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Does constructivism tell us how to teach?

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Abstract: *The addressed question from the interface between theory and teaching practice of constructivism is discussed at the background of whereabouts of the Common Core (CCSS-M) constructivist-based mathematics curriculum. It concerns the formulation of constructivist methodology of teaching, whose existence is called in doubts by US constructivist researchers who formed the basics of the approach of the constructivist philosophy into education. The presentation argues that the research tool, constructivist teaching experiment does define the constructivist teaching methodology and through mathematics teaching-research, it can be introduced into mathematics classroom at large. The conference presentation will address socially based reasons for the professed absence of constructivist teaching methodology, and it will address critically the method of 'scripted lessons' as the substitution for teaching methodology- the two theme absent from the proposal below due to lack of space.*

INTRODUCTION

This question, which for the first time arose during the nineties when constructivist approach was making its initial inroads into mathematics education, becomes particularly relevant at present at the background of whereabouts of the first US national curriculum called Core Curriculum State Standards – Mathematics. CCSS – M is based upon constructivist approach as it is understood in US and it utilizes the concept of hypothetical learning trajectories introduced by Simon (1995). The background of the question takes us deep into the troubled relationship between research and teaching practice as well as between researchers and teachers.

What is a constructivist approach in mathematics education?

The central idea of constructivism refers to the processes through which humans acquire knowledge of the world and asserts that it is through the process of creating meaning for

themselves by reflection upon their own experience. Naturally, the process of creating the meaning is multifaceted, and we are familiar with at least two grand constructivist theories of learning, which analyze the process from two distinctly different angles: Piagetian theory which sees that process primarily in terms of an individual and his or her environment whose tool is reflective abstraction and Vygotskian theory which sees the process of construction of meaning as a socio-cultural process that is in terms of an individual within distinctly social and cultural environment intrinsically connected with it through language. The difficulties in smoothly integrating the two approaches in the process of classroom learning is by some seen as one of the main reasons of absence of visible success of the Core Curriculum in US (Dreyfus, 2018; Baker 2020), some call it even the failure of the approach.

As a teacher-researcher in a working-class community college in South Bronx, I see a significant value in the constructivist point of view upon learning, which focuses on and facilitates student autonomous mathematical thinking through the engagement in the process of creating mathematical meaning. The possibility of losing so defined pathway of learning and teaching makes me feel very uncomfortable as the math educator of 'underrepresented and underserved' of the Bronx.

This time of ambiguity as to whether CCSS – M will take off or not, is filled with a very un-holy, in my opinion, activity of the school districts in US, which are introducing the "scripted lesson" teacher materials aligned with the content and methodology of CCSS-M. The materials, which instruct the teacher what to say in the classroom in different didactical situations are aligned with the standards and of course can be and are used in the classroom by teachers.

Before proceeding further, I want to indicate I encountered very diverse opinions concerning this issue, my own being of radical rejection of that methodology on two accounts:

- as thoroughly unnecessary for the success of the standards, and therefore hiding another motivation;
- destructive to teachers', and therefore to students' creativity.

One could ask why externally 'scripted lessons' are being introduced as teachers' materials to follow the curriculum and the most probable answer would be, because teachers cannot develop them by themselves. In other words, it is the distrust in teachers' professional proficiency vis-à-vis the constructivist-based CCSS-M curriculum.

In the next sections we advance arguments proposing teaching-research as the methodology of teaching constructivist curriculum. Since teaching-research is anchored in teaching practice, every interested and committed teacher of mathematics has the possibility of entering that TR pathway

with the properly designed professional development (Czarnocha et al, 2016). And the teacher doesn't need external scripting.

DISCUSSION

That is the background against which one has to examine the assertions questioning whether constructivism tells us how to teach. Two separated from each other for 20+ years statements yet bearing exactly the same, troubling message:

Relatively recent, (9/05/18) Forbes.com probed the issue, noticing that "the Common Core State Standards initiative did provide more structure to how mathematics is being taught, and it did not, in and of itself, change the approach to teaching mathematics."

This finding is very similar to the point made by Simon (1995), twenty three years earlier, with which we take the serious issue here:

"Although constructivism provides a useful framework for thinking about mathematics learning in classrooms and therefore can contribute in important ways to the effort to reform classroom mathematics teaching, it does not tell us how to teach mathematics; that is, it does not stipulate a particular model" (p.114).

Yes, it does.

Before proceeding with the argument, it's important to examine the relevant background of the issue which by now has eliminated CCSS-M as a viable successful national approach since most of the states in US have withdrawn from CCSS-M partnerships.

The second, related here question of Steffe, (2004): Who is responsible for the design of learning trajectories [the essential tool of CCSM]? - provides more fire to the argument. The author answer to his question suggest that teachers' role starts when researcher have completed their research approach, which then can be taken over by teachers to introduce, scripted if needed, into the classroom. Answers to both questions betray unspoken yet essential connection with the role of the teachers in understanding student thinking and formulating pedagogy based on their understanding.

In the 1970s, while formulating the principles and practice of teaching-research in the inaugural lecture at the University of East Anglia 1979 titled "Research as a basis for teaching," Stonehouse observed that one of the possible explanations for the failure of research

> "…to contribute effectively to the growth of professional understanding and to the improvement of professional practice… was the reluctance of educational researchers to

engage teachers as partners in, and critics of, the research results." (Rudduck and Hopkins,1985).

The reason for the reluctance of researchers to engage teachers as partners has been eloquently characterized Wittmann (1999) with the help of notion of Academic Respectability. Wittmann (1999) focuses his attention on the design of teaching units, the predecessors of learning trajectories, the best of which, he admits, were designed by teachers and published in teaching journals… and as such they were hardly noticed by the research community.

The reason offered for the absence of recognition of teachers' work and mastery of the design process is significant:

> "'in contrast to 'research', the design of teaching units has been considered as a mediocre task normally done by teachers and textbook authors. Why should anyone anxious for **academic respectability** stoop to designing and put himself on one level with teachers? The answer has been clear: he or she usually wouldn't."

Thus, the disregard of teachers' role in classroom teaching design has no meritorious reason but purely social one, the issue of academic respectability. Wittmann (1999) describes in detail the process by which teachers get disenfranchised of their teaching profession. He asserts that,

> "…the design of substantial teaching units, and particularly of substantial curricula, is a most difficult task that needs to be carried out by the experts in the field. By no means it can be left to teachers, though teachers can certainly make important contributions within a framework carried out by the experts, particularly when they are members or in close connection with a research team…a teacher can be compared more to a conductor than to a composer….".

The learning trajectories designed by teachers at Community Colleges of the Bronx are presented in Czarnocha et al (2016).

We surmise from these examples and counterexamples that the central issue for constructivist researchers is the preservation of academic respectability by creating a hierarchical barrier for teachers' participation rather than finding effective constructive methods of learning improvement. Czarnocha and Baker (2020, Chapters 4 & 5) lead the discussion farther demonstrating how the internal constructivist contradictions limit possibilities for students' and teachers' creativity with scripted lessons as their leading example.

The proper and careful introduction of teaching-research as the central methodology of research and teaching can be the bridge within our profession, which can help ameliorate the academic respectability social status difference. If teaching-research is taken as the methodology of work within our profession, then teacher-researchers are between teachers and researchers' social status-wise, precisely because they engage in the work of researchers in their classrooms and thus bring their classrooms closer to the requirements of research. So that the distance of "stooping" to the level of teachers is diminished by half, and fully justified as a correct principled compromise step, yet without losing a significant amount of academic respectability while gaining efficient wholeness of research and practice. Czarnocha et al (2016; Chapter 5.4) discusses the process of mastering teaching-research methodology through the design of PDTR professional development for teacher-researchers.

SCRIPTED LESSONS

Below we have the examples of scripted lessons taken from the document titled New York State

Example 1 of scripting the lesson (p.16)

Will these products be positive or negative? How do you know?
$\{(-\mathbf{1}) \times (-\mathbf{1}) \times \cdots \times (-\mathbf{1})\}^{12}$ (-1) multiplied by itself 12 times

This product will be positive. Students may state that they computed the product and it was positive. If they say that, le them show their work. Students may say that the answer is positive because the exponent is positive; however, this would not be acceptable in view of the next example.

$\{(-\mathbf{1}) \times (-\mathbf{1}) \times \cdots \times (-\mathbf{1})\}^{13}$ (-1) multiplied by itself 13 times
This product will be negative. Students may state that they computed the product and it was negative. If so, ask them to show their work. Based on the discussion of the last problem, you may need to point out that a positive exponent does not always result in a positive product.

Example 2 of scripting the lesson (p.20)

Write an expression with $(-\mathbf{1})$ as its base that will produce a positive product, and explain why your answer is valid.
Accept any answer with $(-\mathbf{1})$ *to an exponent that is even.*

Write an expression with $(-\mathbf{1})$ as its base that will produce a negative product, and explain why your answer is valid.
Accept any answer with $(-\mathbf{1})$ to an exponent that is odd.

NYS Common Core Mathematics Curriculum, Engage[NY], *https://www.scribd.com/document/381944013/Math-g8-m1-Teacher-Materials-1*,p.16

According to anecdotal information obtained from Hostos CC adjunct professors who are also High school and Middle school teachers of mathematics, the materials have been introduced into classrooms to be followed directly by teachers with less teaching experience. The experienced schoolteachers tend to be concerned and scornful of the methodology as inadequate for development of thoughtful and reflective mastery of teaching. The direct introduction of scripted lesson is in contradiction with the United Federation of Teachers contract:

> Since 1990, Article 8 of the teachers' contract has affirmed that the organization, format, notation and other physical aspects of the lesson plans are within a teacher's discretion. Nevertheless, many supervisors continued to require specific components be included in lesson plans which led the Union to file a Union Initiated grievance. In sustaining the grievance, the arbitrator ruled that "lesson plans are for the personal use of the teacher" and that supervisors may not "mandate specific elements of lesson plans. https://www.uft.org/your-rights/know-your-rights/lesson-plans.

Careful reading of the suggested actions in the scripted lesson material reveals that they address themselves not only to the question pedagogy but also mathematical knowledge.

While being critical of the scripted teacher materials designed by constructivist curriculum developers, we are aware of the interesting volume by Zazkis and Herbst (2018), which provides the research background for lesson scripting within the framework of Mathematical Dialogues and Practice. Perusal of the volume suggests its importance for the research on dialogical teaching. I also noticed two sets of comments in the volume that point to the obstacles along the way from research-on-teaching to teaching in a standard public classroom. David Pimm (2018, p.viii) is "…led to wonder how does scripting relays to actual classroom…"; Sandra Crespo (2018) quotes teacher-researchers Cotchran-Smith & Lytle, (1999) who have noted "about the ways in which structures and pedagogy of teacher education positions teachers and teacher

candidates as technicians rather than intellectual partners in the production of knowledge for, in and of teaching."

And such a purely technical view is represented within the attached materials, which "

> …position [teachers] as consumers and reactors to ready-made representation of teaching. They are expected to learn from those representations and replicate the productive teaching moves featured in those representations…when their turn comes to teach in real classrooms."

It's the process of "replicating teaching moves" that is of our concern, as it's antithetical to the teacher creativity in the classroom, and consequently to their students' creativity, especially as the research and professional development are envisioned for teaching novices, who as it has been pointed out by Kennedy (2006), are characterized by having issues between envisioning and implementing the practice. This gap cannot be substituted or filled up by "replicating teaching moves" because in the majority of cases it does not lead to "owning" or interiorizing the teaching move. Thus, instead of replicating the novice teacher needs to start with classroom elementary investigations, where to place that move, how tweak it and what to expect from the student. These are activities of teaching-research and only those activities can assure that novice teachers may own or interiorize "the teaching move".

TEACHING-RESEARCH AS THE MODEL OF CONSTRUCTIVIST TEACHING

Let's consider the description of the constructive teaching experiment formulated by Steffe and Cob (1983), the designers of the instrument.

According to Steffe and Cobb (1983), the central tool of the constructive researcher is the constructive teaching experiment, whose distinguishing feature is "that the researcher acts as a teacher." Steffe and Cobb (1983) inform us that the interest of a researcher–teacher as a researcher lies in "investigating what might go on in children's heads" and in "hypothesizing what the child might learn." Since the experimenter using a teaching experiment technique has to "find ways and means of fostering this learning" and

"based on current interpretation of the child's language, he or she has to make on the spot decisions concerning situations to create and critical questions to ask, he or she acts in this capacity as a teacher."

Hence teaching, in fact constructivist teaching, is the irreducible component of constructivist research. Irreducible means to be the necessary component of the constructive teaching experiment. The constructive researcher has to act as a teacher in order to create a learning environment conducive for hypothesized learning, which means that constructive classroom teaching is formulated together with constructive research. What is missing is the medium of introducing it into classrooms of mathematics at large.

Czarnocha (1999) realized that the researcher-teacher relationship practiced during a teaching experiment can be inverted and transformed to the teacher-researcher relationship using the very same teaching experiment as teaching-research, and consequently, as a teaching methodology. Naturally, the goals of the teacher during the teaching experiment are different from those of the researcher.

The interest of the teacher-researcher as a teacher is "to find means and ways to foster what a student needs to learn in order to reach a particular moment of discovery, or to understand a particular element of the prescribed curriculum." (Czarnocha, 1999)

The interest of teacher-researcher as a researcher is generated by knowledge that "

> since such moments occur only within students' own autonomous cognitive mathematical structures, the teacher has to investigate these structures during a particular instructional sequence. In this capacity he or she acts as a researcher." (Czarnocha, 1999).

The difference is subtle yet profound. The goal of the teacher during the teaching experiment is not to find out what the child might learn in a given experimental situation, but what the child needs to learn to understand a given curriculum concept.

What we have here is the transposition of the whole methodology of the constructive teaching experiment into the classroom to serve the needs of students in the context of a given curriculum. That transposition is the model of teaching offered by constructivist research in contradiction to the quoted assertions of Simon (1995) and Forbes.com (2018). It proposes that the teaching-research model of teaching can be used within the context of the constructive teaching experiment aimed at improvement of classroom learning. Improvement of classroom learning necessitates classroom investigations of student thinking and their mental constructions; it provides motivation for specific classroom actions. The results of classroom investigations impact the pedagogy of teaching in current and future classrooms.

CONCLUSIONS

To clarify possible misunderstanding, we want to assert that we are not suggesting that constructivism states the rules how to teach by saying if you do certain actions in the classroom

consistent with constructivist philosophy then such and such will be the results of learning. Instead, constructivism states the principle of teaching: 'teach in such a way that children have opportunity to construct/discover by themselves significant components of the mathematical curriculum we want them to learn.' This principle is sufficiently general to include within its fold not only teaching-research but also the variety of teaching methods such as discovery and inquiry methods, problem solving and problem posing approach, collaborative problem posing. Consequently, our profession doesn't have to indoctrinate teachers with the given scripted lessons, instead it can and should help to develop into teacher-researchers. But it doesn't. The reasons are deep as we thought to point out.

As teacher-researchers we are sensitive to cognitive and socio-cultural issues on the interphase between teaching and research, characterized by the hierarchy of academic respectability. Through the presentation we have formulated a conjecture that the need to introduce externally scripted lessons into mathematics classroom is related to the presence of hierarchic barrier of academic respectability, which doesn't allow for smooth flow of interaction between teaching practice and research leading to effective education. The smooth flow between the teaching practice and research practice leads through teaching-research, and quite possibly only through teaching-research. In the previous section a compromise was proposed: if one can institutionalize teaching-research as a new level of teacher's proficiency which would advance teachers' social status along the respectability axis by a modest half step. However, that small advance could be helpful to an academician concerned for academic respectability because he or she will not have to "stoop" all the way down; just half a "stoop" will be enough. And that half a step might be just right to open the flow of interaction.

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