

# SIMIODE / SCUDEM

## Assessment/Evaluation Plans and Results

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# DEFINITIONS

- **SIMIODE**: Systemic Initiative for Modeling Investigations and Opportunities with Differential Equations (Workshops and Mini-courses leading to resources and community)
- **SCUDEM**: Student Competition Using Differential Equations Modeling; Sponsored by SIMIODE (2017, 2018....)

# AREAS OF ASSESSMENT/EVALUATION

- SIMIODE MAA-PREP Workshop, July, 2015, Carroll College, Helena, Montana, 14 participants.
- SIMIODE Developer Workshops, 2015 – Carroll College, MO, & Virginia Wesleyan University, VA,
- SCUDEM II 2018, preliminary results of Jennifer Czochoer's work - surveys of both student participants and faculty participants at SCUDEM sites.
- MINDE Workshop, sponsored by NSF and SIMIODE, 22-28 July 2018, plans for assessment.

# SIMIODE MAA-PREP Workshop

- 14 Participants, 13/14 scheduled to teach DE during 2015-16 academic year (4 of these would teach 4 or more DE classes during the year.
- Pre- and Post-Surveys at beginning and end of workshop (open-response)
- 3-month Follow-Up survey (open-response, telephone interviews)
- 3-year “reality check”

# COMMENTS FROM WORKSHOP PARTICIPANTS

- *I liked the organization of the schedule. Having the material prior then presentations from the experienced presenters, then presenting ourselves. We did all this while having the opportunity and the encouragement of the conveners. Must also say that the participants were involved and a very dynamic group.*
- *I liked having the 3 students also participate. That allowed a student perspective that was fresh and valuable. I hope that aspect continues. I hope you keep the pace and length of the workshop.*
- *It was an amazing workshop! Keep up the great work. 😊*
- *The workshop was amazingly well thought-out. Supporting us as humans – who need a break, who do not need to be crammed with information, and time to work on using the materials.*
- *I was impressed with the organization, communication of schedule and itinerary, time built in for “tourist” activity, the boat tour, etc. Well done, thank you!*

# CONCLUSIONS – PRELIMINARY REPORT

- *The organizers of this workshop definitely read the PREP Program Director's Handbook. Participants had good accommodations, good food, time to work hard, and time to socialize (although one participant felt there could have been more socialization). 100% of participants completed both questionnaires. 100% of participants said that the workshop met or exceeded their expectations. and 100% of participants said that there was ample time to complete the activities that the organizers had planned and advertised before the workshop. The result is that the on-site portion of the workshop was very successful. Follow-up activities and an assessment of what participants were able to carry into the 2015-16 academic year are planned.*

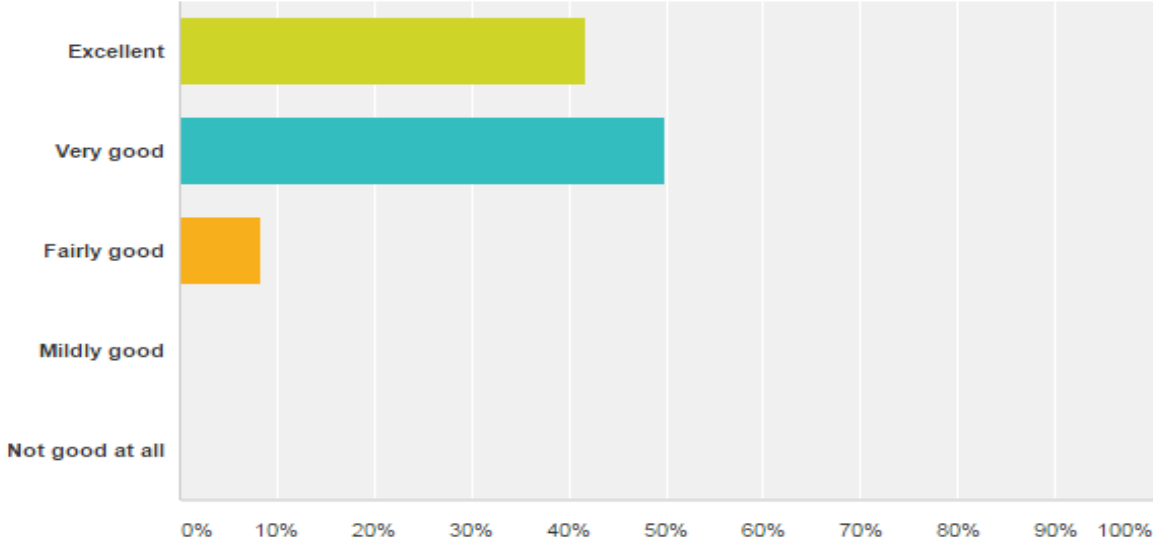
# SIMIODE Developer Workshops, 2015

- SIMIODE WEST – 11 participants
- SIMIODE EAST – 16 participants

# SIMIODE EAST SURVEY RESULTS

Overall, how would you rate the workshop?

Answered: 12 Skipped: 0



Answer Choices	Responses
Excellent	41.67% 5
Very good	50.00% 6
Fairly good	8.33% 1
Mildly good	0.00% 0
Not good at all	0.00% 0
Total	12



# COMMENTS FROM PARTICIPANTS

- *In the short amount of time that we had at the workshop, it was difficult to finish one project and start another. Part of that was because I came to the workshop with one idea that I was going to develop. Perhaps I should have attempted to generate multiple ideas (not all of which are fully developed) before showing up. Overall I was very pleased with the structure and content of the workshop. My goal will be to bring some of what I have learned back to my institution to get them interested in implementing some of the projects from the website in our diff. eq. courses.*

## COMMENTS, cont.

- *I think this was a great first workshop for generating materials for SIMIODE. Providing materials, resources, and time for participants to develop and compile projects was very helpful. As the structure of the website and project submissions becomes more streamlined, the workshops will be even more successful.*
- *This was a great workshop that provided ample opportunity for being productive. I am excited to see all of the projects that come out of this collaborative work session. My partner and I were able to collect data and develop a project which would not have been possible without the workshop!*

# 3-MONTH FOLLOW-UP

- Combined PREP workshop participants and Development workshop participants, sending invitations to complete survey on line or by telephone to 36 people (14 PREP and 22 Development)
- 24/36 responded.
- 17 participants were using or planning to use SIMIODE activities in their DE courses in 2015-16.
- 7 participants hoped to use them next academic year.
- 18 participants had submitted or were close to submitting materials for the SIMIODE website.
- 22 participants said they planned to (or already were) active participants in SIMIODE.

# 3-YEAR RESULTS – Summer, 2018

- 7 of 14 PREP participants active in SIMIODE:
  - Authored modeling scenario(s) (5)
  - Authored journal articles (5)
  - Serve on SIMIODE board of contributing advisors (4)
  - Co-led workshops and mini-courses at MAA JMM and MathFest
  - Reviewed materials for website
  - Hosted SCUDEM competition
  - Co-PI on NSF Grant (2)

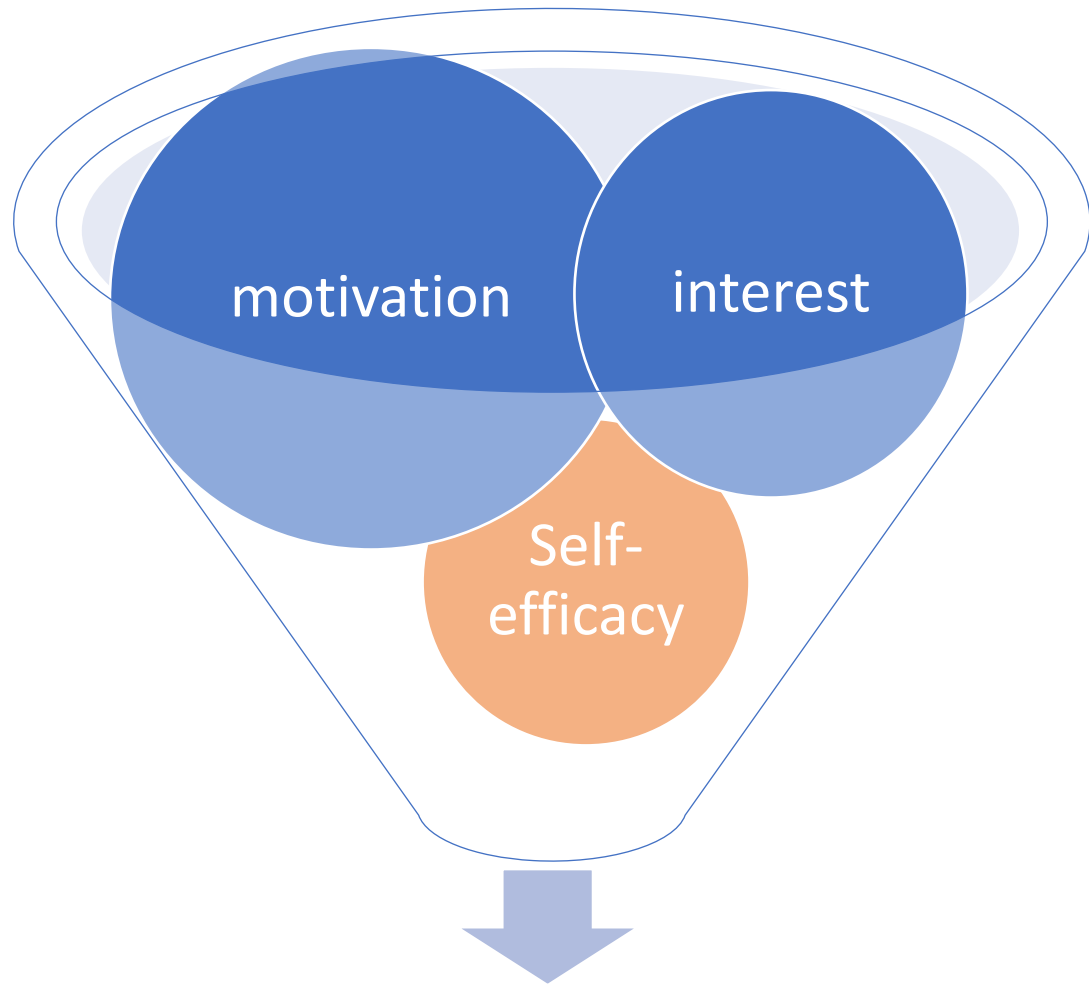
# REALITY CHECK, CONT.

- 23 of 28 Developer Participants are active in SIMIODE
  - Authored Modeling Scenario(s) (20)
  - Authored Journal Articles (2)
  - Presenter at State and National Meetings (6)
  - Lead Author on faculty development workshop materials for SCUDEM
  - Refereed Materials (5)
  - Members of SIMIODE Board of Contributing Advisors (6)
  - Co-PI on NSF grant (2)
  - Host for SCUDEM (3)
  - Coach for SCUDEM (1)

# SCUDEM STUDY - Background

- **Relevance paradox**: disparity between the **objective relevance of mathematics for society** and the **subjective irrelevance of mathematics perceived by students** who study it (Niss & Hojgaard, 2011).
- Interest in mathematics is associated with seeing its practical relevance (Liebendörfer & Schukajlow, 2017).
- Mathematical modeling promotes interdisciplinary thinking (Bliss et al., 2016), mathematical reasoning as a basis of decision making (OECD, 2017), and communication skills (Niss & Hojgaard, 2011)
- Achievement in differential equations increases when using modeling approach (Czocher, 2017; Rasmussen & Blumenfeld, 2007)

# Theory



Modeling competencies

## Modeling Competencies

Identify important variables

Make assumptions to simplify

Estimate parameters

Mathematize

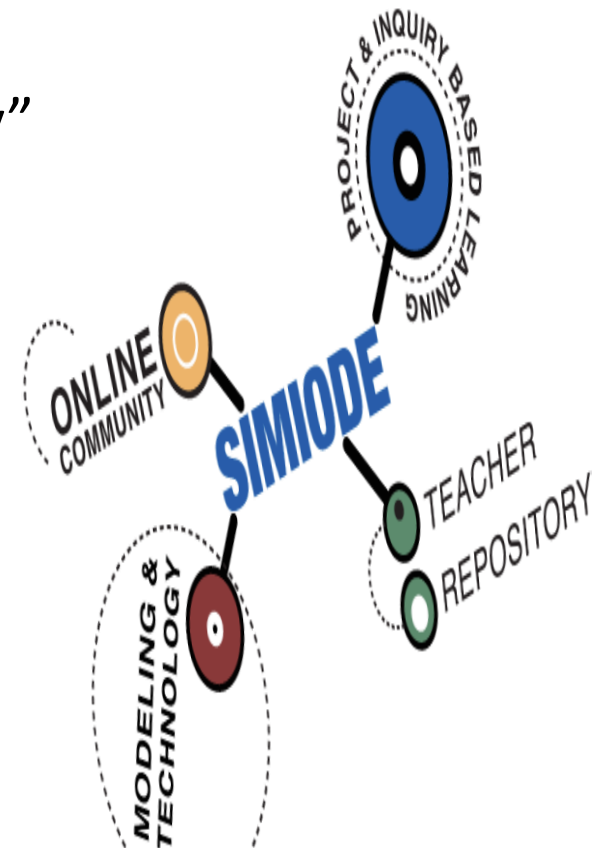
Validate against real world constraints

List potential limitations for the model

Communicate findings and recommendations

# Research Setting and Questions

- International modelling competition hosted by SIMIODE
- Teams of 3 students (high school/undergrad), up to 12 coaches/host site
- Choice of 3 real-world differential equations modelling problems
- One week to work on the problems, write an “executive summary”
- Meet at host sites on Saturday to judge; opportunity to address weaknesses; final presentation
- *Has there been any change in modelling self-efficacy?*



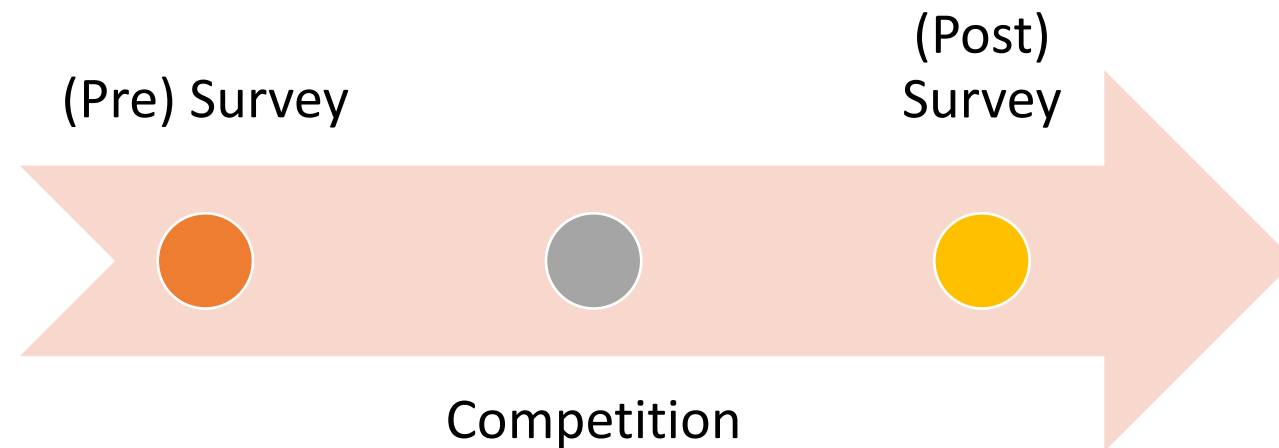


# Demographics

Major (291 respondents)	Count	Taken Diff Eq (291 respondents)	Count	Gender (288 respondents)	Count
other	11	Yes	252	male	188
applied mathematics	42	No	39	female	100
biology	8				
chemistry	11	Coach Rank (74 respondents)	Count	Mean Experience	SD
computer science	25	Student	1	15.24	9.84
electrical engineering	22	Post doc	1		
mathematics	109	Adjunct/Clinical	5		
mechanical engineering	23	Tenure Track	29		
physics	34	Tenured	38		
statistics	1				
system engineering	5				

# Methods

- Administer **self-efficacy surveys targeting modelling competencies** before and after the competition
- 418 competitors (92 complete pre/post surveys) and 125 coaches (43 complete pre/post surveys)
- Preliminary analysis: item-wise analysis via paired samples t-test,  $\alpha = .05$ , (planned, but unneeded Bonferroni correction)



# Survey – Students

Rate your level of confidence by recording a number from 0 to 100 using the scale given below:

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly certain can do

1. Create a differential equation model for the spread of smart home appliances in the United States during the twenty-first century.
2. In (1) identify the important variables leading to a reasonably accurate prediction.
3. In (1) make simplifying assumptions to reduce the number of important variables.
4. In (1) consult appropriate resources to check whether your model was reasonable.
5. In (1) list the real-life and mathematical limitations of your model
6. In (1) create a short presentation to convince a smart appliance manufacturer that they could rely on your model to develop their business plan.
7. Given a differential equation which describes the rate of formation of material A,  
$$A'(t) = \alpha A(t)^\beta,$$
and a data set of observations for time,  $t$ , amount of material A at each time  $t$ , you could estimate the parameters  $\alpha$  and  $\beta$ .

# Results – Students

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Create Model - Create Model	12.796	24.555	2.546	7.739	17.853	5.025	92	.000
Pair 2	Identify Variables - Identify Variables	12.366	19.133	1.984	8.425	16.306	6.233	92	.000
Pair 3	Make Assumptions - Make Assumptions	15.699	22.477	2.331	11.070	20.328	6.736	92	.000
Pair 4	Consult Resources for Validity - Consult Resources for Validity	7.363	20.431	2.142	3.108	11.618	3.438	90	.001
Pair 5	List Limitations - List Limitations	11.935	21.531	2.233	7.501	16.370	5.346	92	.000
Pair 6	Create Presentation - Create Presentation	12.151	22.060	2.287	7.607	16.694	5.312	92	.000
Pair 7	Estimate Parameters - Estimate Parameters	3.441	20.877	2.165	-.859	7.740	1.589	92	.115

Gains on all items, with statistically significant gains in self-efficacy on all competencies except estimating parameters

# Survey - Coaches

Rate your level of confidence by recording a number from 0 to 100 using the scale given below:

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do					Highly certain can do

1. Design a lesson to introduce students to mathematical modeling in differential equations.
2. Lead a ready-made lesson on a mathematical modeling activity in your differential equations course.
3. Create a lesson for your class on building a differential equation model for the spread of the use of solar powered vehicles in the United States during the twentieth century.
4. Create a lesson for your class to teach them to estimate the parameters  $\alpha$ , and  $\beta$  in the following differential equation which describes the time rate of formation of material A,  
$$\dot{A}(t) = \alpha A(t)^\beta,$$
given a set of data from observations for time,  $t$ , and amount of materials A, at time  $t$ , i.e.  $A(t)$ ?
5. Get students to work together well on group tasks

# Results -- Coaches

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Design a Lesson - Design a Lesson	4.286	11.923	1.840	.570	8.001	2.329	41	.025
Pair 2	Lead a Lesson - Lead a Lesson	.952	15.588	2.405	-3.905	5.810	.396	41	.694
Pair 3	Solar Power Lesson - Solar Power Lesson	7.619	24.074	3.715	.117	15.121	2.051	41	.047
Pair 4	Estimate Parameters - Estimate Parameters	2.143	18.417	2.842	-3.596	7.882	.754	41	.455
Pair 5	Group Work - Group Work	1.395	16.985	2.590	-3.832	6.622	.539	42	.593

Gains on all items, with statistically significant gains on Designing a Lesson and Creating a lesson to model the spread of solar powered vehicles

# MINDE\* WORKSHOP

## Plans for Assessment/Evaluation

- \*Model INstructors in Differential Equations
- Pre- & Post-Workshop Surveys
- Short Interviews at workshop
- Follow-up Survey during academic year (on-line, telephone, in-person)
- Eventually, classroom visit
- Final Survey

