Indian e-Journal on Teacher Education (IEJTE)
Bi-Monthly e-Journal (Peer Reviewed)
ISSN 2320 –7566

DEVELOPING REFLECTIVE PRE-SERVICE MATHEMATICS TEACHER – THE KNOWLEDGE QUARTET IN ACTION

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Introduction

The aim of learning Mathematics in the school as envisioned in NCFSE 2023 is the development of the mathematical processes amongst the learners. NCFSE 2023 emphasis on the mathematization of the learner's thought process with learner appreciating mathematics as study of patterns.

This makes imperative for the mathematics teachers to be reflective of their own practices to engage learners in the process of the construction of the mathematical concepts. The researcher as a teacher educator, takes opportunity, to study the use of research-based framework, to empower Pre-Service Mathematics intern to be reflective of her own field experience based on evidence based practice and lay a foundation for their professional development.

The Present Study

NCFSE 2023 lays down aims of Mathematics Education as to develop amongst the mathematics learners the ability of observing patterns, describing patterns, making conjectures based on the observed patterns, generalizing the observations, logical thinking, problem solving, fluency in computations and communicating mathematically across the different strands of mathematics curriculum across different grades.

The above higher goal requires the mathematics teachers who are professionally equipped to continuously engage in reflective practices, reflecting in and on action with perspective of subject matter knowledge and pedagogical content knowledge specific with mathematics as a discipline.

In this context, the researcher, in the present study, encourages the Pre-Service, B.Ed. Intern engaged in teaching mathematics to middle grade learners to reflect on her classroom practices based on research-based Knowledge Quartet framework.

Theoretical Framework

The Knowledge Quartet (Rowland, Huckstep, & Thwaites, 2005) , a research-based framework suggests on reflection on classroom practices in a mathematics classroom with the perspective of four dimensions and the associated codes as shown in the figure below:

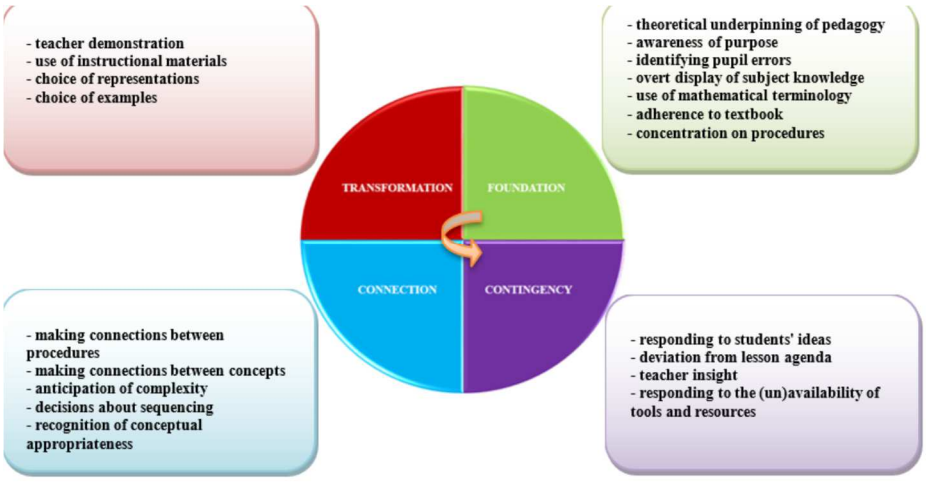


Figure 1. ***Knowledge Quartet and its codes (Rowland, 2013 cited in Kula & Bukova Güzel, 2014)***

The assumptions of the facilitator engaged in teaching mathematics regarding : mathematics as a discipline in the school curriculum, pedagogical considerations for teaching mathematics, the knowledge of the mathematical content, the knowledge of the learners and the knowledge of the learning environment that facilitates learning of mathematics as a discipline is denoted as **Foundation.**

The dimension related with the abstraction of the mathematical concepts in a mathematics classroom through different representations, examples and exploiting use of concretized experiences is denoted as **Transformation.**

The dimension emphasizing on the mathematics as a connected discipline as underlying mathematical concepts within and across the themes are related with each other , with also an impetus on the consideration of the hierarchy in the concepts and relation of mathematics with other disciplines is called **Connectedness.**

The reflection in action by the teacher to the learner's responses as not envisioned by the facilitator during the planning and requiring her in action to consider the changes to the planned tasks is known as **Contingency.**

The Pre-Service Intern who volunteered to participate in the study was facilitated to reflect on basis of the above framework.

Objectives of the Study

The use of the Knowledge Quartet in action, to explore, how it supports the Pre-Service Mathematics Intern to reflect on :

1. The specialized content knowledge for teaching mathematics.
2. The pedagogical content knowledge related with teaching of mathematics.
3. Making implicit connectedness within mathematics and connectedness of mathematics with other disciplines explicit
4. The classroom practices in action.

Methodology

The present study is a qualitative study using the case study. The data is collected by the researcher through the non-participant observation of 08 classes of a Pre-Service Intern (SI,the pseudo name of the Intern).SI* is engaged in teaching the subtheme Multiplication of Fractions to grade 7th students during her School Experience Program, in 2nd year of a 2-year B.Ed. program.

The class observation is followed by debriefing session with SI* as suggested in the Knowledge Quartet. SI, in the debriefing session is empowered to reflect on the classroom practices. A semi structure interview guide as laid was used for the same to encourage the student teacher reflect on:

a) the extent , the learning objectives for the class were accomplished ;

b) the executed tasks , if engaged the mathematics learners in development of the concepts and the mathematical processes;

c) the dilemmas of teaching mathematics;

d) changes to be incorporated if replanning the executed plan.

Of the 08 classes observed, SI* shared her reflections with the researcher during the debriefing sessions immediately after the classroom observation, for the initial 03 executed lessons these were without any intervention by the researcher. In the 04rth debriefing session, researcher intervened and share with SI* the domains of the Knowledge Quartet, and made the Intern, recognize the explicit aspects a mathematics teacher ought to reflect during planning, execution and after execution of the lesson in accordance with the Quartet. The intern after each of the

classroom observation and debriefing session with the researcher was encouraged to lay down written reflections on basis of the executed mathematics class and the debriefing session

Results and Discussions

In the first 03 debriefing sessions, the researcher, realized that Intern was primarily preoccupied with concerns related with exploring tasks for the lesson (most of them based on mathematical facts and procedures), classroom management and completion of the planned lessons. The researcher as a mathematics teacher educator herself, considered it essential to intervene and make the intern reflect upon the aspects related with content knowledge for teaching mathematics and associated constructivist pedagogical considerations for teaching mathematics to engage both the facilitator and the learners in a mathematics classroom in the construction of the mathematical concepts and the development of the mathematical processes , which have been learnt in the first year of Intern's study as a B.Ed. student.

In the 4rth debriefing session, the Knowledge Quartet and its dimensions were discussed with the intern by the researcher in correspondence with the lesson planned for the 4th observation and the class observed. The student intern initiated to reflect upon her planning and classroom practices with the perspective of the Quartet's dimensions.

One of the classroom episodes executed by SI* on Multiplication of Unit Fractions to substantiate the further discussions and analysis, on how the introduction of the research-based framework Knowledge Quartet , provided an opportunity to the intern to reconsider her planning and execution in consideration with mathematics as a discipline and reflect explicitly on aspects related with teaching and learning of mathematics is laid down.

In the vignette SI* represents the Student intern and S* ,S** ,S*** represent the pseudo names of the students responding in class.

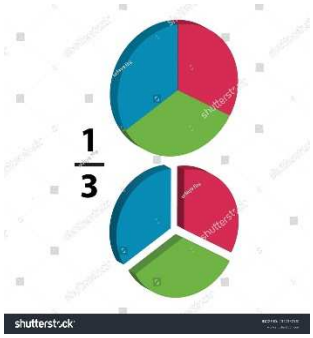
Classroom Vignette on Multiplication of Unit Fractions (as observed by the researcher as Non-Participant Observer)

A Circular cut out as a whole is used to make learners observe the process of finding 1/2 of 1/3 SI* : Consider the circle as a whole. (The cut out is pasted on the blackboard and learners too are distributed with the same in pairs)

SI* : Can someone share how do I divide it into three equal parts

S* : Divides it into three equal parts, each of equal parts is 1/3(shows concretely and also the visual representation in the notebook and shares with classmates)

SI* : Shows three equal parts, of the circular cut out to the class as a whole. Each of the part is pasted on the BB

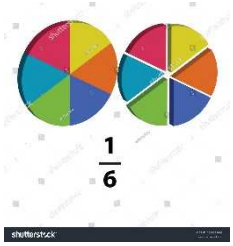


SI* : If each of these 1/3, is divided into two equal parts, how many parts the whole is divided into?

What does each part represent?

Try to do in your notebooks and share ….

S*, S**, S***(responses of the students as observed in notebooks by the SI*)



SI*: How many equal parts the whole is divided into when each of 1/3 is divided into 2 equal parts?

S*: 6 equal parts

SI* : What does each part is of a whole in terms of fraction?

S**: (& many more …) 1/6

SI* : We observe 1/2of1/3 is 1/6… now try to find 1/3 of 1/4

SI *:How will you do?

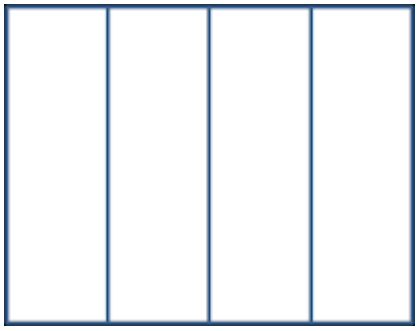
S* :(& many more): Mam…we have to show with pictures ….

SI*: Yes

S* :Can we do with some other shape in place of circle …. Can I take a rectangle….?

SI*: Yes

…. Students representing 1/4 of rectangle , as observed ,in notebooks by SI*

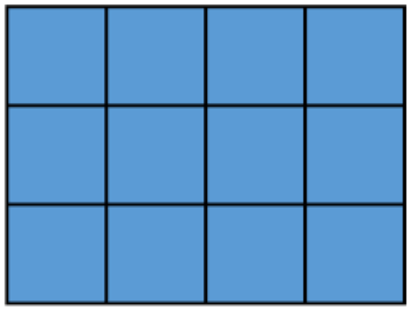


Each part is ¼ of rectangle….(Students as they verbalize)

SI* :We need to find 1/3 of 1/4 , so how we will go ahead?

S*** :We will take 1/4 divide it into three equal parts…and extend this division to whole rectangle

SI* : Represent it in your figure.



S***:

SI* : How many equal parts , the whole is divided into?

S***(&many more) :12 equal parts

SI*: What part represents 1/3 of 1/4?

S* : 1/12

SI* : Do the following Examples and represent visually:

a) 1/5 of 1/2 b)1/5 of 1/3 c) 1/6 of 1/4

S**** Mam can I also use triangle …..to show by pictures

SI* : Yes

Once the learners have represented the above through visual representations , SI*,the Student Intern , herself , tells them the working procedure for multiplication of the unit fractions , namely

multiplying numerator by numerator and denominator by denominator.

Analysis of Classroom Vignette and Debriefing Session with Student Intern

The class observed above was followed with the debriefing session, with, SI*, the Student Intern, was encouraged to share her reflections in correspondence with the Quartet's dimensions.

In words of the Intern SI*

In the last debriefing session, I(SI*) reflected upon the abstract nature of the mathematics and assumptions regarding how learners can be engaged in the process of learning the abstract concepts in mathematics, how learners, as research on learning asserts, to be engaged in the construction of the concepts vis a vis learning the mathematical facts and procedures. The dimension,

Foundation, made me, reconsider, my own, assumptions regarding teaching and learning of mathematics, with perspective of theoretical perspectives I(SI*) have had studied as part of my first year of B.Ed.

I (SI*) realized that instead of focusing just on procedure-based mathematics teaching and learning ought to design tasks during lesson planning, with a belief , that my learners can be engaged in tasks with high cognitive demands and in the development of mathematical processes .The change in my perspective lead to changes in the next lesson planned for , sub concept , Multiplication of unit fractions . I(SI*) ,made , an effort , to study , the texts related with research-based considerations for teaching concepts related with the Multiplication of fractions , for planning the lesson . This has made me reflect on need to study the mathematical concepts and their development myself prior to engage myself in lesson planning . I(SI*) have realized to develop the content knowledge for the mathematical themes I will be teaching.

I (SI*) reflected on the development of the procedural knowledge for multiplying unit fractions with unit fractions in relation with the conceptual knowledge by exploiting the use of the concrete and the visual representations , ***Transforming*** the mathematical knowledge , to empower learners to develop the mathematical procedure with implicit concepts made explicit .Learners were engaged in the representation of the unit fractions and fractions obtained by multiplying a unit fraction with a unit fraction primarily through simple paper cut outs and then by the visuals , they were involved , in relational understanding , relating the concept and the procedure , verbalizing the process and also an appreciation for the symbolic register for fractions both verbal and written.

Since beginning of my Internship ,I (SI*) have , consistently observed ,that all the learners just

emphasize on getting the products to the assigned tasks /questions by following defined set of rules and procedures instead appreciating the implicit process. It was really worthwhile moment today when one of the students asked: "Mam...we have to find the product with pictures" for the follow up working examples assigned to them. This made me consider that there's a beginning shift to motivate learners to relate procedure with concept, ***Connectedness***.

I (SI*)reflected in action, ***Contingency***, regarding sequencing of examples, the ***Connectedness*** as I observed many of the learners were finding challenging to represent double shaded region for example 1/3 of 1/4 but if initiated with simple example1/5 of 1/2 it would have helped learners more to locate the requisite common region representing the product of two-unit fractions. I (SI*) reflected on the need of more concretized experiences with the paper cut outs prior to the visual representations.

I (SI*)***reflected in action***, Contingency , that, prior to encouraging learners to exploit concrete (paper cut out) and visual representations , I ,ought to have exploited the use of context in learning of concepts. A , student's response made me reflect on the use of real-life situations related with the child's context ,as a student towards the end of the class remarked , Mam ,the circular cut out you gave us today and pasted on BB , was the pizza. I(SI*) also ,reflected how learning in context, can, give opportunities to connect mathematics with daily life , ***Connectedness.***

I(SI*) simply responded "yes", when one of the learners asked can we use Triangles to represent the fractions visually ,instead encouraging the learner to do and discern challenges in use of Triangle as a figure to be partitioned in equal parts ***(Reflection on Action)*** and providing an opportunity in class for discussion related to which shapes to be optimally used for representation of fractions and operations on fractions .

After the Intern's reflections, the researcher intervened and asked how you think about you telling the learners the working rule to find product of unit fractions.

Intern shared…. "we as teachers need to….as with large numbers …we cannot expect our learners to visually represent the questions assigned".

The researcher made intern realize that how she could encourage learners to observe the Pattern of products obtained in varied examples assigned to learners and if given an opportunity to generalize their observations, a few of learners would have generalized the procedure in their own words and how the Intern would have facilitated the process of ***Representation, Abstraction and Generalization***, the process of learning mathematics.

Conclusion

The researcher observed that the cognizance of the research based framework , the Knowledge Quartet , and in depth debriefing sessions empowered Pre Service Intern to be involved consistently in the evidence based teaching practices .Pre Service Intern made assertions explicitly with respect to content knowledge and the pedagogical perspectives for teaching and learning mathematics , reflecting on classroom interaction based on tasks , questions , errors, examples ,mathematical language and many more ,substantiating each assertion with classroom observations and experiences.Pre Service Intern evolved as a researcher in action ,exploiting classroom as her space for research.

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