

Imagining Teaching via Scripting Tasks

*Imagining Mathematics teaching
as a preparation for the
“real thing”*

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Teacher Education

- Continuous struggle of STEM colleagues: How to support and improve teacher development?
- “the fundamental issue in working with teachers is to resonate with their experience so that they can *imagine* [my italics] themselves ‘doing something’ in their own situation” (Watson and Mason, 2007 p. 208).
- Imagine in action ==> Role play

What is role playing?

Role-playing is an unscripted “dramatic technique that encourages participants to improvise behaviors that illustrate expected actions of persons involved in defined situations” (Lowenstein, 2007, p. 173).

**In other words, role-playing is “an ‘as-if’ experiment in which the subject is asked to behave as if he [or she] were a particular person in a particular situation”
(Aronson & Carlsmith, 1968, p. 26).**

Role-play advantages

- Increased Interest
- Increased Involvement
- Empathy
- Understanding various perspectives
- Deeper engagement with content
- Increased retention

Role-play Disadvantages

- Time and participation logistics

Q: How to give all students an opportunity to participate?

A: Imagined role-playing OR script writing

Script/Dialogue writing

- Socrates
- Galileo
- Imre Lakatos
- Watson and Mason
- ...
- Here we come

Lesson Play

Rina Zazkis
Nathalie Sinclair
Peter Liljedahl

Lesson Play in Mathematics Education

A Tool for Research and
Professional Development

 Springer

Presenting a lesson in
a form of a script for
a conversation
between a teacher
and her students

Lesson Plan

- Tradition (*play clip*)
- Expectations
- From idea to a template
- Content Vs. Process
- “Real teachers do not plan like that”

In a good lesson plan we may find

- Students engage in an activity that is appropriately chosen
- Students use manipulatives or other visual representations
- Objectives are well-clarified
- Clear organization around main concepts or ideas
- Opportunity for students to share their ideas and reflect on the ideas of classmates
- Evaluation process is clearly related to the declared objective
- Opportunity for extension
- Clear link to students' prior knowledge

In a good lesson plan we cannot find

- What students' difficulties, errors or misconceptions are expected
- How students are guided to overcome those
- What language is used, introduced, corrected and/or supported
- How students are supported pedagogically and emotionally
- What specific questions are used to assess, extend or refine students' understanding
- How different forms of reasoning are treated

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Affordances of lesson plays

- (A) for prospective teachers
- (B) for teacher educators
- (C) for researchers

How this started

- Write a play
- Write a play that addresses a problem
- Write a play following a prompt

Length Measurement Prompt

Students in your class were asked to measure the length of different objects.

The teacher collected their responses.

Teacher: Johnny, how long is the stick that you measured?

Johnny: It is ... seven

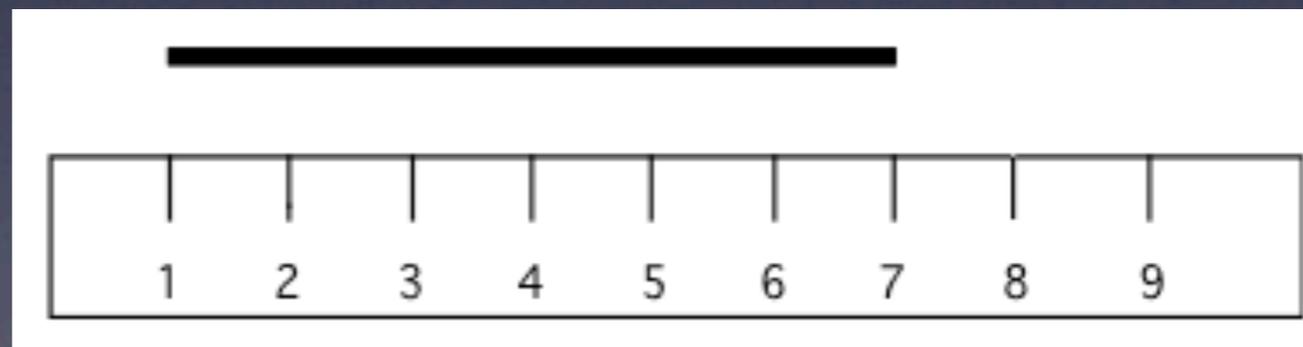
Teacher: Seven what?

Johnny: Seven centimeters

Teacher: Can you show me how you measured?

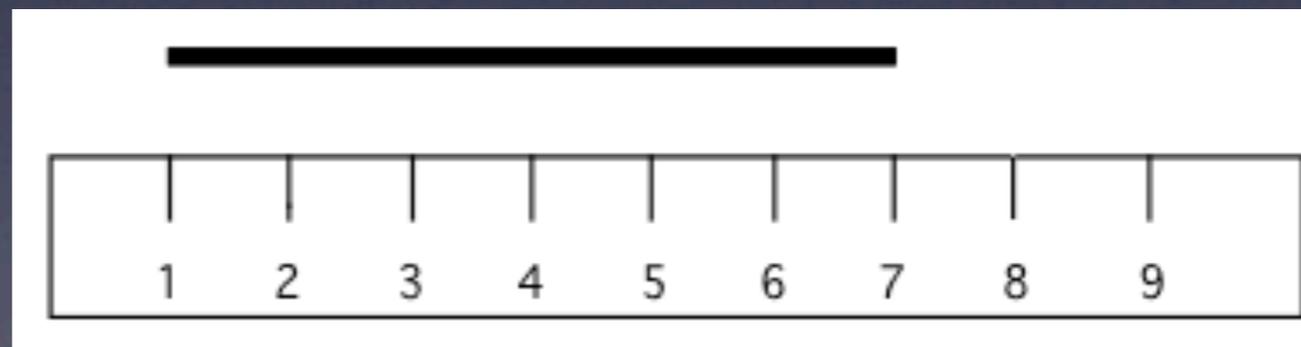
(Johnny places the stick next to the ruler as shown below)

Teacher:



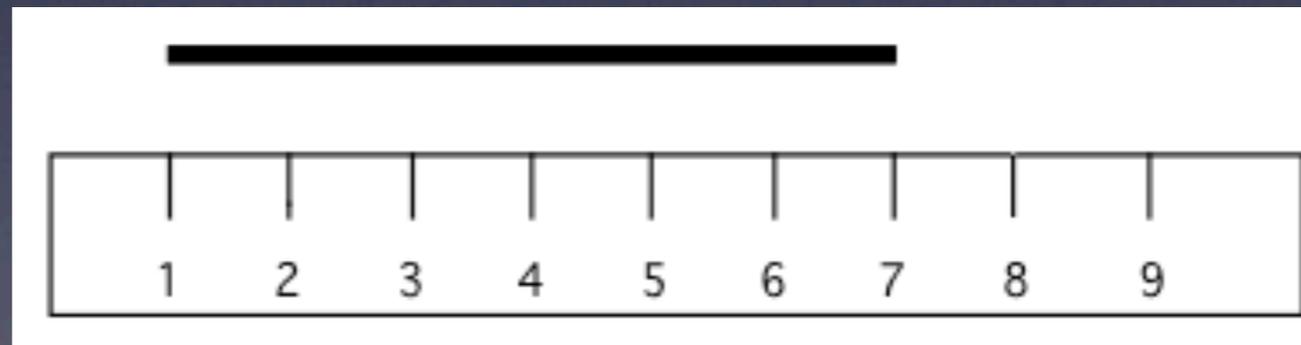
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Teacher	Oh I see, you started there because that is the first number that you saw!
Johnny	Yep – we always start at one!
Teacher	Johnny, you are right! Usually when we are counting we do start at one! But guess what, when we are measuring – <u>there is a special trick that we use when we count!</u>
Johnny	Really? We use a trick?
Teacher	When we measure, we start at the far side here and that is a zero! To make it a little bit easier for you, how about we draw a 0 on your ruler with your pencil so that it will remind you where to start!



#2

Ms. G	Do you remember <u>two important rules for measuring?</u>
Johnny	Um.. Don't skip spaces for measuring and ... um...
Ms. G	And make sure to start at the base. A ruler has a baseline too Johnny. Whenever we measure anything against a ruler, we must start at the baseline. Can you tell me what number is at the baseline this ruler?
Johnny	Yes, it's zero



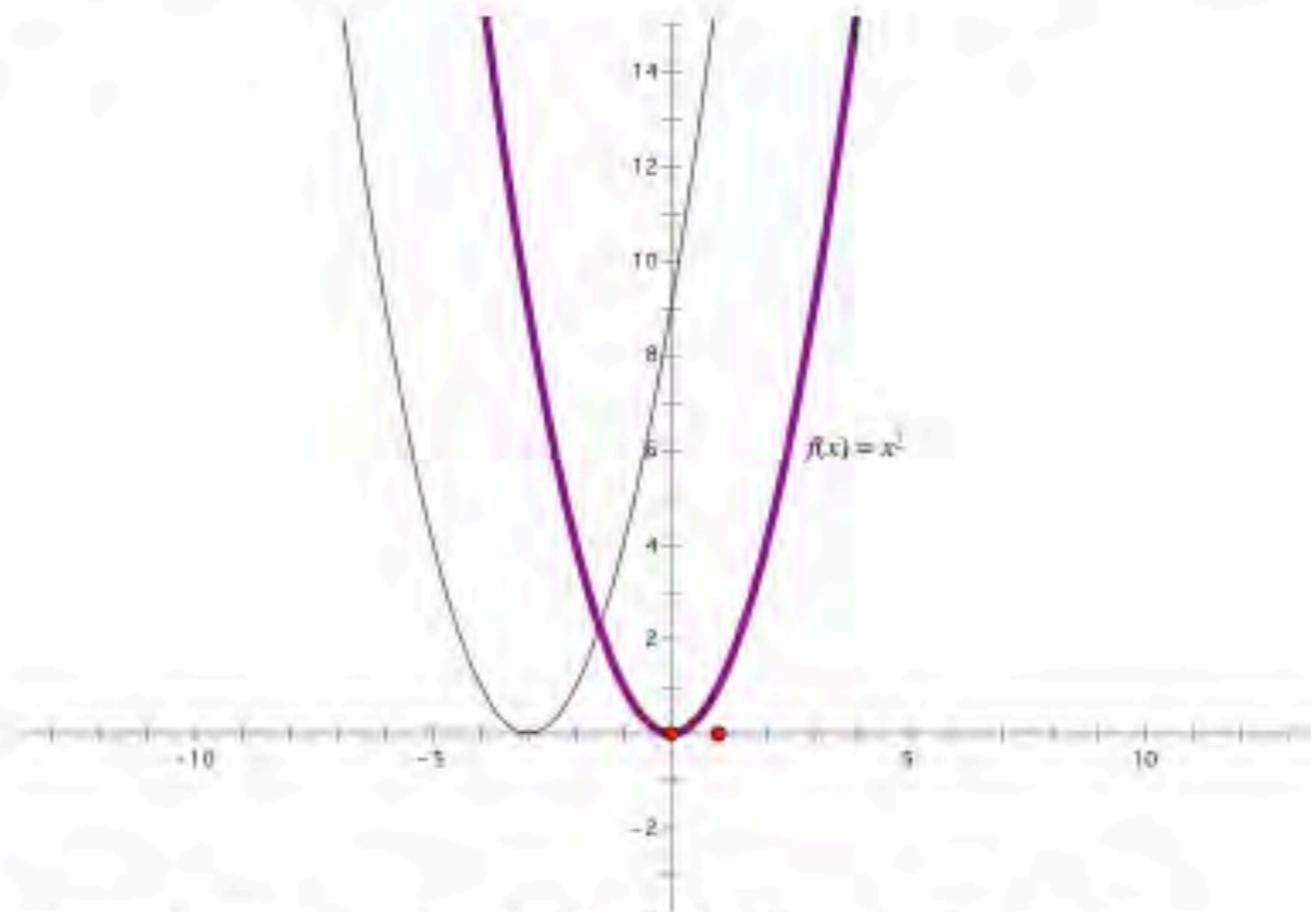
#3

Teacher	<u>If you were to place the stick upright on the table</u> (<i>the teacher demonstrates with his hands</i>) would it be the same length if you measured it with your ruler?
Johnny	Of course.
Teacher	Try it
	<i>(Johnny takes the stick and measures it upright. He makes a face when the ruler reads 6 instead of 7)</i>
Teacher	What happened here?
Johnny	I don't know. Magic?
	[...]
Johnny	I was counting one extra
Teacher	One extra what?
Johnny	One extra centimetre
Teacher	So where should you start?
Johnny	From 0 centimetres.

Parabola prompt

Teacher: We have the graph $y=x^2$.
Would you please draw the graph of $y=(x-3)^2$.

Student: It just moves 3 points left.



Teacher: And why do you say this?

Student: Because of the -3.

Prompt development

A toy train prompt



A toy train has 100 cars. The first car is red, the second is blue, the third is yellow, the fourth is red, the fifth is blue and sixth is yellow, and so on.

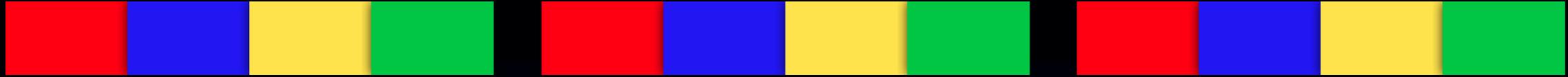
What is the colour of the 80th car?

The teacher is moving through the room observing how the students are progressing. S/he stops and points at one student's work.

T: Why is the 80th car red?

S: Because the 4th car is red, and 80 is a multiple of 4.

A toy train prompt - alternative focus



A toy train has 100 cars. The first car is red, the second is blue, the third is yellow, the fourth is green, the fifth is red and sixth is blue, and so on.

What is the colour of the 39th car?

The teacher is moving through the room observing how the students are progressing. S/he stops and points at one student's work.

T: Why is the 39th car yellow?

S: Because the 3rd car is yellow, and 39 is a multiple of 3.

Prompt development take 2

D1 Teacher: Why do you say that 462 is divisible by 4?

Student: Because the sum of the digits is divisible by 4.

D2 Teacher: Why do you say that 354 is divisible by 4?

Student: Because ...

PN1 Teacher: Why do you say 143 is prime?

Student: Because it is not on our times tables



PN2 Teacher: Why do you say 143 is prime?

Student: Because 2,3,4,5,6,7,8 and 9 don't go into it.

PN3 Teacher: Why do you say 143 is prime?

Student: Because ...



PN4 Teacher: Why do you say 37 is prime?

Student: Because 2,3,4,5,6,7,8 and 9 don't go into it.

Affordances of lesson plays *for prospective teachers*

- IMAGINING teaching
- BUT -- NOT “thinking on your feet”, not real time
- Opportunity to explore erroneous perspective, understand its origins, help overcome
- Opportunity to examine personal response
- Opportunity to imagine “real teaching”
- Creating repertoire or responses and general strategies to be used in future improvisation

Affordances of lesson plays *for researchers*

- Assumption: Teacher-characters' 'moves' reflect personal views of a script writer
- A lens to examine teachers' conceptions of teaching and learning in "semi-action"
- Insight into 'moves' that support a mathematical discourse
- The role of imaginary interactions in developing alternate moves

Teacher: Why do you say that 462 is divisible by 4?

Student: Because the sum of the digits is divisible by 4.

5.10.1	T □	I think we are confusing our divisibility rules for 3 and 4. Let's review them. ¶ <u>(teacher writes the divisibility rules down on the white board while she reviews them)</u> □
5.10.2	□	[...] □
5.10.3	T □	I would like the class to please copy down these divisibility rules into their Math workbooks, <u>we will need to review these rules a few more times</u> before we become comfortable with them. ¶ <u>(the students copy down what is on the white board)</u> □

Forget - hard- review

5.12.1	Teacher	Actually, <u>4 won't divide into 462</u> . We can discover why by looking over the rule of dividing by 4's. Let's talk about the easiest rule for dividing by four. We went over it in class yesterday but I <u>know it's sometimes hard to remember things if you feel confused</u> . Right? Are you thinking about when we did dividing by 3's and if the sum of the number adds up to a number divisible by 3, then the whole number can be divided? □
5.12.2	Student	Yeah. I could only remember the <u>rule for dividing threes</u> . I sort of forget stuff if it's too hard, <u>especially in math</u> . □
5.12.3	Teacher	I have an idea. Let's get out a piece of paper and write down the <u>rules for dividing by 3 and 4's</u> . That way, even if you feel confused and forget, you can go back and review it, all right? □
5.12.4	Student	Okay, that might help. Sometimes I just get home and <u>forget how to do the math</u> . □

On “last two numbers”

364 - ?

5.28.1	S5 ☐	Yeah! And in my group someone said you would know if 354 <u>was divisible if you just look at the last two numbers.</u> But I don't get that?!! ☐
5.28.2	T ☐	Oh! Your group stumbled upon an excellent discovery! ☐
5.28.3	S5 ☐	We DID?!!?? ☐
5.28.4	T ☐	Yes! Talk in your groups for 5 minutes about why 54 might tell you right away if 354 <u>is divisible by 4?</u> ☐
5.28.5	☐	[...] ☐
5.28.6	S6 ☐	Well we didn't think about the 300 part, but that sounds like a good reason, but the 54 part... because we know that's the small part it's easier to look at and it looks like 4 goes into it because of the 4, but 4 doesn't go into 5, so it won't work. So if it doesn't go into the small numbers it can't go into the big number? But we looked at 384 and here 4 goes into 4 and into 8, so this would work. ☐
5.28.7	T ☐	That's right! So you have all figured <u>it out!</u> <u>If the small numbers (ones and tenths column) isn't divisible by 4</u> then there's no point looking into the hundreds column! How is this different from the trick Johnny taught us today? Does everyone understand? ☐

Divisibility tricks

5.15.1	Ms. L	Hey, no worries David. I think you just got the tricks for testing divisibility mixed up. I get things like that confused all the time because <u>there are so many neat math tricks</u> for different things. I can show you where you mixed it up and tell you a few more divisibility tricks at the same time. Do you want to see? ☐
5.15.2	David	Sure ☐
5.15.3	Ms. L	So let us start with 2... ☐

5.17.1	Teacher	<u>hey class, wanna see an awesome trick?</u> ☐
5.17.2	Class ☐	Yah!! ☐
5.17.3	Teacher	<u>okay come sit on the carpet facing the blackboard.</u> ☐
5.17.4	Class ☐	<i>(Goes and sits on the carpet.)</i> ☐
5.17.5	Teacher	Ok, give me any number that is more than two digits and I can tell you if you can divide it by 4 ☐
5.17.6	Class ☐	34 ☐
5.17.7	Teacher	No! <i>(Writes number on board and <u>places an X beside it.</u>)</i> ☐
5.17.8	Class ☐	228! ☐

Affordances of lesson plays *for teacher educators*

- Assumption: Teacher-characters' 'moves' reflect personal views of a script writer
- “Beyond lesson planning”
- Opportunity to highlight appropriate pedagogical responses
- Opportunity to direct further attention to learners
- Opportunity to shift prospective teachers' thinking about preparation for instruction
- Opportunity to enhance and inform personal design of “methods”

Affordances of lesson plays *for researchers*

- Assumption: Teacher-characters' 'moves' reflect personal views of a script writer
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Affordances of lesson plays *for researchers*

- Zazkis, R., Sinclair, N., & Liljedahl, P. (2013). *Lesson Play in Mathematics Education: A tool for research and professional development*. Springer.
- Sinclair, N. & Zazkis, R. (2011). Lesson Plays: Learning how to improvise. *Ontario Mathematics Gazette*, 50(1), 30-35.
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- MORE IN PRESS

Other Scripting Tasks

(WITH OTHER COLLEAGUES)

- Proof scripts (e.g., Pythagorean theorem, Fermat little theorem)
- Conversation with a colleague
- Conversation with a student

Conversation with a student

Scripting Assignment: Power (-1)

T: So today we will continue our exploration of how to find an inverse function for a given function.

Consider for example $f(x) = 2x+5$ Yes, Dina?

S: So you said yesterday that f^{-1} stands for an inverse function

T: This is correct.

S: But we learned that this power (-1) means 1 over, that is, $5^{-1} = \frac{1}{5}$, right?

T: Right.

S: So is this the same symbol, or what?

T: ...

Conversation with a colleague

It is 8:15 in the morning and you are busy preparing for your classes.

A colleague comes to your room and says something like that:

“Listen, I know you are doing your Master’s and all. But have you thought about what this is doing for the kids?”

(PME - in 2 days)

THANKS!

- develop your prompts
- collect your scripts
- let me know how this worked for you

THANKS!

*All the world's a stage,
And all the men and women merely players;
They have their exits and their entrances,
And one man in his time plays many parts...*

William Shakespeare (1603)