DOING SCIENCE ONLINE: THE STATE OF MIDDLE SCHOOL VIRTUAL LABS

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PRESENTATION OUTCOMES

- Summarize what is identified from the NGSS practices and crosscutting concepts in various virtual lab software that middle school cyber charter schools use
- Understand the teacher perspective of delivering virtual labs
- Recall the constructivist design supports present in the virtual labs
- Articulate the difficulties with structuring effective communication in the online learning environment, particularly for younger students

QUICK CHECK

- Has anyone taught in a cyber charter school?
- Does everyone know what a cyber charter school is?
- Have any of you used virtual science labs in either a face-to-face or online environment?
- If so, what are some of the virtual labs software?

CYBER CHARTER SCHOOLS

- 206,000 students enrolled in the 2013-2014
- Operated by Education Management Organizations or Independent organizations
- *Can* increase personalization
- Have the *flexibility* to be more innovative in their pedagogy
- Have to meet state AYP requirements for all public schools
- ALL students receive computer and internet voucher
- Students complete virtual labs primarily by themselves
- No geographic barriers to attendance
- Parents have increased role in student learning

SITUATING CYBER CHARTER SCHOOLS IN PENNSYLVANIA

- Leader in the cyber charter school movement
- 35,000 students enrolled in sixteen cyber charter schools (2012-2013)
- In the 2014-2015 year there were fourteen cyber charter schools
- First cyber charter established in 1998 (Sus-Q Cyber Charter)
- Contentious funding model
- No cyber charters in PA made school performance profile of 70, average was 44.2

SCIENCE LABS AND SCIENTIFIC LITERACY

- laboratory experiences provide opportunities for students to interact directly with the material world (or with data drawn from the material world), using the tools, data collection techniques, models, and theories of science. (National Research Council)

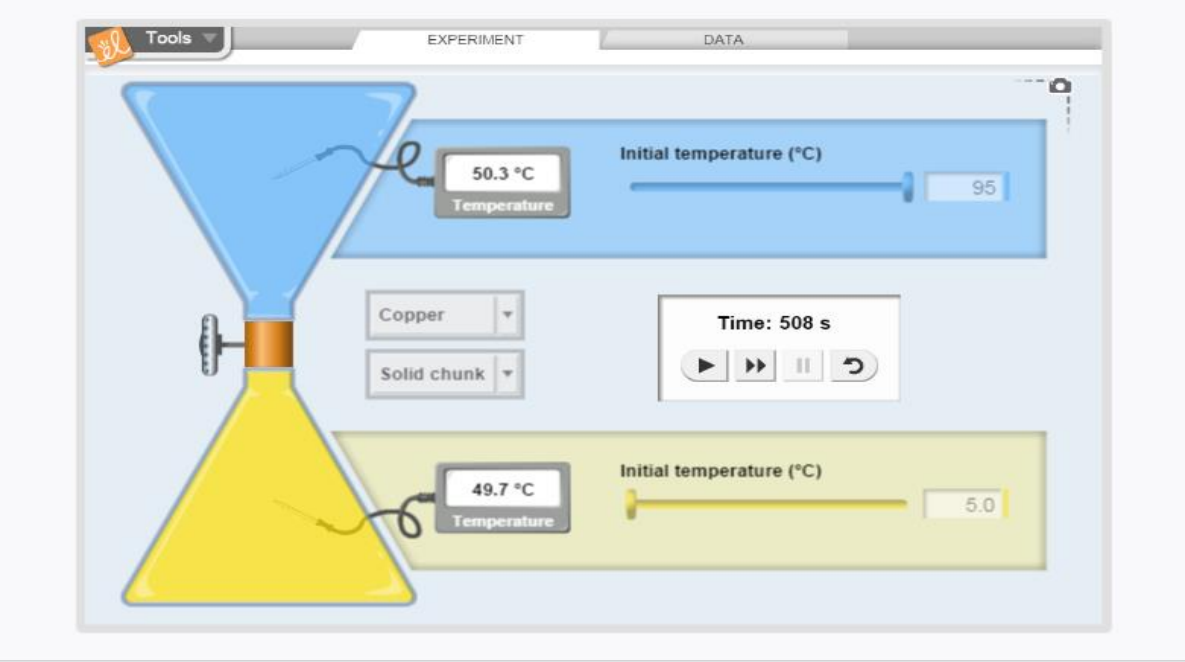
- Science labs can increase the experiences students have to develop their scientific literacy

- Scientific literacy is defined as: the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity."(United States National Center for Education Statistics)
  - Understanding the nature of science – fusion of ideas, concepts, and practices

VIRTUAL SCIENCE LABS

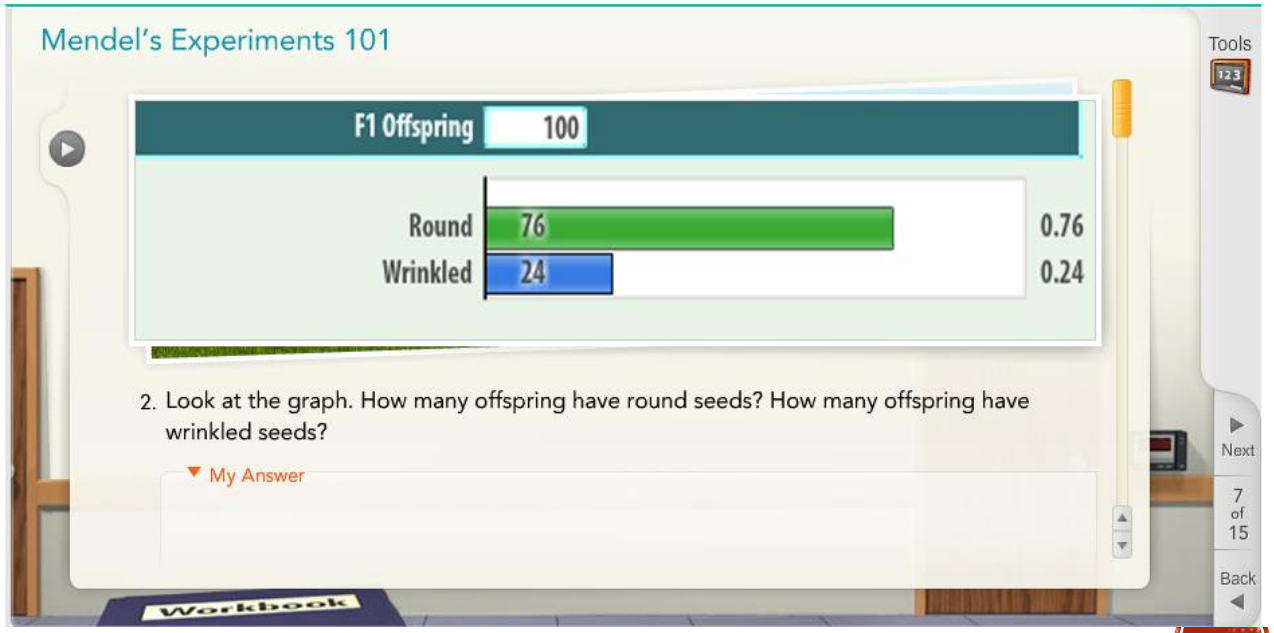
- Virtual science labs should present as a cumulative whole many of the science practices and crosscutting concepts espoused in the NGSS.

- Definition: Allows students to interact with materials in a virtual sense in a way that allows students to develop their scientific practices – from the NGSS the wondering, investigating, questioning, data collecting, and analyzing
  - Virtual Simulations
  - Virtual Fieldtrips
  - Webcams
  - Structured Powerpoint presentations



Lab that looks at conduction

Lab that looks at genetics through Mendel's peas



STUDENTS DOING SCIENCE

Scientific Inquiry

- Lacks a salient definition
- Can lead to a focus on the scientific method while ignoring cyclical nature of science
- Means too many things
- Did not always apply content in practice

Scientific Practices

- Reduces ambiguity of the term inquiry
- Eliminates notion that there is one approach to doing science
- Focuses on practices beyond those commonly thought of to those such as modeling or communicating results

SOCIAL NATURE OF DOING SCIENCE

- Science is naturally social and collaborative
- Laboratories offer a place for collaboration
- Communication needs to be intentional in online learning
- Labs were analyzed with respect to design features that would promote or hinder communication between and amongst students and teachers

NEXT GENERATION SCIENCE STANDARDS

Science Practices

Asking Questions

Developing and Using Models

Planning and Carrying out Investigations

Analyzing and Interpreting Data

Using Mathematics and Computational Thinking

Constructing Explanations

Engaging in Argument from Evidence

Obtaining, Evaluating, and Communicating Information

Crosscutting Concepts

Patterns

Cause and Effect

Scale

Proportion and Quantity

Systems and System Models

Energy and Matter

Structure and Function

Stability and Change

DESIGN OF CONSTRUCTIVIST LES

- Design of instruction matters a great deal
- Labs should have the right amount of
  - Cognitive load
  - Scaffolds
  - Hybridization
  - Sense-making
  - Relevance
  - Questioning
  - Communication

RESEARCH QUESTIONS

- 1. What are the variations of labs that are in the cyber charter schools included in this study?
- 2. Are there identifiable markers observed in the labs in cyber charter middle school classrooms that have the potential to engage students in science practices and crosscutting concepts for the students?
- 3. Are there constructivist design components used in the labs to support the potential the labs have to engage students in science practices and crosscutting concepts?

SAMPLE

- 5 cyber charter schools in Pennsylvania who offer middle school and engage students with virtual science labs
- Located in all parts of the state
- 7 teachers included in the study (three from one school who team taught science)

RATIONALE OF THE STUDY

- Shavelson (2002) eloquently state this when they say: "when a problem is poorly understood and plausible hypotheses are scant – as is the case in many areas of education" that qualitative methodologies "are necessary to describe complex phenomena, generate theoretical models, and reframe questions" (p. 8).

- Communication is emphasized as essential both for learning science and for feeling connected to a learning community in an online environment. Communication is largely absent from these virtual labs.

CLAIMS AND ASSUMPTIONS

This Study does not Answer

- Generalizable claims of practices and concepts in virtual science labs
- Student experience of completing virtual science labs
- Not focused on the hermeneutics of the science labs – analyzes parts of the labs deeply

Assumptions of this Study

- Constructivism is an ideal learning theory for making meaning in science
- Science labs are an essential part of learning science

DATA COLLECTION METHODS

- Observation and participation in 20 virtual science labs → Ethnographic Content Analysis
- Interviews with 7 teachers from 5 cyber charter schools → Thematic Analysis
- Document analysis of associated, but not integral material to the virtual labs → Ethnographic Content Analysis

ETHNOGRAPHIC CONTENT ANALYSIS, ALTHEIDE & SCHNEIDER

- Analyzes the virtual science labs used by PA cyber charter schools
- Looked at from the student perspective in the curriculum sequence
- Researcher central to all parts of the research process
- Assumes that medium of instruction is not a factor in learning outcomes, but design and context of instruction is (Clark, 1994)
- Looked for *potential* of labs to engage students in science practices, crosscutting concepts, and support them with constructivist design components through identifiable markers
  - Explicit
  - Implicit

LAB SOFTWARE USED

	Cyber Charter A	Cyber Charter B	Cyber Charter C	Cyber Charter D	Cyber Charter E
Virtual Software Used	PhEt, ExploreLearning	A variety of sources; always open and free	ExploreLearning, PhET, BrainPop, Prentice Hall Active Arts	McGraw-Hill-Glencoe, PhET, Explore Learning	All delivered through blackboard for regular education students

IMPORTANCE OF THE TEACHER

- History of technology being the panacea to reduce the ‘cost disease’ of higher education
- Student report challenge of online learning is feeling connected to their instructor (Song, Singleton, Hill, & Hwa Koh, 2004)
- Teachers as ‘guide on the side’ are crucial to helping students with their meaning-making
- Teachers were used in this study to contextualize virtual science labs being used in different schools

RESULTS: TEACHER INTERVIEWS

Themes	Quote
Design of the labs	It takes a lot of time to create these items and that is not the amount of time that we have on a regular basis as for what is free and paid.
Teacher dedication and improvisation	They would say the experiment worked and that is all they would say. Well that is not a proper conclusion so obviously I have to help them write a conclusion so I literally do it step-by-step.
Teacher availability to students	Office hours once a week…they will also email me and I will call them back…and we have got Skype for chat
Communication practices	It depends, sometimes it happens and sometimes it doesn't. Like I said that would be an ideal situation

RESULTS TEACHER INTERVIEWS

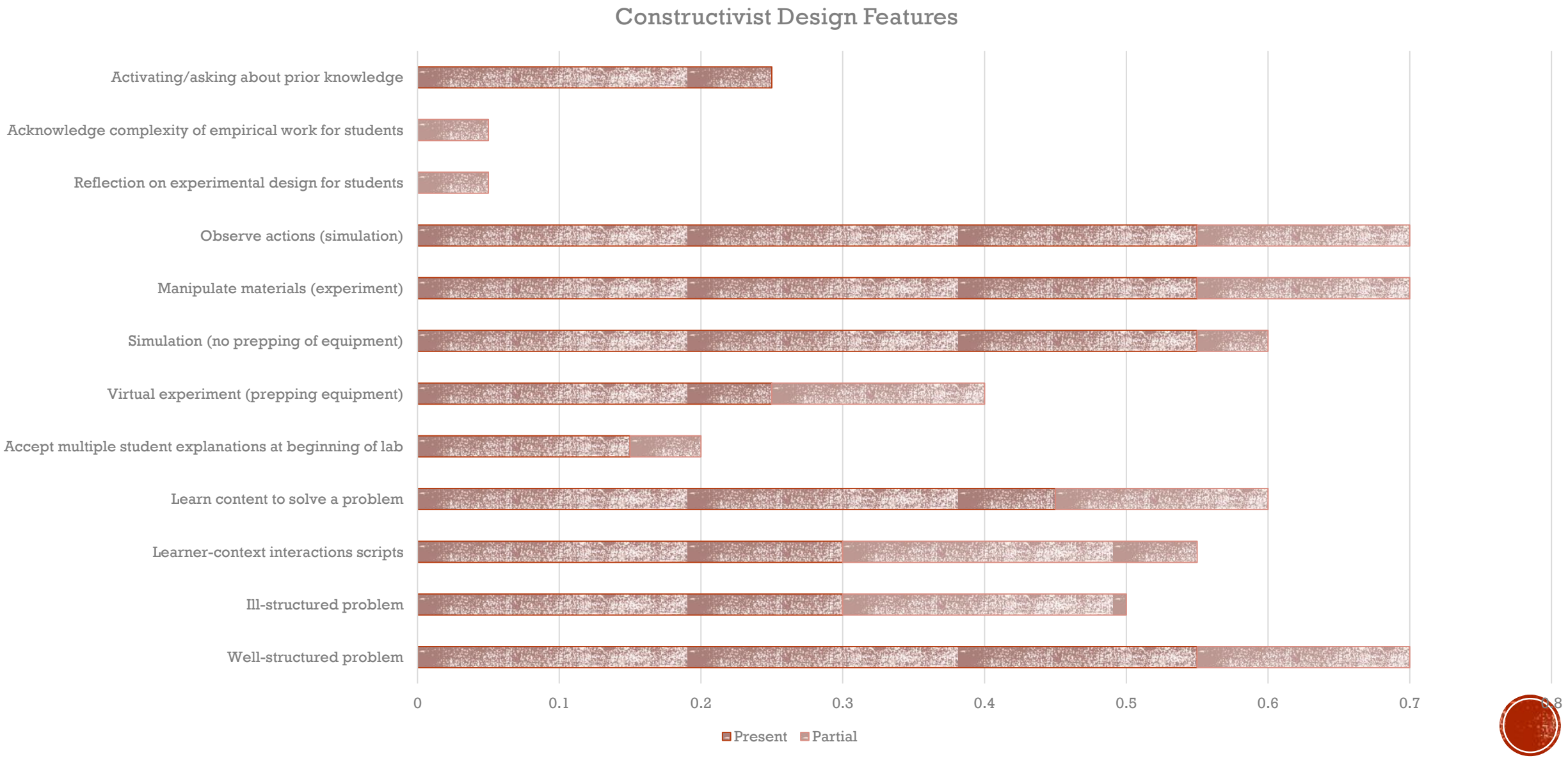
Parental Expectations from the school	I think a lot of the courses that we deal with are almost afraid to ask that to happen because very often there is nobody there that is going to help them
Challenges with the virtual labs	The low functioning kids they get real excited when we have a portfolio…and they will stop and won't do science for 3-4 weeks because of that.
Willingness to allow revisions and give detailed feedback to students	Definitely with this population I give them the chance to go back through and make corrections now whether they do that…
Teacher definitions of labs in the virtual setting	When I think of a lab a lot of these they are not really labs they get some information together…but I would like to see more experimentation which I don't know how you would do that.

	Existing (ex) or Emergent (em)	Present outside of lab in LMS	Present	Partially Present
Science Practices				
Asking Questions	Ex		5	35
Developing and using models	Ex		35	35
Planning and carrying out investigations	Ex		35	35
Analyzing and interpreting data	Ex		40	20
Using mathematics and computational thinking	Ex		50	5
Constructing explanation	Ex		50	-
Engaging in argument from evidence	Ex		10	20
Obtaining, evaluating, and communicating information	Ex	5	10	-

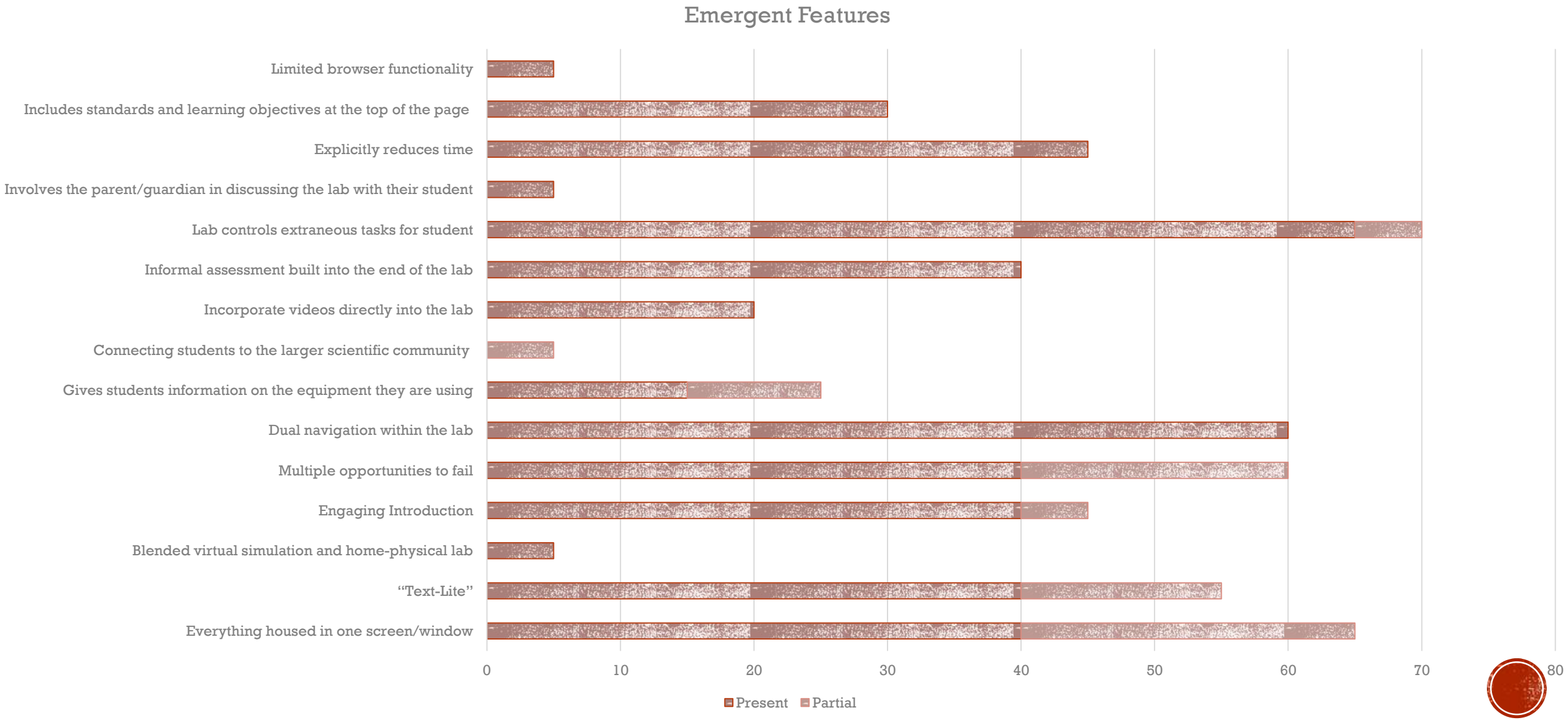
	Existing (Ex) or Emergent (Em)	Explicit	Implicit
Crosscutting Concepts			
Patterns	Ex	30	35
Cause and effect	Ex	45	40
Scale, proportion, and quantity	Ex	15	35
Systems and system models	Ex	5	15
Energy and matter	Ex	10	20
Structure and function	Ex	15	30
Stability and change	Ex	15	65

RESULTS: CONSTRUCTIVIST DESIGN SUPPORTS

RESULTS: CONSTRUCTIVIST DESIGN FEATURES



RESULTS: EMERGING CATEGORIES



IMPORTANT FINDINGS

- No communication takes place while students are completing the labs
- Teachers had ownership of the curriculum
- A clear definition of what is meant by virtual lab in a cyber charter school is needed
- 25% of labs acknowledge prior knowledge
- 20% accept multiple student explanations for phenomena
- Students largely miss the 'whole' of doing science from the wondering to the inferring to the reflecting
  - Labs would ask students to interpret data but then not defend their evidence or communicate findings

IMPORTANT FINDINGS

- If crosscutting concepts were present, they were implicit (34%) more than explicit (19%)
- This environment for doing science limits the amount of uncertainty that students are exposed to
- Labs had reflective or metacognitive prompts 25% of the time
- Observations, simulations, hands-on learning, and experiments are not mutually exclusive terms (reverse of what Crippen et al., 2012) suggested

QUESTIONS AND CONTACT INFORMATION

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