Aktivität 3.5. Algebra und meine Umwelt

Cultural Background

Ein Koordinatensystem dient zur eindeutigen Bezeichnung der Position von Punkten und Objekten in einem geometrischen Raum. Koordinatensysteme sind Hilfsmittel der Mathematik zur Positionsangabe. Sie werden in vielen Wissenschaften und in der Technik verwendet. Auch im Alltag werden Koordinatensysteme häufig verwendet. Ein Kartennetz ist ein System der Längen- und Breitenkreise auf einer geografischen Karte. Ein Kartennetzentwurf (auch Kartenprojektion oder Kartenabbildung genannt) ist eine Methode in der Kartografie, mit der man die gekrümmte Oberfläche der (dreidimensionalen) Erde auf die flache (zweidimensionale) Karte überträgt. Viele Wanderkarten sind Kartennetze.

In Waldsee

In *Waldsee*'s STEM high school program, students use their German to investigate the relationship between the x-and y-axes, with respect to coordinate pairs, lines, shifts horizontally and vertically, and slope, by envisioning a site map of the village. Each student receives an area of the village, either a wooded area with trails, or one adjacent to the lake. From there, students create their own grid maps by choosing different plants/physical characteristics as their "grid markers."

In the Classroom

In this activity students integrate their knowledge of German and algebra to create a grid map. Optimally, this can be done for one's town, or for a smaller space such as a local park, a trail, a garden, or shore of a body of water. If it is impossible to move to a physical location in which to model, the initial area and scale could be done via photos, or using Google Maps or a similar resource.

Objectives

- **Communication**
  - Students will master subject-specific terminology and vocabulary and read, interpret, and solve a variety of mathematical situations in German related to their environment.
  - Students will use their German to create, ask and answer questions.
  - Students will employ German language constructions and vocabulary to use algebraic equations.
  - Students will formulate if/then hypotheses and posit a series of inquiries.
  - Students will document and present grid maps of their environment and will use their German to comment constructively on classmates' maps.

- **Connections**
  - Students will reinforce and integrate their knowledge of math and environmental studies through use of German.
  - Students will deepen their connections to their physical environment and better identify local plants and wildlife, in a new view--and further solidify their understanding of cardinal directions in their local area.

    - Students will integrate art/drawing/sketching and modelling in two and three dimensions, to demonstrate flexibility in math and application to other subject areas.

- **Comparisons**
    - Students will be able to use their German to compare and contrast distances and directions.

Language Functions in Focus

- Understanding general vocabulary and technical language
- Indicating agreement and disagreement
- Explaining processes and procedures
- Inferring and interpreting data (verbally and in writing) in the target language
- Justifying an expressed opinion
- Comparing and contrasting
- Evaluating
- Reporting

Materials

- Paper, straight edge, writing utensils
- Photos of local habits, access to internet-based maps, reference for plant identification
- Scientific and/or graphic calculators
- Measuring sticks/rulers in metric units, tracing paper, pencils, highlighters

Preparation

Students should be familiar with two-dimensional graphs, including labelling and interpreting x-intercepts and y-intercepts. They should be familiar with slope-intercept form, $y = mx + b$ (or, in many German texts, $y = mx + n$). Students should understand the basic language surrounding numbers and simple mathematical operators. They should be familiar with finding slope given two points, either graphically or algebraically, and be comfortable drawing and using slope triangles.

Presentation and Practice

General histograms could be completed on a simple inquiry in the classroom, depending on the level of the students. “Do you like…?” “*Gefällt euch?”* questions could be used for new language learners. Expression preferences for one item over another could be used for more advanced students.

A simple graph with the options along the x-axis, and number of people having selected each option along the y-axis would introduce the idea of comparing two quantities (in this case, number of people versus specific item). From here, a general inquiry increasing (positive slope) or decreasing (negative slope) could be introduced/explored, to develop students’ familiarity with the topic before starting the activity.

In this activity students integrate their knowledge of German and algebra to create a grid map. Optimally, this can be done for one’s town, or in a local park, on a trail, in a garden, or the shore of a body of water.

Students will investigate the relationship between the x-and y-axes, with respect to coordinate pairs, lines, shifts horizontally and vertically, and slope. Students will model coordinates and lines within their own physical environment.

Initially, the teacher asks students to envision a site map of their town, as if overlayed by a coordinate grid, with east-west as the x-axis and north-south as the y-axis. The teacher then can assign responsibility, or students can volunteer, for an specific area of the town. Another option is to focus on a smaller neighboring area, for instance, a wooded area with trails, or one adjacent to the lake.

It may be helpful for the instructor to create a coordinate-grid map beforehand, ideally on a large piece of poster paper; use the physical building of the school, and it's surrounding campus, to provide a familiar example for students. For example, the entrance to the building could be represented on the origin, and the distance to one exterior wall could represent a given set of units, which would then set the scale for the rest of the diagram/drawing. 2 or 3 units to a building edge would allow for a reasonable diagram, and then other campus features, such as stadiums, sports fields, parking, entrance to campus, etc. could all be included with their relative distance. Depending on the actual directional orientation of your building, it may be easier to simplify the axes relative to the school by making one side parallel to the x-axis, which will make the next step easier for students.

Only include a few basic features--such as the building exterior, and the campus entrance(s). Ask students, *"Was seht ihr hier? Haben wir alle wichtige Orte schon auf der Karte? Was fehlt?"* Then, collectively, list what other locations on campus would be large enough to consider "significant." *"Muss der Ort groß sein? Warum oder warum nicht? Warum ist dieser Ort wichtig/relevant für die Karte/Schule?"* Have students get in groups of 2-4, and assign each group one of the previously brainstormed locations. Then, have the group estimate where that location would be found on the grid, and mark their estimation with a post-it note. Ask something along the lines of: *"Wo finden wir euren Ort/Orientierungspunkt? Warum meint ihr, dass er dort zu finden ist?"* Then, have the groups either go outside and measure the physical distance and directionality from the entrance (origin) in meters, or by using something such as Google Maps (satellite images), have them determine precisely the coordinates of the given location. Then, have the students add it to the class map. *"Habt ihr Recht gehabt? Wenn ja, wie habt ihr euren Ort geschätzt? Wenn nicht, was habt ihr falsch geschätzt?"*

If this activity will be done with multiple sections/classes, students can add their landmark with post-it notes, so that the map can easily be reverted to its original "blank" state for the next group. Once students have successfully added their own landmarks to the original class poster, they are ready to work on their individual maps.

To get started on their own maps, first have students brainstorm areas/neighborhoods/parts of town with which they are very familiar. Either list them together on a poster or front board, or on individual pieces of paper--making sure students have filled in one per person. Then, you could assign them randomly, have students write their names next to an area, or have students pick them from a cup/container, and receive their designated area for their own diagram. It is recommended to keep a list of all student names and locations, for accountability later, and to compare similar maps/areas between other classes/sections.

Students are asked to create a grid map of their assigned space. They can choose at which scale level they will create their grid. In this manner, even if multiple students are assigned the same area, they will choose different plants/physical characteristics as their "grid markers," representing single units on their plane, so every map will be different in some fashion. For example, a student would select a specific tree to represent the origin (0,0) on their grid, and use the next tree of the same species in a direct west line to represent 5 units on their x-axis. Or, they could use a specific building, like their home, to be the origin, and the edge of their lawn to be one unit. From here, they will physically measure the distance, and then create a coordinate grid, with a minimum of six different examples of local flora represented by relative coordinates. If a student is assigned a highly urban area with little local flora, they could use buildings or geographic features in place of flora. Then, they will have to model three different lines on their grid, and explain which plants/items represent the points selected, giving slope of the line, an equation for the line, and then annotating a physical photo (printed out) of the area to demonstrate where the line would be represented in reality, were we able to visualize it in the physical space that their grid represents. They will also use their grid model to show where other trees in the area would be located, if they were to consistently grow at the intervals described by the example lines.

If it is impossible to move to a physical location in which to model, the initial area and scale could be done via photos, or using Google Maps or a similar resource. Students would need to be assigned a specific region or location in which to model, and then determine what physical feature and/or landmark would represent the origin. From there, they create their scale with relative landmarks or physically significant items, which could also include buildings, signage, roads, or the like. Students could even take a segment of a road, either in their neighborhood or physical environment, and use it to represent one or more of the axis, and have a crossroad be the origin. In this case, they would then still use landmarks or large features to represent a desired “scale,” and annotate/illustrate their grid accordingly.

Wortschatz

das Koordinatensystem
das Kartennetz
die Zahl
der Bruch
die Kurve
die Skizze
die Steigung
die Gerade
die Funktion
das Steigungsdreieck
die Linie
die Modell
die Lösung
die Achse
die Gleichung
die Erklärung
der Ort

der Orientierungspunkt
der x-Achsenabscnitt
der y-Achsenabschnitt
der Achsenabscnitt
die lineare Gleichung
rechnen
bestimmen
berechnen
finden
kombinieren
beschreiben
interpretieren
erklären
schätzen
zählen
begründen
erweitern

skizzieren
vergleichen
messen
steigend
fallend
hoch
tief
steil
passend
flach
fertig
richtig
falsch
graphisch
algebraisch
als nächstes
später