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NAIL IT!

Normal Academic: Improvements for Learning, Innovations in Teaching

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KEY IMPLICATIONS

- The Replacement Unit Strategy serves the twin purposes of school-based curriculum development and teacher professional development
- Daniel Kahneman's (2011) theory of System 1 and System 2 thinking is useful in the design of mathematics lessons for Normal Academic students

BACKGROUND

Although there is an acknowledged need to attend to the learning needs of low achievers in mathematics, there is relatively scant research in this area especially within the local context. This project contributes to this sub-field within mathematics education. In particular, this study focused on helping Normal Academic (NA) students make improvements in their learning of Mathematics.

This is "hard" research because the typical profile of NA students reveals multi-faceted areas that need attention: mathematically, they lack the requisite content resources for a number of secondary mathematics topics (Mercer & Mercer, 2005); affectively, many of them display low levels of interest which affects motivation to learn mathematics (Karsenty, 2004); in terms of study skills, they struggle with levels of concentration (Karsenty, Arcavi, & Hadas, 2007).

But we did not need to embark on this hard research totally 'from scratch'. In an earlier project (Mathematical Progress and Value for Everyone (MProVE)), we worked closely with mathematics teachers in another research school over a 8-year period to improve their curriculum and instruction in a number of batches of NA classes across all the secondary levels. NA:ILIT is a development project built on the concrete lessons we learnt from MProVE.

FOCUS OF STUDY

For the purposes of curriculum design and the concomitant enterprise of teacher professional development, we used the "Replacement Unit (RU) Strategy". An RU, usually spanning four to eight hours in duration, is a realistic period of engagement with teachers. This avoids the onerous task of redesigning the entire curriculum all at once.

The context of the study is an RU on "Indices" for Secondary 3 NA students. In the re-design of the unit, a number of principles were employed and they are summarised as follows:

The language of coding and decoding

Consistent with the discipline of mathematics, symbols (the coded forms) enable us to represent ideas in a concise way to allow us to manipulate with them to develop other abstractions. When needed, these symbols can be decoded for unpacking.

Sense-making

Throughout the unit, the 'laws of indices' were not introduced as arbitrary rules to follow. Instead, students were led to develop the 'laws' in a way that makes sense mathematically.

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Thinking fast and thinking slow

This is based on Kahneman's (2011) theory of System 1 and System 2 thinking. The first refers to the mode of cognitive operation that is low-effort and is used typically to automate everyday activities. The latter is 'slow' and attentive to details but it draws cognitive resources heavily. We reckon this theory provides a helpful framework to guide design: when students first learn the laws, they should employ System 2; when they become correctly fluent, they can operate primarily using System 1; but when unsure, they should switch to System 2 to slow down for sense-making, which they do so by using the resource of decoding and coding.

KEY FINDINGS

What is the quality of mathematics learning afforded to the students by the RU?

We addressed this question along these five parameters through analysis of a written test attempted by the students at the end of the RU: (1) performance in standard items on Indices; (2) degree of success in the use of the Laws of Indices; (3) extent of coding-decoding as an alternative to direct application of the laws; (4) ability to deal with items that are mistake-prone; (5) perseverance at working on items in the topic of Indices.

On the whole, except for Parameter (4) which indicated that the students were generally deficient in negative indices, students' performances along the other parameters were positive.

What is the quality of teacher learning through their participation in the planning and implementation of the RU?

Our findings showed that the teachers (1) learnt to use the language of coding and decoding; (2) learnt the importance of attending to brackets in the context of indices; (3) were able to explain negative indices using the coding-decoding processes; (4) learnt to look at the topic from a different perspective after the implementation of the RU; and (6) learnt about their students' positive responses to the coding-decoding method.

SIGNIFICANCE OF FINDINGS

The Replacement Unit Strategy

We find further supporting evidence to endorse this as a feasible alternative to doing professional development (PD). Through the strategy, mathematics teachers within the school share common specific instructional goals and work together to improve on a unit of lessons that matters to them. Moreover, through the redesign process, they learnt both about content related to the topic as well as the instructional approaches that are suitable to it.

One-Step Scale-Up

In this project, we were able to 'transfer' the instructional innovation developed in the MProVE research school to another school. It is, at this point in time, a 'one-step' scale-up, defined as a diffusion of the innovation to another school.

PARTICIPANTS

Mathematics teachers from two secondary schools participated in the study. Students from these schools who resident mathematics teachers are included in our observation of their replacement unit implementation.

RESEARCH DESIGN

Design Experiment

The design includes both the replacement units—with all the instructional materials utilised in the lessons—and the teacher development that goes along with the crafting of the units.

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