Pirates, Wobbly Jelly, and Bunnies … Analyzing Applets and Video Games from the Perspective of RME

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Realistic Mathematics Education (RME) is a curricular design theory that involves designing materials with realistic starting points and guiding students through four levels of activity: situational, referential, general, and formal (Gravemeijer, 2020, 1999). This theory has been used to develop a multitude of curricular materials including ones that incorporate technology. This poster investigates the design of three different technologies (video games, GeoGebra, and applets) designed to elicit different forms of activity in an RME sequence. Each technology has a 2D and a 3D version and was either could be used or was designed to be used in a linear algebra classroom. This poster will present the design heuristics of each type of technology that lend themselves to a particular type of activity to be evoked with the goal of providing insight into designing technology for use in an RME-type sequence.

The first technology we analyze is a 2D video game called *Vector Unknown* which was designed to convey a realistic starting part for situational activity. *Vector Unknown* was designed to mimic the first task from the Inquiry-Oriented Linear Algebra (IOLA) Magic Carpet Ride Sequence (Wawro et al., 2013). Mauntel et al. (2021) explored the student strategies from the game. *Vector Unknown* gave rise to a new 3D video game called *Vector Unknown: Echelon Seas* (Plaxco et al., 2023). The video game added a new dimension to gameplay and a different design and environment. This new design generated different strategies including the need to adjust the viewpoint in 3D environments.

Mauntel (2023) built upon the foundations of the game Vector Unknown and used an open GeoGebra environment for students to analyze and refer (referential activity) to the game. GeoGebra was intended to be a tool that would help students analyze the game and explore linear combinations more extensively. One issue with this implementation was that students experienced the technology differently as GeoGebra presented linear combinations to students differently depending upon how they entered them into GeoGebra which created some conflicts with how the game presented linear combinations. We investigate this issue, as it is important to consider when technology supplements an already existing phenomenon as opposed to becoming a new phenomenon itself. In this case, for some students, the GeoGebra open environment became a new realistic starting point as opposed to a tool for referring to the video game.

The final context was the use of GeoGebra applets for a sequence on determinants (Wawro et al., 2023) which were used at the end of an RME sequence to promote generalizations. In this case, there were two applets that were explored, 2D and 3D. This allowed students to make generalizations within a context and between contexts. This poster will look at all three technologies and discuss design choices made in each concerning their alignment along an RME sequence and its relation to student activity.

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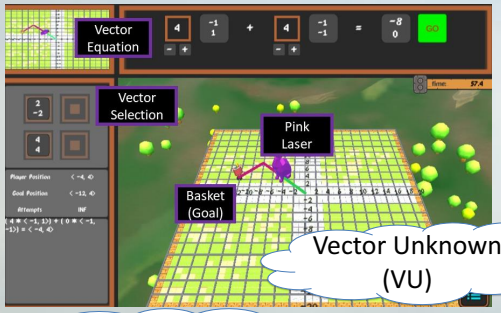
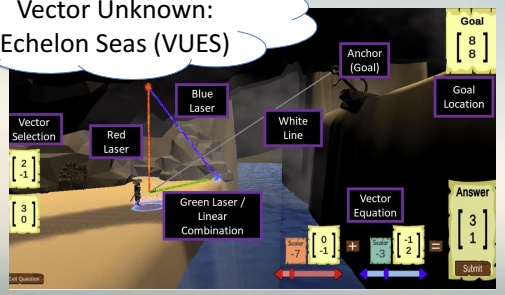
Comparing Contexts

1. Some student strategies between VU and VUES differed because of the presence of the **green laser** and **white line**. Some students tried to move the **green laser** onto the **white line**.
2. After playing VU, a student explored linear combinations with GeoGebra 3D. They found they could rotate the result of a linear combination by changing the scalars. This had implications for how they thought about **all possible linear combinations.**

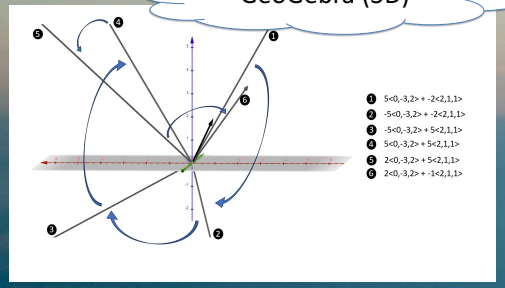


Vector Unknown (VU)

Vector Unknown: Echelon Seas (VUES)

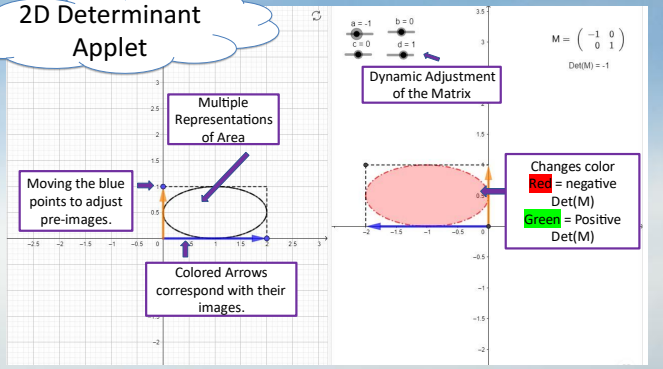


GeoGebra (3D)



Carefully designed digital environments can serve as realistic starting points for student exploration and promote generalizing activity.

2D Determinant Applet



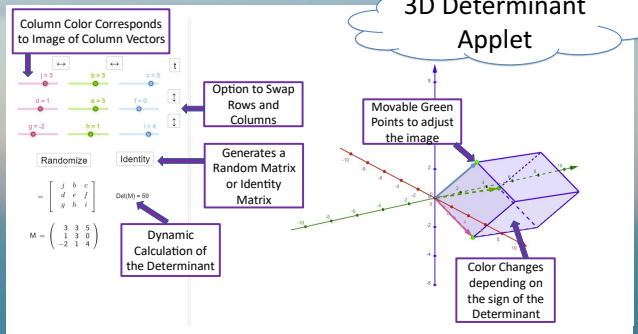
Connections

1. In the 2D and 3D applets we build connections between the matrix, determinant, and associated images using colors and **dynamic color change** associated with the **sign of the determinant**.
2. The **Movable Green Points** were designed to allow students to create biconditional generalizations. We noticed that without the ability to change the images, most generalizations originated with the matrix.
3. Having the option to **switch rows/columns** hints at the importance of **row/column operations**.

Observations Related to RME

1. **Applets and video games** can be great **realistic starting points for RME activities**. If multiple digital environments are used, it is important to consider the connections between design. For example, the student who played VU and then used the GeoGebra applet considered the contexts different and built-up separate strategies.
2. **Randomization** can be a great tool for **generating examples** for generalization and for **designers to scaffold learning**. VU has a difficulty setting (easy) with 0 as an entry because we observed student play and choosing vectors with 0s.

3D Determinant Applet



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