will you navigate on this flight?

Some students may mention that the compass could provide general directional help: e.g., you should fly roughly west-southwest from Elmira toward the town of Corning before heading generally northwest to follow Interstate 390. However, pilotage will also be important.

For example, students may point out the Corning-Painted Post Airport; from here, you should keep following the highway to Bath. You should be able to see quarries on both sides of the town as you fly over. Continue northwest along the highway until the terrain rises and windmills are seen. Following the highway means a turn between two towers and a factory before sighting the town of Dansville and its airport. After Dansville, students may suggest following the power lines across the Genesee River to the drive-in movie theater on Silver Lake before spotting the town of Perry and its airport.

Offer the students a chance to suggest other ways a pilot could prepare for a trip like this. Perhaps they will mention using online maps like those from SkyVector or Google Earth. Some may suggest using a flight simulator. Inform students that the scenery database in a simulator may not have the necessary details for this region. Typically, the most-detailed simulator scenery only represents densely populated areas.

EXPLAIN

Teacher Materials: Plotting Your Course Presentation, Plotting Your Course Teacher Notes 1
Student Materials: Plotting Your Course Student Activity 1, VFR Navigation Log

Slide 12: To begin flight planning, pilots draw a light pencil line on the relevant VFR sectional chart between their origin and destination airports. This represents the planned flight path between the two airports. While a direct line is sometimes preferable, there may be reasons a straight path is not possible. In the example on this slide (from the Wichita Sectional Aeronautical Chart on www.skyvector.com), a pilot has drawn Route 1 (in magenta), which is a direct route to his destination airport.

At this point, pilots must assess if this is a reasonable course. Things to consider are listed below.

Does the route:

- pass through any special use airspace or controlled airspaces such as Class B, Class C, or Class D?
- approach high terrain or large bodies of water that could be avoided?
- pass over large areas (like deserts or open plains) that lack visual references that would aid navigation?

During the flight-planning process, pilots visualize flying the route in an attempt to predict issues they may encounter with terrain, airspace, ATC, etc.

If necessary, pilots will re-draw the course to change the flight path if any issues are perceived. This might mean instead of flying directly to the destination airport, pilots choose a route that has bends, or legs, in order to avoid potential obstacles or to follow more easily identifiable checkpoints.

In this example, the pilot has chosen to draw a second route which detours to the north to avoid the restricted airspace.

Slide 13: Complete the **Formative Assessment**.

Formative Assessment

In the same small groups from the beginning of EXPLAIN, distribute **Plotting Your Course Student Activity 1**. Students will work in their groups to complete the initial planning of a cross-country flight. Sample responses are available in **Plotting Your Course Teacher Notes 1.**

Slide 14: Next, pilots may begin entering en route data in a VFR navigation log. A navigation log helps organize a pilot's list of checkpoints and navigation calculations. While useful for planning prior to the flight, it is also intended for use during the flight. During flight, the pilot can monitor their progress along the planned route.

Teaching Tips

Students should continue working in their pairs or groups of three as they follow the demonstration of how to fill in a navigation log.

The navigation log included in this section is only one example of a log that can be used for flight planning. There are many others, and some pilots even choose to create their own based on the way they prefer to plan and visualize information. This navigation log will be used as an example.

The slide presents a graphic of a VFR navigation log.

Slide 15: The block in the lower-right of the log is for airport information. Organizing airport details such as ATIS, ASOS /AWOS, communication frequencies, airport elevation, and runways ahead of time allows the pilot to efficiently access this important information in flight.

Note that while both columns have the same information, the rows are in different orders: The frequencies are in the order a pilot would expect to use them as they depart or arrive at an airport.

Questions

What source would you use to find the other frequencies not on the sectional chart?

Further airport information is available in the Chart Supplement for the airport.

For reference, the "Block in" and "Block out" times are the times the pilot 1) starts taxiing for takeoff, and 2) parks the airplane after landing. These can be used to calculate a total "Log Time," since they constitute the FAA's definition for flight time.

Slide 16: On the left side of the log, in the first row of the “Check Points” column, the first entry is the starting airport. The first checkpoint will be written in the second row.

In this example, the pilot is taking off from Johnson County Airport, and the first checkpoint will be a bridge.

Slide 17: The next column is for VOR information if the pilot plans to use VORs for navigation along the route. Otherwise, this column can be left blank.

Note the black triangle shape that connects the first and second checkpoint rows. This indicates that the data on the row to the right is how to get from the departure airport to the next checkpoint.

Slide 18: The next column is for a route description. If, for example, the pilot were going to follow the interstate, they might put "I-95." Most of the time, the plan will be to fly direct to the next point. In this case, a pilot might put the symbol for "direct," which looks like a D with an arrow pointing out of it. Because this is sometimes obvious, some pilots choose to use this block for the true course instead.

Slide 19: The next column is for altitude. Generally speaking, this is the pilot's choice, taking into account terrain, airspace restrictions, winds aloft, and engine performance. Remember, Federal Aviation Regulations govern minimum altitudes (FAR 91.119) and cruising altitudes (FAR 91.159). As a reminder, VFR pilots flying on magnetic headings 000–179 degrees should be at an odd altitude + 500 feet, while VFR pilots flying on magnetic headings 180–359 should be at an even altitude + 500 feet. This rule begins above 3,000 feet AGL. Pilots should choose an altitude for this block on the navigation log that meets the regulations.

In this example, the pilot has chosen 2,500 feet.

The next column is for wind and temperature. This navigation log can be started well before the weather is known, so this information will be skipped for now.

Slide 20: The next column is for airspeed. Generally speaking, this is the pilot's choice, taking into account aircraft limitations, fuel usage, time, etc. In this example, the pilot has chosen to fly 100 knots true airspeed.

Slide 21: The next four columns help the pilot complete the math to arrive at the compass heading. First, the pilot obtains the true course (TC) for the first leg using a plotter and the sectional chart. The TC goes in the TC box.

The box below the TC is for the wind correction angle (WCA). The label includes +/– signs as a reminder to adjust TC accordingly. For this example, we will assume no-wind conditions.

To the right of the TC is a box for true heading (TH). This is determined by starting with the TC and adding or subtracting the WCA.

Below the TH is a block for variation. Recall from prior lessons that magnetic variation is displayed on the sectional chart, and that "east is least, west is best" which is reflected in the label of –E/+W. Pilots will reference the sectional aeronautical chart and put the magnetic variation for the first leg in this box.

Adding or subtracting the magnetic variation and the TH would result in the magnetic heading (MH) in the next column. Finally, the magnetic deviation can be obtained from the compass card for the airplane they're planning to fly. Once all of this math is complete, the result will be the actual heading the pilot will fly, the compass heading (CH), which goes in the next column.

In this example, with no wind, the TC is the TH of 245°. There is a 3° west variation (+3°), and the airplane has a +2° magnetic deviation, so the compass heading is 250°.

Slide 22: The next column is for distance. In the first white block at the top of the column, pilots place the total distance for the route from the departure airport to the destination airport. In each subsequent row, the top block will be the distance of the current leg, and the bottom block will be the distance remaining after this leg is complete.

Slide 23: The next few columns have a combination of planning data and actual flight data. Groundspeed entries will depend on the velocity of any winds that are forecast for the flight. In this example, we are assuming no wind. The block below the estimated groundspeed will be left blank so that during flight, the pilot can write in the actual groundspeed. This will allow the pilot to update the planned data according to actual conditions.

The next column is time: the "Time Off" is the time at takeoff. The estimated time en route (ETE)—the amount of time it takes the pilot to fly the leg—will be calculated using the estimated groundspeed value, and the estimated time of arrival (ETA) will be entered once the takeoff time is known. The actual time en route (ATE) will be measured in flight, and the actual time of arrival (ATA) will be noted by the pilot upon landing. The ATE between two checkpoints may be used to confirm and/or update the rest of the flight planning data based on the actual wind and flight conditions.

For this example with no wind, the true airspeed would be the estimated groundspeed. The ETE would be calculated with the groundspeed and distance. For example, flying 18 miles at 100 knots would take 11 minutes.

Slide 24: The next column is fuel, measured in gallons per hour (GPH) and listed at the top of the column. This number normally comes from the performance data for the aircraft. For the subsequent rows, the first block is for fuel used on that leg (in gallons), which is calculated with the GPH and ETE for the leg. The second block is for fuel remaining on board.

In this example, the aircraft burns 8 GPH (obtained from the Pilot's Operating Handbook), and the amount of fuel available at the beginning of the flight is 48 gallons. Based on the fuel consumption rate and ETE for the leg, the pilot would expect the aircraft to use 1.5 gallons of fuel on this leg, leaving 46.5 gallons available at the beginning of the next leg.

In this example, the planning data for the first leg of the route is complete. For the second leg, the next checkpoint will go in the checkpoint column and the pilot will continue entering data across the row.

Slide 25: Once all navigation legs are complete, pilots may wish to add one more "leg" labeled "Reserve," with just one piece of information: reserve fuel. In the "Fuel" block for that "leg," pilots put the amount of fuel reserves required (in gallons).

In this example, 30 minutes at 8 GPH would be 4 gallons of reserve fuel.

Once all rows are complete, some of the columns are totaled at the bottom. The total distance should be the same as the distance at the top of the column. The ETE should be totaled to provide a total trip time, and the fuel used should be totaled to show how much fuel the entire trip will take (including required reserves).

Slide 26: Remind students that after takeoff, an aircraft requires a certain amount of time, distance, and fuel to climb to the desired cruise altitude. This climb segment reduces the overall groundspeed of the first leg and increases the amount of time to complete the leg. The calculations for the climb segment can be included in the first leg, or the first checkpoint can be a "level off" point where the aircraft has reached the planned cruising altitude.

Most general aviation aircraft fly at relatively low speeds and altitudes, so the numbers for time, distance, and fuel consumption in the initial climb are fairly small. However, in some cases (for example, a twin-engine aircraft climbing to 23,000 feet), the time, distance, and fuel consumption in the climb could be significant and should be accounted for. Time, distance, and fuel consumption in the climb can be calculated using the aircraft's performance data in the Pilot's Operating Handbook.

EXTEND

Teacher Material: Plotting Your Course Presentation

Session 2

Slides 27-36: As a warm-up/Extend activity for the beginning of Session 2, review the FAA Private Pilot Knowledge Test questions. This may be a whole class activity, or you may choose to ask students to create an answer sheet allowing them to record their responses so you can review the correct answers as a group.

EVALUATE

Teacher Materials: Plotting Your Course Presentation, Plotting Your Course Teacher Notes 2
Student Materials: Plotting Your Course Student Activity 2, VFR Navigation Log

Slide 37: Conduct the **Summative Assessment.** Students can now begin to fill out a **VFR Navigation Log** for the route they planned in **Student Activity 1.** Working in the same groups as before, students should work steadily and check their numbers and calculations often for reasonableness, because errors made early on can compound as the planning process continues. Each student should complete their own **VFR Navigation Log.**

For this scenario, they will be planning a flight in a Cessna 172 with an airspeed of 120 knots at a fuel consumption rate of 8 GPH. There will be no wind or magnetic deviation.

Summative Assessment

Distribute **Student Activity 2: A Navigation Log for Your Cross-Country Flight**. Sample responses are available in **Plotting Your Course Teacher Notes 2.** Have each student complete a copy of their own VFR Navigation Log and a written statement justifying their route, checkpoint selection, and any reflections about the experience: would they do anything differently on their next flight plan, based on what they learned from completing the exercise?

[DOK-L4; *synthesize*]

Summative Assessment Scoring Rubric

- Follows assignment instructions
- Postings show evidence of one or more of the following:
  - Knowledge of the difference between pilotage and dead reckoning.
  - Selection of adequate checkpoints, 5 to 10 NM apart, that should be easily located from the air.
  - Explanation of rationale for selected checkpoints.
- Contributions show understanding of the concepts covered in the lesson.
- Contributions show in-depth thinking including analysis or synthesis of lesson objectives.

Points **Performance Levels**

9-10 Correctly synthesizes information from aeronautical charts and mathematical calculations to plot and plan a cross-country flight in visual conditions. Answers all the questions correctly.
7-8 Adequately uses information from aeronautical charts and mathematical calculations to plot and plan a cross-country flight in visual conditions. Answers 2 of the questions correctly.
5-6 Is not able to use information from aeronautical charts and mathematical calculations to plot and plan a cross-country flight in visual conditions. Answers 1-2 questions correctly with some gaps in understanding.
0-4 Shows little or no understanding of the lesson objectives. Answers 0-1 of the questions with many gaps in understanding.

STANDARDS ALIGNMENT

NGSS STANDARDS

Three-Dimensional Learning

- **HS-ETS1-2** - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
    - Science and Engineering Practices
        - Asking Questions and Defining Problems
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.A: Defining and Delimiting Engineering Problems
    - Crosscutting Concepts
        - None
- **HS-ETS1-3** - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
    - Science and Engineering Practices
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.B: Developing Possible Solutions
    - Crosscutting Concepts
        - None

COMMON CORE STATE STANDARDS

- **RST.11-12.2** - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- **RST.11-12.4** - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.
- **WHST.11-12.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
- **WHST.11-12.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
- **WHST.11-12.9** - Draw evidence from informational texts to support analysis, reflection, and research

FAA AIRMAN CERTIFICATION STANDARDS

PRIVATE PILOT

I. Preflight Preparation

Task D. Cross-Country Flight Planning

- Knowledge - The applicant demonstrates understanding of:
    - **PA.I.D.K1** Route planning
    - **PA.I.D.K2** Altitude selection accounting for terrain and obstacles, glide distance of the airplane, VFR cruising altitudes, and the effect of wind.
    - **PA.I.D.K3** Calculating:
        - **PA.I.D.K3a** Time, climb and descent rates, course, distance, heading, true airspeed, and groundspeed
        - **PA.I.D.K3b** Estimated time of arrival to include conversion to universal coordinated time (UTC)
        - **PA.I.D.K3c** Fuel requirements, to include reserve
- Skills - The applicant demonstrates the ability to:
    - **PA.I.D.S1** Prepare, present, and explain a cross-country flight plan assigned by the evaluator including a risk analysis based on real-time weather, to the first fuel stop.
    - **PA.I.D.S2** Apply pertinent information from appropriate and current aeronautical charts, Chart Supplements; NOTAMs relative to airport, runway and taxiway closures; and other flight publications.
    - **PA.I.D.S3** Create a navigation plan and simulate filing a VFR flight plan

Task E. National Airspace System

- Knowledge - The applicant demonstrates understanding of:
    - **PA.I.E.K1** Types of airspace/airspace classes and associated requirements and limitations.
    - **PA.I.E.K2** Charting symbology.
    - **PA.I.E.K3** Special use airspace (SUA), special flight rules areas (SFRA), temporary flight restrictions (TFR), and other airspace areas.

VI. Navigation

Task A. Pilotage and Dead Reckoning

- Knowledge - The applicant demonstrates understanding of:
    - **PA.VI.A.K1** Pilotage and dead reckoning.
    - **PA.VI.A.K2** Magnetic compass errors.
    - **PA.VI.A.K3** Topography
    - **PA.VI.A.K4** Selection of appropriate
        - **PA.VI.A.K4a** Route
        - **PA.VI.A.K4b** Altitude(s)
        - **PA.VI.A.K4c** Checkpoints
    - **PA.VI.A.K5** Plotting a course, to include
        - **PA.VI.A.K5a** Determining heading, speed, and course

        - **PA.VI.A.K5c** Estimating time, speed, and distance
- Skills - The applicant demonstrates the ability to:
    - **PA.VI.A.S1** Prepare and use a flight log.

REFERENCES

FAA Pilot's Handbook of Aeronautical Knowledge, Chapter 16 https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/

FAA Aeronautical Information Manual
https://www.faa.gov/air_traffic/publications/atpubs/aim_html/index.html

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https://www.faa.gov/air_traffic/publications/media/pcg_4-03-14.pdf

Spirit of St. Louis Anniversary, USA
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"Charles Lindbergh"
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