Strengthening Secondary School Teacher Capacities for Higher Order Thinking with Inclusion and Equity

CL4STEM Project Phase II Scaling Open Educational Modules Report
BHUTAN
2024

Subject: Mathematics

The module implementation reports presented here are an outcome of the *Connected Learning for Teacher Capacity Building in Science, Technology, Engineering, and Mathematics (CL4STEM) project*, which aimed to enhance the capacities of secondary STEM teachers to foster higher-order thinking and promote inclusion and equity (HOTIE) in their classroom practices. The CL4STEM project is funded by the International Development Research Centre (IDRC) under the Global Partnership for Education Knowledge and Innovation Exchange (GPE-KIX). It is a South-South collaboration among higher education institutions from Tanzania, Nigeria, and Bhutan, which curated subject-specific, contextualised Open Educational Resources (OER) modules to support the professional development of teachers in enhancing their knowledge, attitudes, and practices (KAP). These OERs were created based on the Connected Learning Initiative (CLIx) model, which was implemented in India by the Tata Institute of Social Sciences (TISS).

The OER modules were hosted on the Moodle Learning Management System (LMS) and PD was supported by scaffolding their progress through the LMS and a social learning platform, Telegram chat group. Each OER module was implemented over six weeks, with teacher participants expected to dedicate approximately 5 hours per week. Since the design of the PD programme was practice-based, teacher participants were required to complete pre-tests and post-tests, design two lesson plans, implement them, conduct peer or supervisor-observed teaching sessions, and write reflections on their experiences.

This report documents the teachers' experiences and the lessons learned throughout the modules implementation. It highlights the outcomes of their engagement with the modules, including their achievements, professional growth, and the knowledge-sharing and learning dynamics within the Telegram chat group.

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Disclaimers

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Acknowledgment

This work was supported by the Global Partnership for Education Knowledge and Innovation Exchange, a joint endeavour with the International Development Research Centre, Canada.

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Module 1: Geometry

1.1 Introduction

This module focuses on fostering competency-based education in Geometry and Transformations. The geometry segment encompasses fundamental concepts such as calculating area and perimeter for various geometrical figures, addressing misconceptions related to these measurements, and integrating hands-on and technology-aided activities. In the context of Geometrical Transformations, the module provides a deeper understanding of concepts of transformation and their types, accompanied by a range of exploratory activities designed to enhance comprehension. Additionally, the module critically examines case studies that foster students' thought processes, their grasp of concepts, and potential misconceptions, besides identifying and exploring resources. Competency-based education remains the cornerstone of the module, providing a robust framework for cultivating students' proficiency and understanding in Geometry and Transformations.

a. Timeline of implementation in the country: March 13, 2024 – April 24, 2024

b. Learning objectives

This module helped the students to explore geometric measurements of area and perimeter and also about different types of geometric transformations. It examined students' difficulties in these concepts and learned about ways to deal with them. The module also incorporated case studies of student thinking, their understanding, and misconceptions. Besides these, it provided the opportunity to explore resources to address the concepts. Students were expected to acquire the following knowledge and skills:

- Understanding the concept of area and perimeter
- Understanding units for the area and for perimeter
- Understanding different types of transformations and its effect on shapes
- Understanding the variant and invariant properties of area and perimeter
- Knowing about Special quadrilaterals and deriving formula
- Knowing about students' difficulties and misconceptions of the concepts taught
- Understanding the perimeter, area and its scope (dimension)
- Drawing a relationship between the two measurements (area and for perimeter)-classroom- examples and their units
- Explaining issues with memorising formulas instead of deriving them

c. Number of units

The module comprises four units: Unit 1: Prepare**,** covering an introduction to the module, a pre-test, and understanding student thinking; Unit 2: Present**,** focusing on a concept map and key module concepts**;** Unit 3: Practice**,** including the teaching sequence, model lessons, and assignments; and Unit 4: Assessment**,** encompassing a post-test and a self-reflection assignment.

d. Concepts covered

The concepts covered under this module include: standard and non-standard units, perimeter, area, transformations, their variant and invariant properties.

e. The modality of the module presentation

Prepare	Present	Practice	Assessment
This section provided the purposes of the measurement as one of the fundamentals in Mathematics followed by module learning objectives, topics to be covered, Assignments and tasks required, and the structure of the module. It included pre-test and understanding students' thinking specific to geometry and transformation.	This section provided conceptual understanding of concept map and its usage as handy tool for making meaningful connections between the main idea and other information followed by numerous hands-on activities and online activities. It also dealt issues with respect to the topics. Case studies as a form of reading were presented with reflection questions.	In the practice section, the participants were exposed to the five model lesson plans, then develop new three lessons of their own, implement with their students. They were expected to write reflection of the lesson implementation and submit along with lesson plans.	As a part of assessment, the participants were mandated to complete pre and post-test with questions on belief, Knowledge Pedagogy Content. They were also assessed through submission of self-reflection paper on the module interaction, discussions in CoP too.

f. Resources - activities, readings

Series of readings were presented in the form of articles and case studies. Every reading was followed by simple activities such as reflection questions. Hands on activities particularly use of GeoGebra were provided. Independent task such as YouTube and online simulations links were shared. Beside these, sharing of resources related to the module and clarification confusions or doubts (if any) were also addressed using CoP platform discussion (Telegram).

g. Nature and purpose of assessments

The module assessments were carried out in the form of formative and summative assessments. **Formative**: reflection writing on module implementations and lesson plan development. **Summative:** pre-post-test on belief knowledge pedagogy content.

1.2 Course completion rate

1.2.1 Overall completion

Table 1.1 illustrates that all 35 participants (100%) completed the course within the 81-100% category. This suggests that the participants found the online course highly engaging and enjoyable, leading to their successful completion of the geometry module.

Table 1.1: *Course completion rate by teachers*

Completion rate	No. of participants	Total
1 - 20%	-	-
21 - 40%	-	-
41 - 60%	-	-
61 - 80%	-	-

81 - 100%	35	35
Total	35	35

1.2.2 Assessment completion rate

Table 1.2 shows that all participants successfully completed both the pre-test and post-test. While all participants submitted Session Plan 1, only 94.28% completed Session Plan 2. Additionally, 97.14% of participants submitted their reflections, and 82.86% provided videos of their classroom observations. These results suggest that the majority of participants were highly motivated to engage with the course, as evidenced by their completion of most of the course tasks.

Table 1.2: *Teachers' Pre-Test & Post-tests completion rate*

SN	Course Item	No. of participants who submitted the course items	Total
1	Pre-test	35	35
2	Session plan 1	35	35
3	Session plan 2	33	33
4	Reflection	34	34
5	Post-tests	35	35
6	Observation Forms	17	17
7	Video	29	29

1.3 Time spent by teachers on the course platform

Table 1.3 displays the time participants spent on the Moodle platform. It shows that 54.28% of participants spent between 10-20 hours on Moodle, while 45.71% spent less than 10 hours. This suggests that the majority of participants dedicated a significant amount of time to completing the required tasks on the platform. Notably, none of the participants have spent 21-30 hours or more than 30 hours on Moodle, implying that the remaining time was likely spent offline working on assignments, lesson planning, implementing lessons in class, assessing students, and providing feedback.

Table 1.3: *Time spent by teachers on Moodle platform*

Hours spent	No. of participants	Total
Less than 10	16	16
10 to 20	19	19
21 to 30	-	-
More than 30	-	-
Total	**35**	**35**

1.4 Change from pre- test and post- test

The average total score in the pre-test was 61.54 % and that in the post-test was 62.94%. It is observed that there is a difference of 1.4 % in the average score for the pre-test and post-test.

TTable 1.4 shows the difference in the score at the individual level:

Table 1.4: *Individual differences in Pre-test and Post-Test*

SN	1	2	3	4	5	6	7	8	9	10	11	12
ID	5116	5117	5118	5119	5121	5122	5123	5124	5125	5126	5127	5128
Pre-test	54	56	66	78	66	58	52	68	74	60	60	70
Post-test	64	64	86	82	62	68	60	70	74	58	48	74
Difference	**10**	**8**	**20**	**4**	**-4**	**10**	**8**	**2**	**0**	**-2**	**-12**	**4**
Changes	Increase	Increase	Increase	Increase	decrease	Increase	Increase	Increase	No change	decrease	decrease	Increase

SN	13	14	15	16	17	18	19	20	21	22	23	24
ID	5129	5131	5132	5133	5134	5135	5136	5137	5138	5139	5140	5141
Pre-test	66	70	58	58	48	68	54	60	62	66	70	48
Post-test	66	76	56	48	60	70	66	56	60	62	60	38
Difference	**0**	**6**	**-2**	**-10**	**12**	**2**	**12**	**-4**	**-2**	**-4**	**-10**	**-10**
Changes	No change	Increase	Decrease	decrease	Increase	Increase	Increase	decrease	decrease	decrease	decrease	decrease

SN	25	26	27	28	29	30	31	32	33	34	35
ID	5142	5143	5144	5146	5149	5150	5151	5152	5153	5154	5155
Pre-test	60	54	52	70	66	60	78	58	54	48	64
Post-test	72	48	48	70	68	60	76	62	68	54	50
Difference	**12**	**-6**	**-4**	**0**	**2**	**0**	**-2**	**4**	**14**	**6**	**-14**
Changes	Increase	decrease	decrease	No change	Increase	No change	decrease	Increase	Increase	Increase	decrease

In the case of change from Pre-test to Post-test, of the 35 participating teachers, 14 participating teachers`` scores decreased; while 4 participating teachers with no change in their scores and scores of 17 participants increased. The highest increase in score was 20 scored by the student withID 5118 and the lowest increase in the score was 2 (ID5124). On the other hand, the highest decrease in score was (-14) and the lowest decrease in the score was (-2). It means that about 48.57% of the participating teachers improved in the achievement of learning this module whereas

about 51.43% of them did not improve rather remained unchanged or decreased in scores from the pre-test to the post-test.

1.5 Detailed analysis of pre-post-test data

The analysis of the pre-test and post-test data indicates that the OER module on Geometry-Area, Perimeter and Transformation had a mixed impact on the targeted competencies. While the intervention was successful in some areas of the targeted competencies, its overall effectiveness varied. Notably, the module significantly enhanced participants' ability to evaluate resources for diverse content representations. This positive outcome is corroborated by other data sources such as classroom observations, lesson plans development, and reflections, which collectively indicate a beneficial effect on professional development. Analysis of pre-test and post-test data reveal notable differences in average mean scores and standard deviations, reflecting changes in understanding and proficiency. Detailed examination of the data highlights both progress and opportunities for further development in participants' skills following the intervention. Tables 1.1, 1.2, and 1.3 provide a comprehensive summary of the data, including descriptive statistics, changes in mean scores, standard deviations, and effect sizes, offering a clear representation of the intervention’s impact.

In Theme K1.2, while there was a slight increase in the ability to recognise participants' prior conceptions and misconceptions with the pre-test mean of 2.86(SD=0.94) to a post-test mean 3.03(0.89). This change points that training given to the participants have some positive impact on the instructional strategies. The decrease in standard deviation suggests that some participants made improvements indicating a better understanding of the instructional strategies.

In Theme K1.3, the data reveals a positive trend with a modest improvement in recognising areas of difficulty that participants face, reflected in the increase from a pre-test mean of 2.92 (SD = 0.93) to a post-test mean of 3.18 (SD = 0.75) as reflected in Table 1.1. This progress underscores the impact of effective strategies provided during the training, which helped participants better understand and identify student challenges.

Theme K2.1 shows a small decline in the ability to understanding the nature of mathematics, with the mean score decreasing slightly from 3.32 (SD = 1.08) to 3.20 (SD = 0.9) (Table 1.1). This decrease may indicate that the topic is complex or that new concepts introduced during the training challenge participants' previous understandings. It serves as a reminder that fully grasping the nature of mathematics can be challenging and might require more comprehensive support.

Although Theme K2.2 also saw a slight decrease in the ability to identify big ideas, key concepts, and theories, the overall strong baseline score suggests that participants already had a solid foundation in this area. The data provides an opportunity to explore new ways to reinforce these concepts during future training sessions. Similarly, the small decline in Theme K2.3, where participants' ability to explain the goals of teaching the subject decreased, indicating that participants are already confident in explaining the objectives of their teaching, or it could suggest that this aspect requires more emphasis in future training sessions. In Theme K2.4, while there was a slight reduction in the ability to sequence and connect concepts within subjects and across grades, this finding highlight that while some educators may find it straightforward to link different ideas, others could benefit from more practice in making these connections clear and meaningful for their students.

The ability to evaluate resources for multiple forms of representing content (Theme K3.1) saw a notable increase, which shows that participants are becoming more skilled at evaluating various teaching resources, which is crucial for offering diverse and engaging learning experiences. It suggests that the intervention successfully equips educators with the tools to assess the quality and suitability of different materials for their classrooms. Similarly, in Theme K3.2, there is slight increase in selecting instructional strategies to support multiple forms of participants' engagement indicating participants' ability to choose strategies that engage students in different ways remains relatively stable. This could suggest that while they understand the basics of student engagement, additional strategies could help further enhance student participation and interest. In the theme K3.3 the scores goes up a bit from 3.47 to 3.51 indicating that that participants are starting to use more diverse assessment methods. This is a positive development, as it shows an increasing appreciation for a more holistic approach to assessment, catering to different learning styles and allowing all students to demonstrate their understanding. Finally, the theme 3.4 also saw a slight increase from 2.67 to 2.77 indicating that participants are becoming more aware of the broader contexts that influence education. Even though the improvement is small, it shows a positive trend towards integrating local and national issues into the curriculum, which can make learning more relevant and engaging for students.

Table 1.5: *Summary of Pre-test and Post-test Scores by Theme*

Theme	Measure	N	Mean	SD	Change
K1.2 Recognise students' prior conceptions and misconceptions	Pre-test	35	2.86	0.94	0.17
	Post-test	35	3.03	0.89	
K1.3 Recognise areas of difficulty that students face	Pre-test	35	2.92	0.93	0.26
	Post-test	35	3.18	0.75	
K2.1 Understand nature of science/ mathematics	Pre-test	35	3.32	1.08	-0.12
	Post-test	35	3.20	0.90	
K2.2 Identify 'Big' ideas, key concepts and theories	Pre-test	35	2.64	1.03	-0.01
	Post-test	35	2.63	1.24	
K2.3 Explain goals of teaching the subject	Pre-test	35	3.72	1.02	-0.02
	Post-test	35	3.7	1.17	
K2.4 Sequence and connect between concepts within subjects and across grades	Pre-test	35	3.02	1.25	-0.04
	Post-test	35	2.98	1.18	
K3.1 Evaluate resources for multiple forms of representing content	Pre-test	35	2.98	0.89	0.34
	Post-test	35	3.32	1.02	
K3.2 Select instructional strategies to support multiple forms of students' engagement	Pre-test	35	3.17	1.07	0.01
	Post-test	35	3.18	1.18	
K3.3 Choose multiple tools of assessments to encourage multiple modes of expression	Pre-test	35	3.47	1.15	0.04
	Post-test	35	3.51	1.04	
K.3.4 Relate to the contexts of school, local issues and the regional/ national educational system	Pre-test	35	2.67	1.35	0.10
	Post-test	35	2.77	1.37	

Note: SD = Standard Deviation.

Overall, Participants show progress in several areas, such as identifying challenges and improving resource use. However, some topics still need further development. Even small gains are valuable steps toward becoming more effective educators.

The descriptive statistics in Table 1.6 below offer insightful details on the participants' pre-test and post-test performance across various themes, highlighting areas of growth and valuable directions for future focus.

In the theme K1.2 that recognise students' prior conceptions and misconceptions, the pre-test mean is 2.86 with a standard deviation of 0.94, while the post-test mean is 3.03 with a standard deviation of 0.89. The mean increased by 0.17, and the standard deviation slightly decreased (-0.05), suggesting a slight improvement in recognising students' prior knowledge with less variability.

In theme K1.3 recognise areas of difficulty that students face, pre-test mean is 2.92, and the post-test mean is 3.18, with standard deviations of 0.93 and 0.75, respectively. There is a mean increase of 0.26 and a decrease in standard deviation by -0.19, indicating better identification of students' difficulties and a more consistent understanding across the group.

The themes K2.2 understanding the nature of science/mathematics, K2.2 Identify 'Big' ideas key concepts and theories, K2.3 explaining teaching goals and K2.4 Sequence and connect between concepts within subjects and across grades showed minimal changes in mean scores, suggesting stable understanding. However, there was a mix of increased and decreased variability, indicating diverse interpretations or stable but unchanged knowledge levels.

Some improvement was observed in theme K3.1 Evaluate resources for multiple forms of representing content and theme K3.3 choose multiple tools of assessments to encourage multiple modes of expression, with slight increases in mean scores and decreases in variability, indicating more consistent application of instructional strategies. However, the theme K3.2 select instructional strategies to support multiple forms of students' engagement and theme K3.4 relate to the contexts of school local issues and the regional/national educational system showed minimal changes, with slight increases in variability, suggesting diverse responses among participants.

Table 1.6: *Descriptive Statistics for Pre-test and Post-test Scores*

Theme	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Change	SD Change
K1.2 Recognise students' prior conceptions and misconceptions	2.86	0.94	3.03	0.89	0.17	-0.05
K1.3 Recognise areas of difficulty that students face	2.92	0.93	3.18	0.75	0.26	-0.19
K2.1 Understand nature of science/ mathematics	3.32	1.08	3.2	0.90	-0.12	-0.18
K2.2 Identify 'Big' ideas, key concepts and theories	2.64	1.03	2.63	1.24	-0.01	0.21
K2.3 Explain goals of teaching the subject	3.72	1.02	3.7	1.17	-0.02	0.16

Theme	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Change	SD Change
K2.4 Sequence and connect between concepts within subjects and across grades	3.02	1.25	2.98	1.18	-0.04	-0.07
K3.1 Evaluate resources for multiple forms of representing content	2.98	0.89	3.32	1.02	0.34	0.13
K3.2 Select instructional strategies to support multiple forms of students' engagement	3.17	1.07	3.18	1.18	0.01	0.10
K3.3 Choose multiple tools of assessments to encourage multiple modes of expression	3.47	1.15	3.51	1.04	0.04	-0.11
K.3.4 Relate to the contexts of school, local issues and the regional/ national educational system	2.67	1.35	2.77	1.37	0.10	0.03

Note: SD = Standard Deviation.

The analysis from the Table 1.7 data suggests that while there have been some positive gains in certain areas, there is still room for improvement in understanding fundamental concepts and effectively sequencing and connecting concepts across subjects and grades.

Table 1.7: *Change in Mean Scores across Themes*

Theme	Pre-test Mean	Post-test Mean	Change in Mean	Cohen`s d value	Effect Size
K1.2 Recognise students' prior conceptions and misconceptions	2.86	3.03	0.17	0.18	Small
K1.3 Recognise areas of difficulty that students face	2.92	3.18	0.26	0.28	medium
K2.1 Understand nature of mathematics	3.32	3.2	-0.12	-0.11	small
K2.2 Identify 'Big' ideas, key concepts and theories	2.64	2.63	-0.01	-0.01	small
K2.3 Explain goals of teaching the subject	3.72	3.7	-0.02	-0.02	small
K2.4 Sequence and connect between concepts within subjects and across grades	3.02	2.98	-0.04	-0.03	small
K3.1 Evaluate resources for multiple forms of representing content	2.98	3.32	0.34	0.38	medium
K3.2 Select instructional strategies to support multiple forms of students' engagement	3.17	3.18	0.01	0.01	small
K3.3 Choose multiple tools of assessment to encourage multiple modes of expression.	3.47	3.51	0.04	0.03	small
K.3.4 Relate to the contexts of school, local issues and the regional/ national educational	2.67	2.77	0.1	0.07	small

system					

The analysis of pre-test and post-test data for the Geometry-Area, Perimeter, and Transformation OER module reveals both progress and areas for further improvement across various themes. Significant gains were observed in Theme K1.3 (recognising student difficulties) and Theme K3.1 (evaluating resources for multiple forms of representing content). However, slight declines were noted in Themes K2.1 (understanding the nature of mathematics), K2.2 (identifying key concepts), K2.3 (explaining the goals of teaching the subject), and K2.4 (sequencing and connecting concepts within subjects and across grades). These areas represent valuable opportunities for targeted enhancement, particularly in Theme K2.1, where there is a clear need to deepen participants' understanding of the nature of mathematics. Overall, the findings demonstrate meaningful progress and highlight areas for ongoing development to further strengthen participants' teaching practices.

Table 1.8: Result of change from pre- and post-test

Number of teachers (N=35)		**Post Test**			
		Novice (0-25%)	Emerging (26-50%)	Proficient (51-75%)	Accomplished (76-100%)
Pre-test	0-25% Novice	-	-	-	-
	26-50% Emerging (3 teachers in pre-test)	-	1	2	-
	51-75% Proficient (30 teachers in pre-test)	-	4	24	2
	76-100% Accomplished (2 teachers in pre-test)	-	-	-	2

A total of 35 teachers participated in the pre-test and post-test programme. As shown in Table 1.8, initially, 3 teachers were categorised as Emerging, with mean scores ranging from 26-50% in the pre-test. However, in the post-test, one teacher remained in the Emerging category (26-50%), while the other two improved their mean scores, moving up to the Proficient category (51-75%). Of the remaining 32 candidates, 30 initially fell into the Proficient category (51-75%) in the pre-test. In the post-test, 4 of them fell to the Emerging category, while 24 remained in the Proficient category. Interestingly, 2 candidates improved their mean scores enough to fall within the 76-100% range in the post-test. Additionally, 2 candidates out of 35 retained their position as Accomplished in both the pre-test and post-test.

The results of the pre-test and post-test programme indicate a generally positive impact on the participating teachers' performance. While a few teachers experienced a decline in their scores, with 4 moving from Proficient to Emerging, the majority either maintained or improved their performance. Notably, 2 teachers advanced from Proficient to the highest category, achieving scores in the 76-100% range. Additionally, the consistency of the 2 Accomplished teachers in maintaining their high performance throughout the programme underscores the effectiveness of the professional development initiative.
Overall, the programme seems to have contributed to the professional growth of the participants, with more teachers improving or maintaining their proficiency levels suggesting that while some teachers showed significant improvement, others faced challenges, highlighting the need for targeted support and resources to help all educators enhance their performance.

1.6 **Practice** (Session plans and reflections)

The following table (Table 1.9) presents the result of the professional growth of the participating teachers in terms of their ability to develop learners` academic growth, the content of their teaching materials, and the pedagogy of teaching-learning. The assessment to obtain this result was carried out by assessing the two different lesson plans, one reflection, and observation records of each participating teacher. The assessment was carried out using the assessing criteria: *Absent = 0; Present but inappropriate=1; Present and appropriate=2*. To capture the details of the performance components of the participating teachers, these assessing criteria have been further developed into four breakups in a successive range, as follows:

Break up: 0 - 0.5: Considered absent (Novice); 0.6 - 1: Present but inappropriate (Emerging); 1.1 - 1.5: Present but moderately appropriate (Proficient); 1.6 - 2: Present and appropriate (Accomplished). The result has been presented in Table 1.9

Table 1.9: *Result of practice of the participating teachers in implementing the OER Geometry*

Total no. of Participants, N= 35	**Number of Participants**			
Criteria	**0 – 0.5**	**0.6 – 1**	**1.1 – 1.5**	**1.6 - 2**
1. Learners				
P1.1 Promote inclusion and equity: Possible examples to look for a) Creates opportunities for students to participate; b) Pays attention to students who need help and have special needs c) Uses inclusive language d) Does not discriminate/exclude based on socio-economic and linguistic background and abilities	2 (5.7%)	4 (11.43%)	18 (51.43%)	11 (31.43%)
P1.2 Build on students' prior conceptions	0 (0%)	1(2.86%)	9 (25.71%)	25 (71.43%)
P 1.3 Address misconceptions and areas of difficulties	8 (22.86%)	3 (8.57%)	13 (37.14%)	11 (31.43%)
Subtotal	**10**	**9**	**40**	**37**
2. Content				
P2.1 Use processes in science and mathematics. Possible examples to look for: Encouraging students to hypothesise or draw conjectures	3 (8.57%)	6 (17.14%)	15 (42.86%)	11(31.43%)
P2.2 Facilitate higher-order thinking Possible examples to look for: a) Defines scientific/mathematical terms and monitors use b) Uses correct explanations/ elaboration c) Facilitates problem-solving and reasoning d) Encourage students to hypothesise or draw conjectures e) Promotes conceptual understanding	0 (0%)	1 (2.85%)	13 (37.14%)	21 (60%)

rather than just factual/procedural knowledge f) Making connections with other concepts, subjects, daily life experiences				
P2.3 Plan to build students' competencies to meet the goals of teaching science/ mathematics	1(2.83%)	3 (37.14%)	17 (48.57%)	14 (40%)
Subtotal	**4**	**10**	**45**	**46**
3. Teaching and Learning				
P3.1 Use instructional strategies for active learning. Possible examples to look for: a) Use of group work; b) Use of mixed-gender group work c) Use of mixed ability group work; d) Use open-ended questions e) Creates opportunities for students to ask questions f) Gives feedback to student's response g) Probes students to elaborate/explain/justify their response h) Builds on students' responses	2 (5.71%)	0 (0%)	12 (34.29%)	21 (60%)
P3.2 Use multiple representations of content. Possible examples to look for: a) Use of multiple representations (Use of resources- Nature, type and frequency) b) Use of examples and analogies; c) Use of games / Gamifying pedagogy – bingo; d) Use of surroundings/infrastructure e) Use of textbooks - for exercises? or activities? f) ICT - Interactives, simulations, audio-visual g) Drawing, Pictures visual representations; h) Others _____	2(5.71%)	3(37.14%)	8 (22.86%)	22 (62.86%)
P3.3 Create opportunities for multiple modes of expression Possible examples to look for: a) Oral; b) Written test ; c) Performance ; d) Projects e) Presentations; f) Open-ended; g) Interactive; h) Individual i) Collaborative; j) Task-based	0 (0%)	2 (5.71%)	16 (45.71%)	17 (48.57%)
P3.4 Use locally available materials	8 (22.86%)	5 (14.29%)	8 (22.86%)	14 (40%)
P3.5 Link conceptual content to students' everyday life experiences and prior knowledge	7 (20%)	3 (8.57%)	10 (28.57%)	15 (42.86%)
Subtotal	19	13	54	89

Grand Total	33	32	139	173

1.6.1 Interpretations and conclusions

a. Learner

P1.1 Promote inclusion and equity:

Among the 35 participants, 5.7% show a significant lack of focus on promoting inclusion and equity in their lessons. For instance, Teacher 5118 designed a lesson where students are directed to attempt a quiz on translating an image through a provided link (https://quizizz.com/join/quiz/63a8222d12bbcc001d3c603b/start), leaving them to engage in self-learning and self-assessment without additional guidance or consideration for inclusion. Similarly, Teacher 5129 did not include any lesson plans that incorporate strategies for promoting inclusion and equity.

Approximately 51.43% of the participants have lesson plans that are moderately appropriate for promoting inclusion and equity. For example, Teacher 5128's lesson plan states, "This activity will be done in 7 groups of 4 members each." Additionally, Teacher 5137 assigns individual activities, tailors' instruction based on student needs, and provides additional support where necessary.

Lastly, 31.43% of the participants have well-developed lesson content that effectively promotes inclusion and equity. For example, Teacher 5152 supplements group presentations by asking questions to reinforce understanding and assigns extra worksheets as homework to familiarise students with the concept of rotating shapes around an origin. Similarly, Teacher 5154 (score - 1.8) divided students into 5 groups, arranging sitting arrangements to allow students to sit face-to-face. Each group had a maximum of 5 members, with all students actively participating and interacting with each other.

The report highlights varying levels of emphasis on promoting inclusion and equity among the 35 participating teachers. While a small percentage (5.7%) show a significant lack of focus on these crucial aspects, the majority demonstrate some level of commitment. Specifically, 51.43% of the teachers have lesson plans that are moderately aligned with inclusion and equity principles, incorporating group work and tailored instruction to meet students' needs. Notably, 31.43% of the participants excel in creating lesson content that effectively fosters an inclusive and equitable learning environment, actively engaging all students and encouraging interaction. These findings suggest that while there is a room for improvement, especially for those with minimal focus on inclusion, a substantial portion of the participants are already making strides towards fostering an inclusive and equitable educational experience.

P1.2 Build on students' prior conceptions

Of the participants, 71.86% have lessons that appropriately build on students' prior conceptions, while 2.86% have lessons that are less effective in this regard. Notably, none of the participants have lessons completely lacking in content that builds on students' prior knowledge.

For example, Teacher 5128's lesson plan involves students working in groups to investigate the relationship between a regular polygon and its perimeter, effectively building on their prior understanding of the subject matter.

In conclusion, most participants are successfully incorporating students' prior conceptions into their lessons, which is crucial for effective learning. However, there is still a small need for

improvement among those who do not appropriately build on prior conceptions.

P 1.3 Address misconceptions and areas of difficulties

Among the participants, 31.43% effectively address misconceptions and areas of difficulty, while 37.14% do so to a moderate extent. However, 8.57% of the participants address these issues inappropriately, and 22.86% provide no evidence of addressing misconceptions or areas of difficulty at all. For instance, Teacher 5126 take students outside to observe real-world examples, such as the school mirror and water pool, helping them to better understand concepts and clear up misconceptions. In contrast, the lesson plans, reflections, and observation forms of Teachers 5127, 5129, 5133, and others show no evidence of addressing misconceptions or areas of difficulty.

The report reveals a mixed approach among participants in addressing student misconceptions and areas of difficulty. While 31.43% effectively tackle these challenges and 37.14% do so to a moderate extent, a notable portion of participants either address them inappropriately (8.57%) or fail to provide any evidence of addressing them (22.86%). This suggests that while some teachers are successfully helping students overcome misunderstandings, there is a significant need for improvement among others. Targeted professional development may be necessary to ensure that all teachers are equipped to effectively address misconceptions and areas of difficulty in their lessons.

b. Contents

P2.1 Use processes in science and mathematics.

Among the participants, 31.43% effectively use scientific and mathematical processes to help students hypothesise and draw conjectures. For example, Teacher 5138's lesson plan addresses the misconception that dilation always enlarges objects by explaining that dilation can also reduce an object's size if the scale factor is between 0 and 1. This type of lesson encourages students to hypothesise and make conjectures.

Additionally, 42.86% of the teachers incorporate these processes in a moderately appropriate manner. For instance, Teacher 5116’s lesson plan prompts students to find the vertices and describe what happens to an object during reflection, guiding them to engage in scientific and mathematical reasoning.

However, a small percentage (8.57%) of teachers' documents show no evidence of using these processes in their lessons.

In conclusion, the majority of participants are effectively incorporating scientific and mathematical processes into their teaching, with 31.43% using these processes to facilitate hypothesis and conjecture, and 42.86% demonstrating a moderately appropriate use. However, there is still a small portion, 8.57%, where such processes are not evident, indicating room for improvement in ensuring consistent application across all educators.

P2.2 Facilitate higher-order thinking

60% of the participants effectively facilitate higher-order thinking. For example, Teacher 5137's lesson encourages students to actively engage in discussions and activities, while Teacher 5142's

lesson plans include higher-order thinking questions, such as 'How does this relate to dilation?' and 'Can you explain the difference between enlargement and reduction in geometry?' Notably, all participants have some plan in place to promote higher-order thinking in their teaching.

The report indicates that the majority of participants (60%) are successfully promoting higher-order thinking in their lessons, using strategies that encourage active student engagement and critical thinking. The fact that all participants have incorporated some level of higher-order thinking into their teaching is a positive outcome, suggesting a strong overall commitment to fostering deeper cognitive skills in students. However, there may still be room for further development to enhance the effectiveness of these strategies across all participants.

P2.3 Plan to build students' competencies to meet the goals of teaching science/ mathematics

40% of the participants' lesson plans, reflections, and observation forms demonstrate a strong focus on building students' competencies to meet the goals of teaching science and mathematics. Additionally, 48.57% reflect a moderately appropriate approach, while 8.57% reflect an inappropriate approach. However, 2.83% of the participants' documents show no evidence of such plans.

For instance, Teacher 5143 incorporates project-based learning tasks, and Teacher 5146 discusses the real-life applications of maxima and minima in commerce and economics, both of which are effective strategies. Teacher 5135's lesson plans, which encourage students to demonstrate reasoning skills by analysing the relationship between the area and perimeter of a composite shape, are examples of a moderately appropriate approach.

Conversely, 2.83% of the teachers' lesson plans, reflections, and observation forms lack any evidence of efforts to build students' competencies in science and mathematics."

The report highlights that while a significant portion of participants (40%) effectively design lessons to build students' competencies in science and mathematics, and nearly half (48.57%) do so to a moderate extent, there remains room for improvement. A notable 8.57% of participants fall short in this area, and a small percentage (2.83%) provide no evidence of efforts to meet these goals. This suggests that while many teachers are on the right track, targeted professional development may be necessary to ensure that all teachers are equipped to effectively build students' competencies in line with educational goals.

c. Teaching and Learning

P3.1 Use instructional strategies for active learning.

60% of the participants appropriately utilise instructional strategies for active learning, while 34.29% employ them to a moderate extent. Notably, no participants use these strategies inappropriately, although 5.71% of the participants' documents lack any evidence of instructional strategies for active learning.

For example, Teacher 5153 engages students by having them form pairs labelled A and B. All A students create three different shapes and present them to the B students, who then calculate the areas of those shapes. Together, they verify their answers, demonstrating an effective use of active learning strategies. In contrast, Teacher 5122's lessons include observing and providing feedback on questions asked during class activities and employing Kagan structures, which

represent a moderately appropriate approach to active learning."

The report indicates a strong overall commitment among participants to using instructional strategies for active learning, with 60% effectively implementing these strategies and another 34.29% doing so moderately. The absence of inappropriate use of these strategies is a positive sign; however, the 5.71% of participants who provided no evidence of such strategies suggests there is still room for improvement. Targeted professional development may help ensure that all teachers can effectively incorporate active learning techniques into their instruction, further enhancing student engagement and learning outcomes.

P3.2 Use multiple representations of content.

62.86% of the participants appropriately use multiple representations of content, while 22.86% do so in a moderately appropriate manner. However, 37.14% employ these strategies inappropriately, and 5.71% show no evidence of utilising multiple representations in their lessons.

For example, Teachers 5128, 5129, 5131, and 5132 effectively provided links to video lessons, demonstrating appropriate use of multiple representations of content. The relevant video links include Video 1: , Video 2, and Video 3.

On the other hand, 37.14% of participants used multiple representations inappropriately. For instance, Teacher 5152 supplied students with the necessary materials for activities, while Teacher 5154 utilised whiteboards, markers, rulers, squared graph paper, pencils, and calculators, which did not effectively demonstrate the concept of multiple representations of content.

The report highlights that while a majority of participants (62.86%) effectively use multiple representations of content in their teaching, a notable 37.14% apply these strategies inappropriately. Additionally, 5.71% of participants lack any evidence of using multiple representations altogether. The findings suggest a need for professional development focused on enhancing the effective use of multiple representations in instruction, ensuring that all teachers can engage students through diverse and effective content representations. This improvement could lead to better understanding and retention of concepts among students.

P3.3 Create opportunities for multiple modes of expression

48.57% of the participants created opportunities for multiple modes of expression appropriately, while 45.71% did so in a moderately appropriate manner. Notably, there are no lesson plans, reflections, or observation forms from teachers that lack opportunities for multiple modes of expression. For example, in Teacher 5153's lesson, learning was assessed through questioning techniques and interactive worksheets, utilising the GeoGebra online tool. A few students were invited to engage hands-on with this software, which was displayed on the projector screen. Additionally, the class textbook was utilised. Teacher 5127's lesson plans included designing a worksheet to record properties of the shapes being studied, ensuring that these details would be assessed and applied to relevant topics."

The report indicates that a significant majority of participants (48.57%) effectively create opportunities for multiple modes of expression in their teaching, while an additional 45.71% do so to a moderate extent. The absence of any lesson plans or reflections lacking these opportunities is a positive sign of engagement. This suggests a strong commitment among teachers to provide diverse methods for student expression and assessment. Continued focus on these strategies

can further enhance student learning experiences, encouraging creativity and deeper understanding in the classroom.

P3.4 Use locally available materials

40% of the participants use locally available materials appropriately, 22.86% of them use considerably appropriately, 14.29% use inappropriately, and 22.86% have no evidence of having used locally available materials. For example, Teacher 5126 used natural resources like a mirror to draw the reflection of their first name; Teacher 5149 used a Table, Whiteboard, paper, ruler, and scissors.

The analysis of the report indicates that while a portion of participants (40%) appropriately use locally available materials in their teaching, there is a significant number (37.15%) who either use these materials inappropriately (14.29%) or lack any evidence of their use (22.86%). Examples of effective practices include Teacher 5126's use of natural resources for reflection activities and Teacher 5149's integration of common classroom supplies. This highlights the need for improvement in the consistent and effective use of locally available materials among some educators, suggesting a potential area for professional development and support.

P3.5 Link conceptual content to students' everyday life experiences and prior knowledge

42.86% of the participants appropriately link conceptual content to students' everyday life experiences and prior knowledge. For example, Teacher 5146 let students understand the different turning points of a function, enables them to apply higher-order derivatives to check for maximum, minimum, and inflexion points and solves simple problems related to maxima and minima. 20% of them link considerably appropriately: Teacher 5137 ask students "Can you think of any applications of matrix inversion in real life?"
8.57% of them link inappropriately: Teacher 5127``s lesson plans reflect that the students will be given to explore through YouTube videos and other sources to appreciate the use of constructions in real-life situations. 28.57% of the teachers` documents do not have any evidence of linking the conceptual content to students' everyday life experiences and prior knowledge.

The analysis of the report reveals that while 42.86% of participants effectively link conceptual content to students' everyday life experiences and prior knowledge, a significant portion (28.57%) lacks any documented evidence of making these connections. Additionally, 20% link content considerably appropriately, and 8.57% do so inappropriately, as illustrated by Teacher 5127's reliance on YouTube videos without clear connections to real-life applications. This indicates that while some educators successfully integrate real-life contexts into their teaching, there is a substantial need for improvement in ensuring that all teachers make these essential links to enhance student understanding and engagement.

1.7 Social learning in CoPs:

1.7.1 Frequency of posts

Table 1.10 indicates that the majority of posts were made by Inservice teachers (55.17%), followed by Teacher Educators (44.83%). Notably, no posts were contributed by Research Fellows.

Table 1.10: *Frequency of posts by participants*

Role	Number of posts

Inservice Teachers	80
Teacher Educators	65
Research fellow	-
Total	**145**

1.7.2 Frequency of posts by contents and types

Of the 145 posts analysed, the majority were categorised under communication/administrative topics, comprising 92 posts. This was followed by posts related to technical aspects. In contrast, there were only 12 posts focusing on Pedagogical Content Knowledge (PCK) and none addressing Universal Design for Learning (UDL). These findings are detailed in Table 1.11.

Regarding the nature of the posts, the analysis revealed that 87 of the contributions were text-based, making this the most common format. This was followed by 52 posts that utilised images. Additionally, some posts incorporated audio files or involved sharing external links, highlighting a diverse range of communication methods used by participants.

Table 1.11: *Frequency of posts by contents and types*

Frequency of posts by content	**Number of posts**
PCK	12
UDL	0
Technical	41
Communication/ Administrative	92
Total	**145**
Frequency of posts by types	**Number of posts**
Text only	87
Images	52
External Links to other resources	4
Others(voice/audio)	2
Total	**145**

1.7.3 Qualitative dialogues/ discussion threads

Few instances of posts or threads in the CoP forum effectively motivated other members to undertake similar activities or tasks. Notably, the sharing of a simulation by one participant was particularly compelling and inspired others to explore the use of IT and content delivery methods. This simulation not only facilitated the development of critical thinking and the drawing of inferences akin to real-life experiences but also enhanced student engagement. Refer to Figure 1.1.

Another significant discussion within the CoP forum centered around the course completion rates shared by one of the participants. This disclosure prompted a collective reflection among the members and fostered a sense of healthy competition, motivating them to complete the course. Additionally, it spurred further discussions related to the course activities, with participants actively seeking clarifications and engaging in deeper dialogues about the content and expectations. These interactions not only enhanced understanding but also contributed to a more collaborative learning environment as reflected in Figure 1.2.

The sharing of links and access to resources emerged as another exemplary practice among the CoP participants. For instance, one participant shared links related to measuring the Earth's circumference and utilising the Mathigon platform. This contribution not only facilitated peer exploration of these educational tools but also encouraged colleagues to maximise the benefits derived from the platform's interactive activities. Such resource sharing fostered a collaborative learning environment, enabling participants to enhance their instructional strategies and broaden their pedagogical approaches.

Sharing of links and access to resources (Refer Fig. 1.3) was another best practices of the CoP participants. One participant shared the links on measuring Earth circumference and use of mathigon platform. This in a way helped the colleagues to explore how it is being carried out and draw maximum benefits of use of activities in the platform too.

Fig. 1.1

Fig. 1.2

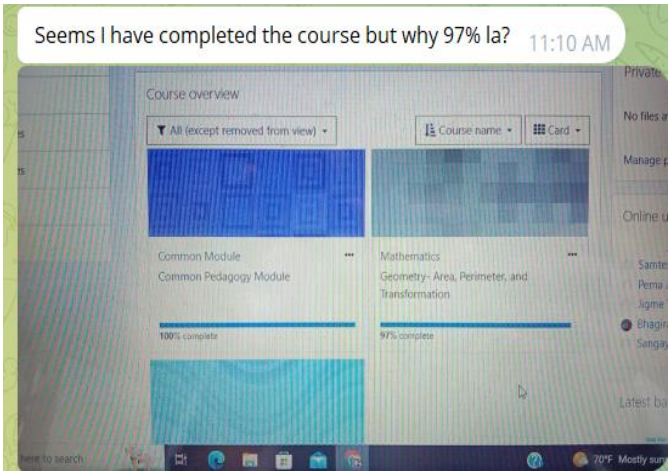
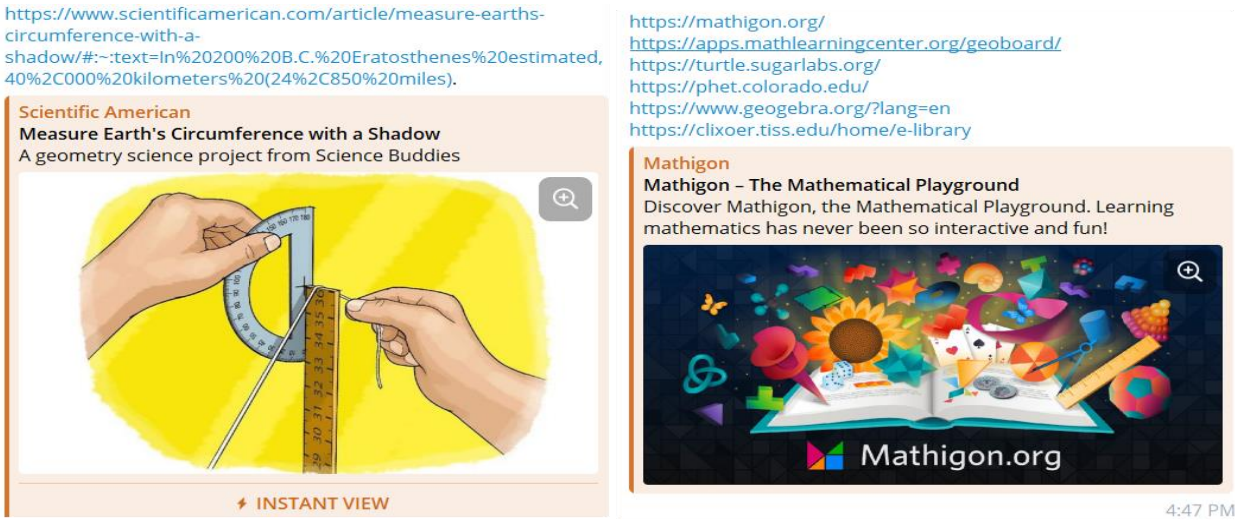


Fig. 1.3



1.8 Teacher Educator's reflection on the overall implementation (Moodle and CoP):

1.8.1 Participation of teachers

1.8.2 Challenges

As module implementers, several challenges were encountered throughout the course of the programme. One significant challenge was the delayed completion of tasks by some participants, necessitating repeated reminders to ensure timely submissions. This issue not only impacted the workflow but also required additional effort from the implementers to maintain course momentum. Additionally, technical issues frequently arose, with participants flagging various difficulties related to platform accessibility, functionality, and other IT-related concerns. These challenges are indicators of the need for enhanced support mechanisms and more robust technological infrastructure to facilitate smoother module implementation.

1.8.3 Surprises

Despite the heavy workload due to high attrition rates faced by many schools across the country, along with various school-related responsibilities, the majority of participants displayed remarkable perseverance and a strong interest in exploring the technology embedded within the course. Their unwavering enthusiasm extended beyond the prescribed curriculum, as they actively sought out additional opportunities for exploration. This unexpected outcome, observed upon course completion, highlights a deep passion for the discipline and a strong commitment to self-directed learning. Such a response underscores the participants' dedication to professional growth and their resilience in the face of challenges.

1.8.4 Any changes required in the module design

Based on the experiences and observations gathered from completing this module, it appears that only minor adjustments are necessary. Participants suggested a reduction in the number of course activities, recommending a focus on a single lesson planning and implementation task to streamline the workload. Additionally, the process of creating and uploading video lessons was identified as particularly challenging, primarily due to low internet speeds, which impeded the efficient sharing of these resources.

Module 2: Proportion and Percentage

2.1 Introduction

Proportional reasoning is one of the crucial mathematical ideas that the students develop over the school years. It is a good indicator of learners' understanding of the relationship between two quantities through one-to-one correspondence at the primary level. For example, when students compare that the price of 2 cupcakes will be Nu 10 if the price of one cupcake is Nu 5. Proportional reasoning forms the basis for understanding measurement and conversion among units of measurement and therefore a foundation concept for comparing quantities. At the middle and secondary levels, the understanding of proportional reasoning integrates the understanding of rational numbers and related multiplicative concepts and at the same time, it lays the foundation for more complex concepts of mathematics.

a. **Timeline of implementation in the country:** May 7, 2024 – July 18, 2024

b. **Learning objectives:**

This module explored discussions on part-whole (continuous quantity and discrete quantity), equivalent fractions, proportions, decimals and percentages and relationships among these concepts. It also examined case studies of student thinking, their understanding, and misconceptions and explored appropriate and relevant resources to aid in deepening the concepts. *After going through this module, teachers were expected to:*

i) Identify the key concepts and ideas needed to strengthen students' understanding of proportions and percentages.
ii) Clarify the misconceptions held by students related to proportions and percentages.
iii) Demonstrate an understanding of the concept with the help of technology as well as hands-on activities.

c. **Number of units:** 4

d. **Concepts covered:** As per the topics mentioned in the following:

Topic 1: Key Concepts to Understand "Proportions"

- What is proportional reasoning?
- Unit fractions
- Different meanings of fractions
- Additive, Multiplicative and Relative thinking
- Identifying proportional and non-proportional situations

Topic 2: Percentage

- Expressing one quantity as a percentage of another
- Misconception in the learning of percentage Pedagogy (Multiple representations)
- Percentages consider each 'whole' as broken up into 100 equal parts, each one of which is a single per cent.
- Decimal and fraction percentages

Topic 3: Commercial Mathematics on Budget Introduction

- The modality followed was as per the following:

Prepare	Present	Practice	Assess
Participants collected information about their current level of understanding to help themselves gauge their growth once they are through with the course.	Presented the contents of the module to engage and learn for developing new knowledge, skills and change of mindsets. The activities in the module provided them with opportunities to understand the content and the pedagogy associated with it.	The participants were provided with an opportunity to develop and implement lesson plans.	The participants` understanding of the content of the module was assessed through pre-test and post-test, assignments that included writing module reflections, an online forum for discussions in CoP (Telegram)

e. Resources - activities, readings: Throughout the module, numerous case studies were presented followed by different types of questions to gauge the participants` understanding of the content and help them diagnose the areas where they must focus and practice.
Link to YouTube videos and numerous educational videos are uploaded in the OER for their view. For example, the links used are as follows:

1. https://youtu.be/aes71wbjbiM
2. https://youtu.be/QL_DDuFf-WM
3. https://mathedu.hbcse.tifr.res.in/wp-content/uploads/2014/01/JS-KS-SN-BV_2008_ICME_comb-share-measure-mng-fraction-faclt-std-rsng-abstract.pdf
4. https://youtu.be/qRHx9mocrKo
5. https://youtu.be/qRHx9mocrKo
6. clix - Lesson 4: Ice Cubes in Lemon Juice (tiss.edu) to learn about direct and indirect variations
7. A book titled “TEACHING FRACTIONS AND RATIOS FOR UNDERSTANDING” Essential Content Knowledge and Instructional Strategies for Teachers by SUSAN J. LAMON was used for developing Proportional reasoning OER.

f. Nature and purpose of assessments: The module assessed understanding of the content presented and thereby provided the participants with feedback on which areas they should focus on as the teacher.

1. **Formative Assessment**: Our teacher participants wrote a series of reflections after completing a topic/unit/task. They were formatively assessed through their reflections.
2. **Summative Assessment**: Pre-test and Post-test were administered to assess their progress.

2.2 Course completion rate

2.2.1 Overall completion

Table 2.1 illustrates that the majority of the participants 34 (97.14%) completed the course within the 81-100% category however only 1 participant completed it within 61- 80%. This suggests that the participants found the online course highly engaging and enjoyable, leading to their successful completion of the Proportion & percent module.

Table 2.1: *Course completion rate by the participating teachers*

Course completion rate	1 - 20%	21 - 40%	41 - 60%	61 - 80%	81 - 100%	Total
No. of teachers	0	0	0	1	34	35

2.2.2 Assessment completion rate

Table 2.2 shows that all participants completed both the pre-test and post-test including session plans 1 & 2 (Session Plan 1 & Session Plan 2). Additionally, 88.57% of the participants submitted their reflections, and 62.86% provided videos of their classroom observations. These results suggest that the majority of participants were highly motivated to engage with the course, as evidenced by their completion of most of the course tasks.

Table 2.2: *Assessment completion rate*

SN	Course Item	No. of participants who submitted the course items	Total
1	Pre-test	35	35
2	Session plan 1	35	35
3	Session plan 2	35	35
4	Reflection	31	31
5	Post-tests	35	35
6	Observation Forms	9	9
7	Video	22	22

2.3 Time spent by teachers on the course platform

Table 2.3 displays the time participants spent on the Moodle platform. It shows that 11.43% of participants spent between 10-20 hours on Moodle, while 88.57% spent less than 10 hours. This suggests that most participants dedicated a significant amount of time to completing the required tasks on the platform. Notably, none of the participants have spent 21-30 hours or more than 30 hours on Moodle, implying that the remaining time was likely spent offline working on assignments, lesson planning, implementing lessons in class, assessing students, and providing feedback.

Table 2.3: *Time spent by teachers on Moodle platform*

Hours spent	Less than 10	10 - 20	21 - 30	> 30	Total
No. of teachers	31	4	0	0	35

2.4 Change from pre- and post- test

The average total score in the pre-test was 52.17% and that in the post-test was 60.40%. It is observed that there is a difference of 8.23% in the average score for the pre-test and post-tests.

The following table (Table 2.4) shows the difference in the score at the individual level:

Table 2.4: *Individual differences in Pre-test and Post-Test*

Sl. No	1	2	3	4	5	6	7	8	9	10	11	12
ID	5116	5117	5118	5119	5121	5122	5123	5124	5125	5126	5127	5128
Pre-test	30	58	64	58	56	42	60	48	54	54	36	58
Post-test	54	54	100	72	60	50	78	68	66	62	42	98
Difference	**24**	**-4**	**36**	**14**	**4**	**8**	**18**	**20**	**12**	**8**	**6**	**40**
Changes	increase	decrease	increase	increase	increase	increase	increase	increase	increase	increase	increase	increase

SN	13	14	15	16	17	18	19	20	21	22	23	24
ID	5129	5131	5132	5133	5134	5135	5136	5137	5138	5139	5140	5141
Pre-test	52	64	46	60	46	70	60	48	62	68	54	44
Post-test	56	96	52	34	72	76	30	22	74	72	44	50
Difference	**4**	**32**	**6**	**-26**	**26**	**6**	**-30**	**-26**	**12**	**4**	**-10**	**6**
Changes	increase	increase	increase	decrease	increase	increase	decrease	decrease	increase	increase	decrease	increase

SN	25	26	27	28	29	30	31	32	33	34	35
ID	5142	5143	5144	5146	5149	5150	5151	5152	5153	5154	5155
Pre-test	36	58	28	60	50	48	54	42	62	44	52
Post-test	94	34	24	78	66	68	50	52	62	42	62
Difference	**58**	**-24**	**-4**	**18**	**16**	**20**	**-4**	**10**	**0**	**-2**	**10**
Changes	increase	decrease	decrease	increase	increase	increase	decrease	increase	no change	decrease	increase

In the case of change from Pre-test to Post-test, of the 35 participating teachers, scores of 9 participating teachers` decreased; 1 participating teacher with no change in their scores and 25 participants with an increase in their scores. The highest increase in score was 58 in the score of ID 5142 and the lowest increase in the score was 4. On the other hand, the highest decrease in score was (-30) and the lowest decrease in the score was (-2). It means that about 71.43% of the participating teachers improved in the achievement of learning this module whereas about 28.57% of them did not improve rather they were either remained status quo or decreased in scores from the pre-test to the post-test.

2.5 Detailed analysis of pre-post-test data

The analysis of the pre-test and post-test data indicates that the OER module on Proportion & Percentage had a mixed impact on the targeted competencies. While the intervention was

successful in some areas of the targeted competencies, its overall effectiveness varied. Notably, the module significantly enhanced participants' ability (71.43%) to relate to the contexts of school, local issues and the regional/national educational system. This is further corroborated by other data sources such as classroom observations, lesson plan development, and reflections carried out by the participants. Analysis of pre-test and post-test data reveals notable differences in average mean scores and standard deviations, reflecting changes in understanding and proficiency. Detailed examination of the data highlights both progress and opportunities for further development in participants' skills following the intervention. *Tables 2.5, 2.6, 2.7 and 2.8 provide a comprehensive summary of the data, including descriptive statistics, changes in mean scores, standard deviations, and effect sizes, offering a clear representation of the intervention's impact.*

Table 2.5 shows the following result:
In theme K1.2, there was a slight (modest) increase in the participants' ability to recognise prior conceptions and misconceptions as seen in their pre-test mean score of 2.71 (SD=1.18) and the post-test mean score of 3.14 (SD=1.31). This change points out that the training given to the participant has some positive impact on the instructional strategies.

In theme K1.3, the data reveals a positive trend with a modest improvement in recognising areas of difficulty that participants face, reflected in the increase from a pre-test mean of 2.94 (SD = 0.91) to a post-test mean of 3.29 (SD = 1.36). This progress underscores the impact of effective strategies provided during the training, which helped participants better comprehend and identify student challenges.

Theme K2.1 shows a slight increase in the participants' ability to understand the nature of science/mathematics as reflected in the increase from a pre-test mean of 2.29 (SD = 1.27) to a post-test mean of 2.77 (SD = 1.70). This indicates that the proportion & percent OER module used as the intervention measure was useful/successful and the participants were able to elevate their conceptual understanding in science/mathematics.

Theme K2.2 also saw a slight increase in the participants ability to identify big ideas, key concepts, and theories as evidenced from their pre-test mean of 1.94 (SD=1.16) and post-test mean score of 2.46 (SD=1.58). This shows that the participants were able to enhance their conceptual knowledge and spatial thinking after taking the proportion and percent OER. This also indicates that, while the intervention was useful, there is an opportunity to explore new ways to reinforce these concepts during future training sessions.

Similarly, theme K2.3 shows a very small increment in the participants ability to frame and explain the goals of teaching the subject as evidenced from the pre-test mean of 2.89 (SD=1.25) and the post-test mean score of 2.94 (SD=1.55). Since the participants were school teachers, they were already familiar with how to frame learning objectives and outcomes, which explains the minimal increase in their mean score after the interventions.

In theme K2.4, there was a slight increase in the participants ability to sequence and connect concepts within subjects and across grades as evidenced from their pre-test mean score of 2.29 (SD=1.10) and post-test mean score of 2.91 (SD=1.27). This finding indicates that, the intervention measure in the form of proportion and percent OER was successful in elevating the concept mapping abilities of the participants.

The ability to evaluate resources for multiple forms of representing content (Theme K3.1) saw a slight (0.34%) increase, which shows that participants` progress at evaluating various teaching resources is gradual, which is not appreciable for offering diverse and engaging learning experiences. It suggests that the intervention slightly equips educators with the tools to assess the quality and suitability of different materials for their classrooms.
Similarly, in theme K3.2, there is a slight (0.11%) increase in selecting instructional strategies to support multiple forms of participants' engagement indicating participants' ability to choose strategies that engage students in different ways remains relatively stable. This could suggest that while they understand the basics of student engagement, additional strategies could help further enhance student participation and interest.

In the theme K3.3, we observe a notable increase (in the participants' competencies to choose multiple tools of assessments to encourage multiple modes of expression as seen in the pre-test mean score of 2.20 (SD=1.13) and post-test mean score of 2.74 (SD=1.48). This illustrates that the participants are starting to use more diverse assessment methods. This is a positive development, as it shows an increasing appreciation for a more holistic approach to assessment, catering to different learning styles and allowing all students to demonstrate their understanding.

Finally, the theme K3.4 also saw a notable increase from 1.97 to 2.63 indicating that the participants are becoming more aware of the broader contexts that influence education. It shows a positive trend towards integrating local and national issues into the curriculum, which can make learning more relevant and engaging for students.

Table 2.5: *Summary of Pre-test and Post-test Scores by Theme*

Themes	Measure	N	Mean	SD	Change (Mean)	Change (SD)
K1.2 Recognise students' prior conceptions and misconceptions	Pre-test	35	2.71	1.18	0.43	0.13
	Post-test	35	3.14	1.31		
K1.3 Recognise areas of difficulty that students face	Pre-test	35	2.94	0.91	0.34	0.46
	Post test	35	3.29	1.36		
K2.1 Understand nature of science/ mathematics	Pre-test	35	2.29	1.27	0.49	0.43
	Post test	35	2.77	1.70		
K2.2 Identify 'Big' ideas, key concepts and theories	Pre-test	35	1.94	1.16	0.51	0.42
	Post test	35	2.46	1.58		
K2.3 Explain goals of teaching the subject	Pre-test	35	2.89	1.25	0.06	0.30
	Post test	35	2.94	1.55		
K2.4 Sequence and connect between concepts within subjects and across grades	Pre-test	35	2.29	1.10	0.63	0.17
	Post test	35	2.91	1.27		
K3.1 Evaluate resources for multiple forms of representing content	Pre-test	35	3.46	0.78	0.34	0.40
	Post test	35	3.80	1.18		

Themes	Measure	N	Mean	SD	Change (Mean)	Change (SD)
K3.2 Select instructional strategies to support multiple forms of students' engagement	Pre-test	35	3.40	1.17	0.11	0.00
	Post test	35	3.51	1.17		
K3.3 Choose multiple tools of assessments to encourage multiple modes of expression	Pre-test	35	2.20	1.13	0.54	0.35
	Post test	35	2.74	1.48		
K.3.4 Relate to the contexts of school, local issues and the regional/ national educational system	Pre-test	35	1.97	1.07	0.66	0.58
	Post test	35	2.63	1.65		

Note: SD = Standard Deviation.

The descriptive statistics in Table 2.6 offer insightful details on the participants' pre-test and post-test performance across various themes, highlighting areas of growth and valuable directions for future focus.

In K1.2 which recognises students' prior conceptions and misconceptions, the pre-test mean is 2.71 with a standard deviation of 1.18, while the post-test mean is 3.14 with a standard deviation of 1.31. The mean increased by 0.43, and the standard deviation increased by 0.13, indicating some improvement in recognising students' prior knowledge with less variability.

In theme K1.3 recognise areas of difficulty that students face, the pre-test mean is 2.94, and the post-test mean is 3.29, with standard deviations of 0.91 and 1.36, respectively. There is a mean increase of 0.34 and an increase in standard deviation by 0.46, indicating better identification of students' difficulties and a more consistent understanding across the group.

The themes K2.1 understanding the nature of science/mathematics, K2.2 identifying 'Big' ideas key concepts and theories, K2.3 explaining teaching goals and K2.4 Sequence and connect between concepts within subjects and across grades showed positive changes in mean scores, suggesting stable understanding. There is also some increase in variability, indicating diverse variation in knowledge levels under these themes.

Some moderate improvement was observed in theme K3.1 Evaluate resources for multiple forms of representing content. Only a small improvement was observed under theme K3.2 Selecting instructional strategies (mean change of 0.11). The unchanged SD (0.00) reflects consistent performance across participants from the pre-test to the post-test. Participants improved significantly under theme K3.3 selecting multiple assessment tools (mean change of 0.54). The increase in SD (0.35) indicates that the post-test responses were more varied. The theme K3.4 related to the contexts of school, local issues, and the regional/national educational system saw the largest mean improvement (0.66), reflecting a better understanding of contextualising education within broader societal frameworks. However, the SD increase (0.58) indicates that participants' post-test responses were more variable, suggesting some participants had significantly greater improvement than others.

The overall analysis shows positive progress but with some themes needing additional attention to ensure more consistent outcomes across all participants.

Table 2.6: *Descriptive Statistics for Pre-test and Post-test Scores*

Theme	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Change	SD Change
K1.2 Recognise students' prior conceptions and misconceptions	2.71	1.18	3.14	1.31	0.43	0.13
K1.3 Recognise areas of difficulty that students face	2.94	0.91	3.29	1.36	0.34	0.46
K2.1 Understand nature of science/ mathematics	2.29	1.27	2.77	1.70	0.49	0.43
K2.2 Identify 'Big' ideas, key concepts and theories	1.94	1.16	2.46	1.58	0.51	0.42
K2.3 Explain goals of teaching the subject	2.89	1.25	2.94	1.55	0.06	0.30
K2.4 Sequence and connect between concepts within subjects and across grades	2.29	1.10	2.91	1.27	0.63	0.17
K3.1 Evaluate resources for multiple forms of representing content	3.46	0.78	3.80	1.18	0.34	0.40
K3.2 Select instructional strategies to support multiple forms of students' engagement	3.40	1.17	3.51	1.17	0.11	0.00
K3.3 Choose multiple tools of assessment to encourage multiple modes of expression	2.20	1.13	2.74	1.48	0.54	0.35
K.3.4 Relate to the contexts of school, local issues and the regional/ national educational system	1.97	1.07	2.63	1.65	0.66	0.58

Note: SD = Standard Deviation.

The analysis from the Table 2.7 data suggests that while there have been some positive gains in all the areas, there is still room for improvement in explaining the goal of teaching the subject.

Change in Mean Scores across Themes

Cohen's d is a standardised effect size measure. It characterises the effect size by relating the mean difference to variability, similar to a signal-to-noise ratio. A large Cohen's d indicates that the mean difference is large compared to the variability13. The formula used to calculate Cohen`s D value is as follows (McLeod,2023):

Effect Size = [Change in means divided by Pooled Standard Deviation]

The Pooled Standard Deviation is a weighted average of standard deviations for two or more groups. The individual standard deviations are averaged, with more "weight" given to larger sample sizes.

Cohen suggested that the d value represents the size of the effect as follows: 0.2: small, 0.5: medium, and 0.8 large effect size.

Table 2.7: *Change in Mean Scores across Themes*

SN	Theme	Pre-test Mean	Post-test Mean	Mean Change	Avg SD	Cohen`s d value	Effect size
1	K1.2 Recognise students' prior conceptions and misconceptions	2.71	3.14	0.43	1.24	0.34	medium
2	K1.3 Recognise areas of difficulty that students face	2.94	3.29	0.34	1.13	0.30	medium
3	K2.1 Understand the nature of science/ mathematics	2.29	2.77	0.49	1.49	0.33	medium
4	K2.2 Identify 'Big' ideas, key concepts and theories	1.94	2.46	0.51	1.37	0.38	medium
5	K2.3 Explain goals of teaching the subject	2.89	2.94	0.06	1.40	0.04	small
6	K2.4 Sequence and connect between concepts within subjects and across grades	2.29	2.91	0.63	1.18	0.53	Large
7	K3.1 Evaluate resources for multiple forms of representing content	3.46	3.80	0.34	0.98	0.35	medium
8	K3.2 Select instructional strategies to support multiple forms of student' engagement	3.40	3.51	0.11	1.17	0.10	small
9	K3.3 Choose multiple tools of assessment to encourage multiple modes of expression	2.20	2.74	0.54	1.31	0.42	medium
10	K.3.4 Relate to the contexts of school, local issues and the regional/ national educational system	1.97	2.63	0.66	1.36	0.48	medium
	Overall Average	26.09	30.20	4.11	12.64	0.33	medium

Summary

The analysis of pre-test and post-test data for the Proportion & Percentage OER module reveals both progress and areas for a slight improvement across various themes.

Table 2.7 shows significant gains (effect size =Large) were observed in Theme K2.4 (Sequence and connection between concepts within subjects and across grades). In other themes, slight declines were noted, and In Theme K2.3 (Identify 'Big' ideas, key concepts and theories) and Theme K3.2 (Select instructional strategies to support multiple forms of student engagement), the gains observed were significantly low.

Overall, the findings demonstrate acceptable progress and highlight areas for ongoing development to further strengthen participants' teaching practices.

Table 2.8: *Change from pre- and post-test*

Number of teachers (n=35)		**Post Test**			
		Novice (0-25%)	Emerging (26-50%)	Proficient (51-75%)	Accomplished (76-100%)
Pre test	0-25% Novice	-	-	-	-
	26-50% Emerging	2	4	7	1
	51-75%Proficient	-	5	10	6
	76-100% Accomplished	-	-	-	-

A total of 35 teachers participated in the pre-test and post-test. As shown in Table 2.8, initially, 14 teachers were categorised as Emerging, with mean scores ranging from 26-50% in the pre-test. However, in the post-test, 2 teachers moved down to the Novice category (0-25%), while the 4 teachers remaining in the same category, 8 teachers improved their mean scores in which 7 teachers moved up to the Proficient category (51-75%) and interestingly one teacher improved the mean score in Accomplished category (76-100%).

Of the remaining 21 candidates, all 21 candidates initially fell into the Proficient category (51-75%) in the pre-test. In the post-test, 5 of them fell in to the Emerging category, while 10 remained in the Proficient category and 6 candidates improved their mean scores enough to fall within the 76-100% range in the post-test.

The results of the pre-test and post-test programme indicate a generally positive impact on the participating teachers' performance. While a few teachers experienced a decline in their scores, with 2 moving from Emerging to Novice, 5 teachers moving down to Emerging from Novice. The majority of the teachers either maintained or improved their performance. Notably, 7 teachers advanced to the highest category, achieving scores in the 76-100% range.

Overall, the programme seems to have contributed to the professional growth of the participants, with more teachers improving or maintaining their proficiency levels suggesting that while some teachers showed significant improvement, others faced challenges, highlighting the need for targeted support and resources to help all educators enhance their performance.

2.6 Practice (Assessment: Together of Lesson plans, reflections, and Observations):

Table 2.9: *Category of participants based on competency levels across themes*

Criteria	**Novice (0 – 0.5)**	**Emerging (0.6 – 1)**	**Proficient (1.1 – 1.5)**	**Accomplished (1.6 – 2)**
1. Learners				
P1.1 Promote inclusion and equity: Possible examples to look for a) Creates opportunities for students to participate; b) Pays attention to students who need help and have special needs c) Uses inclusive language	0	6 (17.14%)	6 (17.14%)	23 (65.71%)

d) Does not discriminate/exclude based on socio-economic and linguistic background and abilities				
P1.2 Build on students' prior conceptions	0	3 (8.57%)	5 (14.29%)	27 (77.14%)
P 1.3 Address misconceptions and areas of difficulties	16 (45.71%)	**3 (8.57%)**	**4 (11.43%)**	**12 (**34.29%**)**
Subtotal	**16**	**12**	**15**	**62**
2. Content				
P2.1 Use processes in science and mathematics. Possible examples to look for: Encouraging students to hypothesise or draw conjectures	10 (28.57%)	5 (14.29%)	6 (17.14%)	14 (40%)
P2.2 Facilitate higher-order thinking Possible examples to look for: a) Defines scientific/mathematical terms and monitors use b) Uses correct explanations/ elaboration c) Facilitates problem-solving and reasoning d) Encourage students to hypothesise or draw conjectures e) Promotes conceptual understanding rather than just factual/procedural knowledge f) Making connections with other concepts, subjects, daily life experiences	0	5 (14.29%)	11 (31.43%)	19 (54.29%)
P2.3 Plan to build students' competencies to meet the goals of teaching science/ mathematics	1(2.86%)	3 (8.57%)	7 (20%)	24 (68.57%)
Subtotal	**11**	**13**	**24**	**57**
3. Teaching and Learning				
P3.1 Use instructional strategies for active learning. Possible examples to look for: a) Use of group work; b) Use of mixed-gender group work c) Use of mixed ability group work; d) Use open-ended questions e) Creates opportunities for students to ask questions f) Gives feedback to student's response; g) Probes students to elaborate/explain/justify their response; h) Builds on students' responses	1(2.86%)	1 (2.86%)	7 (20%)	26 (74.29%)
P3.2 Use multiple representations of content. Possible examples to look for: a) Use of multiple representations (Use of resources- Nature, type and frequency); b) Use of examples and analogies; c) Use of	2(5.72%)	4 (11.43%)	9 (25.71%)	20 (57.14%)

games / Gamifying pedagogy – bingo; d) Use of surroundings/infrastructure e) Use of textbooks - for exercises? or activities? f) ICT - Interactives, simulations, audio-visual; g) Drawing, Pictures visual representations; h) Others _____				
P3.3 Create opportunities for multiple modes of expression Possible examples to look for: a) Oral; b) Written test; c) Performance ; d) Projects; e) Presentations ; f) Open-ended ; g) Interactive ; h) Individual i) Collaborative; j) Task-based	3 (8.57%)	5 (14.29%)	10 (28.57%)	17(48.57 %)
P3.4 Use locally available materials	1 (2.86%)	3 (8.57%)	8 (22.86%)	23 (65.71%)
P3.5 Link conceptual content to students' everyday life experiences and prior knowledge	3 (8.57%)	3 (8.57%)	7 (20%)	22 (62.85%)
Subtotal	10	16	41	108
Grand Total	37	41	80	227

2.6.1 Interpretations and conclusions

a. Learners

The "learners" mentioned here refer to the participating teachers who implemented select matter knowledge (SMK) of the OER module Proportion and Percentage (PAP) in the intervention schools. Table 2.9 shows that of all the teachers who practised implementing the *promotion of inclusion and equity*, 65.71% of them are in the accomplished category, the rest of the teachers are in either category of proficient or emerging while no one is in the emerging category.

Similarly, of all the teachers who practised *building on students` prior conceptions*, 77.14% of the teachers are in the accomplished category and none in the emerging category.

Interestingly, of all the teachers who practised *addressing the misconceptions and areas of difficulty*, 45.71% of the teachers were in the Novice category, and only 34.29% were in the accomplished category.

b. Content

The "content" referred to the Pedagogical Content Knowledge (PCK) used to implement the content on the subject matter knowledge (SMK) of the OER PAP by the participating teachers in the intervening schools. Table 2.9 shows that of all the teachers who *used processes in science and mathematics,* 40% are in the accomplished categories, 28.57% are in the novice category, and the rest are either in the emerging category or proficient category.

Similarly, of all the teachers who Facilitate higher-order thinking, 54.29% of them are in accomplished categories, none of them are in the novice category, and the rest are in either the emerging category or proficient category.

On the other hand, of all the teachers who *planned to build students' competencies to meet the goals of teaching science/ mathematics*, 68.57% of them are in the accomplished category, 2.86% of them are in the novice category, and the rest are in either emerging category or proficient category.

c. Teaching and Learning

The "Teaching and Learning" refers to the general pedagogical knowledge (GPK) applied by the participating teachers in the process of implementing the SMK of the OER PAP in the intervening schools. Table 2.9 shows that of all teachers who *used instructional strategies for active learning,* 74.29% of them are in the accomplished category, 20% in the proficient category, and all the rest are in either the emerging category or the Novice category.

Similarly of all the teachers who *used multiple representations of content,* 57.14% of them are in the accomplished category, 25.71% in the proficient category, 14.29% in the emerging category, and the rest are in the Novice category.

Of all the teachers *creating opportunities for multiple modes of expression,* 65.71% of them are in the category of accomplished, 28.57% in the proficient category, 14.29% in Emerging, and the rest are in the Novice category. Regarding the *use of locally available materials,* 65.71% of them are in the accomplished category, 22.86% in the proficient category, and at least 2.86% of them are in the Novice category.

Lastly, in *linking conceptual content to students' everyday life experiences and prior knowledge,* 62.85% of them are in the accomplished category, 20% in the proficient, and the rest are in the emerging or the Novice category.

2.7 Social learning in CoPs:

2.7.1 Frequency of posts

Table 2.10 shows that most posts were done by in-service teachers (72) followed by Teacher Educators (36). The Research Fellow made no post. From the table, it is also evident that the frequency of the posts made by in-service is double the Teacher Educators, and this is being post mostly centred around replies made to the posts of the teacher educators.

Table 2.10: *Frequency of posts by participants*

Role	Number of posts
In-service Teachers	72
Teacher Educators	36
Research fellow	0
Total	**108**

2.7.2 Frequency of posts

Of the 108 posts analysed, the majority were categorised under communication/administrative topics, comprising 73 posts. This was followed by posts related to technical aspects. In contrast, there were only 5 posts focusing on Pedagogical Content Knowledge (PCK) and none addressing Universal Design for Learning (UDL). These findings are detailed in Table 2.11.

Regarding the nature of the posts, the analysis revealed that 70 of the contributions were text-based, making this the most common format. This was followed by 34 posts that utilised images. Additionally, some posts incorporated audio files or involved sharing external links, highlighting a diverse range of communication methods used by participants (Table 2.11).

Table 2.11: *Frequency of posts by content and type*

Frequency of posts by content	
Type of Posts	**Number of posts**
PCK	5
UDL	0
Technical	30
Communication/ Administrative	73
Total	108
Frequency of posts by type	
Text only	70
Images	34
External Links to other resources	2
Others	2
Total	108

2.7.3 Qualitative dialogues/ discussion threads

In Fig 2.1 and Fig 2.2 below, a teacher educator posed a mathematical problem in the CoP group for the participants to solve and share their solutions. They were genuinely interested in tackling the problem and jumped right into sharing ideas and tips in the CoP group. The teacher educator kept the momentum going by nudging them with hints and prompts to help guide their thinking. It was an engaging experience that mirrored how they might approach things as a mathematics teacher at their school; working together, brainstorming, and learning from each other. This back-and-forth created a lively, supportive atmosphere that made solving the problem feel both fun and collaborative.

In Fig 2.3 and Fig 2.4, the participants quickly skimmed through the sections of the module, not reading thoroughly, which caused them to struggle with accessing the next parts. The module's settings required careful reading before progressing, leaving no option for quick navigation. This led to frustrations, and many participants began voicing their complaints in the Community of Practice (CoP) group. With a growing number of participants facing the same issues, the teacher educator ultimately had to abandon the current course setup to address these concerns.

In Fig 2.5, a key discussion in the CoP forum revolved around participants sharing their course completion rates, which led to a moment of group reflection. This openness inspired a sense of friendly competition, motivating others to progress through the course. It also sparked more in-depth conversations about course activities, as participants sought clarifications and engaged in thoughtful discussions about the content and expectations. These exchanges not only deepened understanding but also fostered a more collaborative and supportive learning environment.

In Fig 2.6, the teacher educator shared a thought-provoking video about education in Singapore, focusing on how pedagogical content knowledge (PCK) is addressed in their educational institutions. The video highlighted Singapore's approaches to integrating content knowledge with effective teaching methods, sparking interest among the participants. After watching, several participants shared their reflections, noting insights on how these practices could enhance their own teaching methods and classroom interactions. The video served as a catalyst for meaningful discussions on improving pedagogy and adapting successful strategies from Singapore's education system.

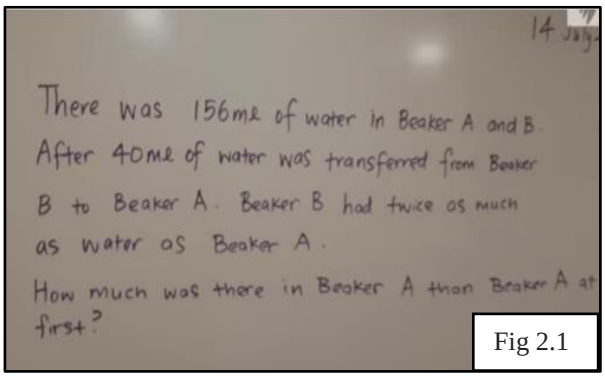


Fig 2.1

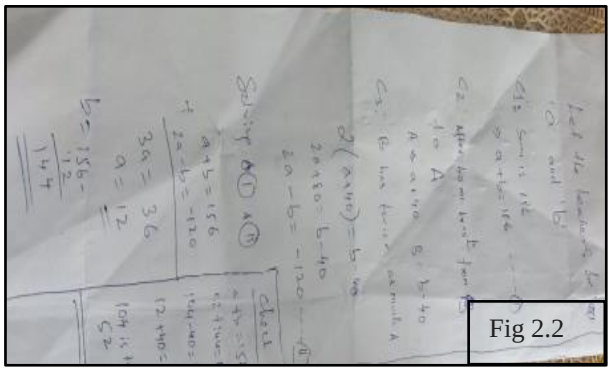


Fig 2.2

This is one example of post made by teacher educator to engage in-service teachers. Many teacher participants attempted this word problem and shared responses. But in introducing percentage, it is restricted unless the activity concepts to learn in proportions and percentages marked completed.

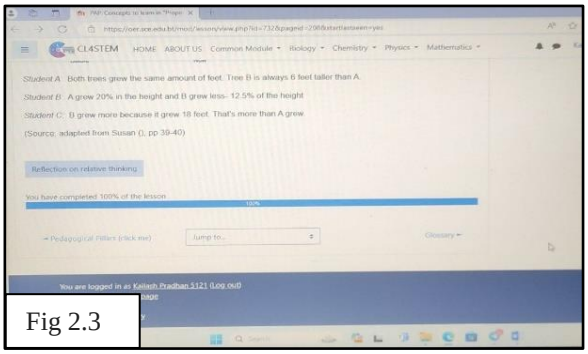


Fig 2.3

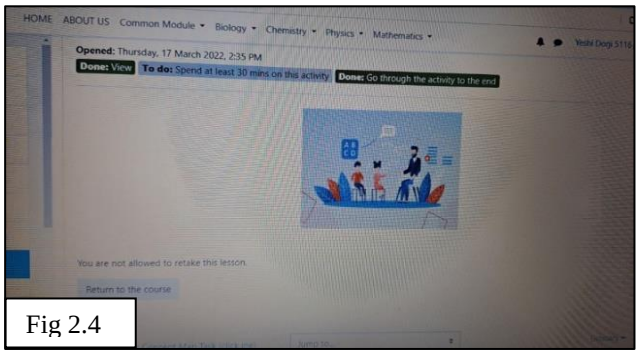


Fig 2.4

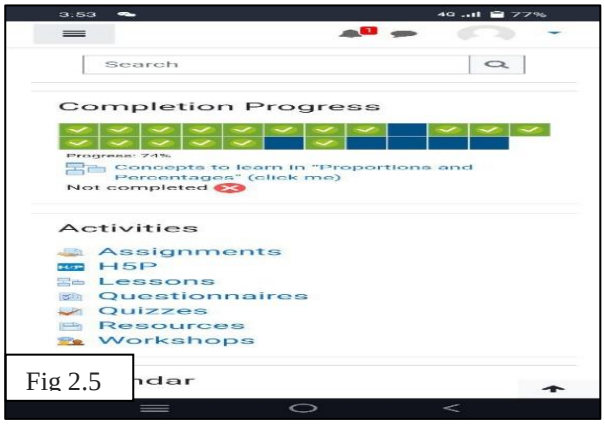


Fig 2.5

Fig 2.6

2.8 Teacher Educator's reflection on the overall implementation (Moodle and CoP):

2.8.1 Participation of teachers

To help participants stay on track with the module, we began sending reminders in their personal Telegram chats, encouraging them to complete their tasks. This strategy proved to be efficient than sending the reminder in our common CoP group since we were able to see our participants

immediately committing their time to the module. Many participants expressed that the course was rich with insights and valuable for improving their teaching skills; however, they struggled to find free time to work on it due to commitments at their workplaces. Despite these challenges, their dedication was evident, as they consistently responded to every question in the module. They also frequently reached out for hints and guidance, eager to solve the problems and fully engage with the material.

2.8.2 Challenges

As we worked on implementing the module, we faced several challenges along the way. A key issue was that some participants were slow in completing their tasks, requiring us to send multiple reminders to keep things on track. On top of that, technical problems cropped up often, with participants reporting issues like trouble accessing the platform or dealing with functionality glitches. These challenges point to the need for better support and stronger tech infrastructure to make the module run more smoothly for everyone involved.

2.8.3 Surprises

The online course was full of surprises, particularly in how participants managed their time and engagement. While some participants had to leave the course to pursue study abroad or leave teaching profession, those who remained were impressively dedicated. Despite their demanding schedules in school, they worked hard to pursue the module, showing a surprising ability to balance their professional duties with their commitment to learn something new. It was evident through the numerous queries they raised about various course components, demonstrating a deep interest in fully understanding the material. They also engaged actively, contributing thoughtful responses and answers to many of the course's questions, further highlighting their passion for learning.

2.8.4 Any changes required in the module design

NA

Module 3: Algebra - Linear Equations

3.1 Introduction

Algebra- Linear Equations is one of the crucial mathematical ideas that the students develop over the school years. It is a good indicator of learners' understanding of the relationship between two quantities through one-to-one correspondence at the primary level.

The Mathematics team at Samtse College of Education, in collaboration with a subject specialist from the Ministry of Education and Skills Development, developed and revised this Open Educational Resource (OER) to adapt it for use in Bhutanese Lower Secondary and Middle Schools by Mathematics teacher participants. The learning contents selected for this OER are competency-based learning of Linear Equations of Algebra because of their potential contribution to teachers' professional development in enhancing their subject matter knowledge (SMK), pedagogical content knowledge (PCK), General Pedagogical Knowledge (GPK), integration of technology, and inclusive pedagogies.

This OER offers short courses on a comprehensive understanding of simple Linear Equations, Inequalities in one variable and Simple Simultaneous Equations relevant to the grades VIII & IX Mathematics curriculum of Bhutan. It will empower them to identify and address common misconceptions among students. Additionally, the OER will provide teachers with accessible student resources for teaching key subtopics within linear equations and offer strategies to effectively tackle these misconceptions. Besides strengthening PCK, it has embedded principles of UDL in the module for inclusivity in Math teaching and learning by catering to diversity in learners. Furthermore, technology infusion in teaching, learning, and assessment has been specified in the module.

Overall, this module will help students become competent in the basic subject areas of algebra: simple linear equations, Inequalities in one variable, and simultaneous equations.

This OER tries to address students' varied learning needs and abilities. It tries to develop participants into knowledgeable people who understand the natural world and can engage with it, solve problems, and make decisions about it.

The module aims to equip newly qualified teachers (NQTs) with a comprehensive understanding of the sequential topics essential for teaching linear equations.

a. Timeline of implementation in the country

According to the research calendar, the module was scheduled for a six-week implementation. The module was opened to the participants on **July 28 and closed on September 15, 2024.**

b. Learning objectives

The Competency-based learning objectives of the OER are as follows:
At the end of the completion of this course, the participating teachers will be able to:

- demonstrate retention of pedagogical principles in teaching simple equations, linear inequalities, and simultaneous equations.
- apply varied pedagogical practices effectively in response to identified student misconceptions.
- implement acquired knowledge by designing and executing lessons aligned with module principles.

- engage in self-assessment and reflection to evaluate the effectiveness of lesson plans and classroom execution.
- develop comprehensive lesson plans and assessments integrating module learnings.

c. **Number of units:**

This OER was delivered across the four units in sequence: Unit I (Prepare), Unit II (Present), Unit III (Practice), and Unit IV (Assessment).

d. **Concepts covered:**

The concepts covered in this OER are Simple *Linear Equations* (Forming linear equations , inverse operations, Checking answers to equations, and Solving equations in one variable using models, Guess and Test), Inequalities in one variable (Concept of inequalities, Operations with inequalities, and Graphical representation of inequalities, and Forming Equations (Solving equations in two variables, Guess and Test, Graphical method, Elimination method, and Substitution method, and Checking answer to equations)

e. **Resources - activities, readings**

The resources of this OER are based on learning components of Lessons (Text lessons, Video lessons, Interactive video lessons, audio lessons); Experiential Learning (Online/offline learning activities, Interactive videos); Assessment (Online/offline submission, voice recording); and the Learner`s reflection (Submission of reflection by online/offline mode).

f. **Nature and purpose of assessments**

In the module, there are formative and summative assessments throughout to evaluate participants' learning. The pre-requisite of the module was a pre-test at the start, which included 50 MCQs on the key themes: learners, content, and teaching-learning. They were given one hour for this pre-test to access the module. Each unit consisted of several in-process assessment activities, including quizzes, short answer writings, reflections, and practical activities with the students. At the end of the module, the participants took a similar 50-MCQ post-test within an hour.

Besides, participants were asked to prepare two lesson plans based on the concepts developed within the module and one reflection after the implementation of the plans. In addition, the participants peer-reviewed lesson plans and recorded teaching sessions assigned by a colleague apart from the assessments by the tutor. Of these 35 teachers, a sample of eight was selected as the focus group whose lesson plans and teaching were assessed by the tutor, officials in MoESD, and their supervisors. All the assessments were supported by a uniform rubric while evidence focuses on learners, content, and effectiveness in teaching and learning.

3.2 Course completion rate

3.2.1 Overall completion

Table 1 illustrates that the majority of the participants (88.57%) completed the course within the 81-100% category however only 11.43% of the participants completed it within 61- 80%. This suggests that the participants found the online course highly engaging and enjoyable, leading to their successful completion of the OER Algebra-Linear Equations.

Table 3.1: *Course completion rate by the participating teachers*

Course completion rate	1 - 20%	21 - 40%	41 - 60%	61 - 80%	81 - 100%	Total
No. of teachers	0	0	0	4 (11.43%)	31(88.57%)	35

3.2.2 Assessment completion rate

Table 3.2 shows that all participants completed both the pre-test and post-test successfully, 34 completed Lesson Plan 1, and only 33 completed Lesson Plan 2. On the other hand, 34 of them completed reflections, 23 completed observations form 7(a), only 12 completed observations form 7(b), and only 23 of them submitted video recordings of their classroom teaching.

Table 3.2: *Assessment completion rate*

SN	Course Item	No. of participants who submitted the course items	Total
1	Pre-test	35	35
2	Session plan 1	34	34
3	Session plan 2	33	33
4	Reflection	34	34
5	Post-tests	35	35
6	Observation Forms 7a	23	23
7	Observation Forms 7b	12	12
8	Video	23	23

3.3 Time spent by teachers on the course platform

Table 3.3 displays the time spent by the participants on the Moodle platform. It shows that 28 of the participants spent less than 10 hours, and 7 of them spent between 10-20 hours on Moodle. This suggests that most participants (80%) dedicated a significant amount of time to completing the required tasks on the platform. Notably, none of the participants have spent 21-30 hours or more than 30 hours on Moodle, implying that the remaining time was likely spent offline working on assignments, lesson planning, implementing lessons in class, assessing students, and providing feedback.

Table 3.3: *Time spent*

Hours spent	Less than 10	20-Oct	21 - 30	> 30	Total
No. of teachers	28	7	0	0	35

3.4 Change from pre- and post- test

Table 3.4 shows the results of the Change from pre- and post-test. A total of 35 teachers participated in the pre-test and post-test. As shown in Table 5, initially, seven teachers were categorised as Emerging, with mean scores ranging from 26-50% in the pre-test. However, in the post-test, one teacher remained in the same category, while six teachers improved their mean scores in which three teachers moved up to the Proficient category (51-75%) and the other three teachers in the Accomplished category (76-100%).

Of the remaining 28 candidates,22 candidates initially fell into the Proficient category (51-75%) in the pre-test and in the post-test, one of them moved down to the Emerging category, while 12 remained in the Proficient category and nine candidates improved their mean scores enough to fall within the 76-100% range in the post-test. Finally, the remaining six teachers fell into the Accomplished category (76-100%) range in the pre-test, while in the post test three teachers moved down to Proficient category and three teachers remained in the same category.

The results of the pre-test and post-test programme indicate a generally positive impact on the participating teachers' performance. While a few teachers experienced a decline in their scores, with one teacher moving down from Proficient to Emerging category and three teachers moving down to the Proficient from the Accomplished category. The majority of the teachers either

maintained or improved their performance. Notably, 12 teachers advanced to the highest category, achieving scores in the 76-100% range and three teachers to Proficient category.

Overall, the programme seems to have contributed to the professional growth of the participants, with more teachers improving or maintaining their proficiency levels suggesting that while some teachers showed significant improvement, others faced challenges, highlighting the need for targeted support and resources to help all educators enhance their performance.

Table 3.4: *Change from pre- and post-test*

Number of teachers		**Post Test**			
		Novice (0-25%)	Emerging (26-50%)	Proficient (51-75%)	Accomplished (76-100%)
Pre test	0-25% Novice	-	-	-	-
	26-50% Emerging teachers	-	1	3	3
	51-75%Proficient teachers (Good)	-	1	12	9
	76-100% Accomplished	-	-	3	3

3.5 Detailed analysis of pre-post-test data

The analysis of the pre-test and post-test data indicates that the OER module on Algebra-Linear Equations had a mixed impact on the targeted competencies. While the intervention was successful in some areas of the targeted competencies, its overall effectiveness varied. Notably, the module significantly enhanced the ability of 65.71% of 35 participants to relate to the contexts of school, local issues and the regional/national educational system.

This is further corroborated by other data sources such as classroom observations, lesson plan development, and reflections carried out by the participants. Analysis of pre-test and post-test data reveals notable differences in average mean scores and standard deviations, reflecting changes in understanding and proficiency. Detailed examination of the data highlights both progress and opportunities for further development in participants' skills following the intervention.

The following Table 3.5 shows the difference in the score at the individual level:

Table 3.5: *Individual differences in Pre-test and Post-Test*

Sl. No	1	2	3	4	5	6	7	8	9	10	11	12
ID	5116	5117	5118	5119	5121	5122	5123	5124	5125	5126	5127	5128
Pre-test	38	60	58	62	64	70	80	72	64	82	62	64
Post-test	78	64	74	74	74	68	64	64	80	86	82	56
Difference	**40**	**4**	**16**	**12**	**10**	**-2**	**-16**	**-8**	**16**	**4**	**20**	**-8**
Changes	Increase	Increase	Increase	Increase	Increase	decrease	decrease	decrease	Increase	Increase	Increase	decrease

Sl. No	13	14	15	16	17	18	19	20	21	22	23	24
ID	5129	5131	5132	5133	5134	5135	5136	5137	5138	5139	5140	5141
Pre-test	80	74	72	38	68	72	82	76	56	74	50	48
Post-test	86	62	78	66	52	80	72	82	50	76	64	70
Difference	**6**	**-12**	**6**	**28**	**-16**	**8**	**-10**	**6**	**-6**	**2**	**14**	**22**
Changes	Increase	decrease	Increase	Increase	decrease	Increase	decrease	Increase	decrease	Increase	Increase	Increase

Sl. No	25	26	27	28	29	30	31	32	33	34	35
ID	5142	5143	5144	5146	5149	5150	5151	5152	5153	5154	**5155**
Pre-test	46	72	50	84	54	72	70	70	54	58	44
Post-test	28	80	78	58	58	70	64	78	86	86	84
Difference	**-18**	**8**	**28**	**-26**	**4**	**- 2**	**-6**	**8**	**32**	**28**	**40**
Changes	decrease	Increase	Increase	decrease	Increase	decrease	decrease	Increase	Increase	Increase	Increase

3.5.1 Descriptive Statistics for Pre-test and Post-test Scores by Theme

Table 3.5 below provides a comprehensive summary of the data, including descriptive statistics, changes in mean scores, standard deviations, and effect sizes, offering a clear representation of the intervention's impact.

a. Learner

In theme K1.2, there was a modest increase in the participants' ability to recognise prior conceptions and misconceptions as seen in their pre-test mean score of 3.14 (SD=1.12) and the post-test mean score of 3.57 (SD=1.07).

The mean increased by 0.43, and the standard deviation decreased by -0.05, indicating some improvement in recognising students' prior knowledge with less variability. This change points out that the training given to the participant has some positive impact on the instructional strategies.

In theme K1.3, the data reveals a remarkable amount of positive trend with a modest improvement in recognising areas of difficulty that participants face, reflected in the increase from a pre-test mean of 3.69 (SD = 1.18) to a post-test mean of 3.97 (SD = 0.82).

There is a mean increase of 0.28 and a decrease in standard deviation by -0.36, indicating better identification of students' difficulties and a more consistent understanding across the group. This progress underscores the impact of effective strategies provided during the training, which helped participants better comprehend and identify student challenges.

Therefore, *i*n the area of Learners, the result of all the themes K1.2 and K1.3 showed positive changes in mean scores, suggesting that there is an improvement in learners` ability to recognise prior conceptions and misconceptions and areas of difficulty they face. There is also some increase in variability, indicating diverse variation in knowledge levels under these themes.

b. Content

Theme K2.1 shows a significant increase in the participant's ability to understand the nature of science/mathematics as reflected in the increase from a pre-test mean of 3.86 (SD = 1.12) to a post-test mean of 4.09 (SD = 1.01). This indicates that the proportion & percent OER module used as the intervention measure was useful/successful and the participants were able to elevate their conceptual understanding in science/mathematics.

Theme K2.2 also saw a significant increase in the participant's ability to identify big ideas, key concepts, and theories as evidenced from their pre-test mean of 2.43 (SD= 0.78) and post-test mean score of 3.00 (SD=1.00). This shows that the participants were able to enhance their conceptual knowledge and spatial thinking after taking the proportion and percent OER. This also indicates that, while the intervention was useful, there is an opportunity to explore new ways to reinforce these concepts during future training sessions.

Similarly, theme K2.3 shows a very significant increment in the participant's ability to frame and explain the goals of teaching the subject as evidenced from the pre-test mean of 2.06 (SD=1.33) and the post-test mean score of 2.86 (SD=1.24). Since the participants were school teachers, they were already familiar with how to frame learning objectives and outcomes, which explains the minimal increase in their mean score after the interventions.

In theme K2.4, there was a slight increase in the participant's ability to sequence and connect concepts within subjects and across grades as evidenced from their pre-test mean score of 3.06 (SD=1.14) and post-test mean score of 3.14 (SD=1.33). This finding indicates that, the intervention measure in the form of Algebra-Linear Equations OER was successful in elevating the concept mapping abilities of the participants.

In general, the result of all the themes K2.1 K2.2 K2.3 and K2.4 showed positive changes in mean scores, suggesting there is an improvement of content knowledge (SMK) of the participants. There is also some increase in variability, indicating diverse variation in knowledge levels under these themes.

c. Teaching and Learning

Similarly in the theme of K3.1, the ability to evaluate resources for multiple forms of representing content saw a slight increase in the mean by 0.32% from the pre-test to the post-test, which shows that participants` progress at evaluating various teaching resources is gradual, which is not appreciable for offering diverse and engaging learning experiences. It suggests that the intervention slightly equips educators with the tools to assess the quality and suitability of different materials for their classrooms.

Similarly, in theme K3.2, there is a negligible amount of 0.05% increase in the mean from the pre-test to the post-test in selecting instructional strategies to support multiple forms of participants' engagement indicating participants' ability to choose strategies that engage students in different ways remains almost the same. This could suggest that while they understand the basics of student engagement, additional strategies could help further enhance student participation and interest.

In theme K3.3, we observe a very small increase (in the participants' competencies to choose multiple tools of assessments to encourage multiple modes of expression as seen in the pre-test mean score of 2.83 (SD=, 0.98) and the post-test mean score of 2.94 (SD=0.91). This illustrates

that a very small number of the participants are starting to use diverse assessment methods. This is a positive development, as it shows an increasing appreciation for a more holistic approach to assessment, catering to different learning styles and allowing all students to demonstrate their understanding, although it is not a significant result.

Finally, the theme K3.4 also saw a notable increase from 2.71 to 3.23 in the mean score from the pre-test to the post-test, indicating that the participants are becoming more aware of the broader contexts that influence education. It shows a positive trend towards integrating local and national issues into the curriculum, which can make learning more relevant and engaging for students. In general, the result of the themes K3.1, K3.2, K3.3 and K3.4 showed positive changes in mean scores, suggesting there is a moderate improvement in the teaching and learning practice of the participants.

Table 3.5: *Descriptive Statistics for Pre-test and Post-test Scores by Theme (N=35)*

Category	Theme	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Change in Mean	Change in SD	Cohen "d"	Effect size
	Overall Average	32.00	6.32	35.31	6.29	3.31	-0.03	0.53	medium
Learner	K1.2 Recognise students' prior conceptions and misconceptions	3.14	1.12	3.57	1.07	0.43	-0.05	0.39	small
	K1.3 Recognise areas of difficulty that students face	3.69	1.18	3.97	0.82	0.29	-0.36	0.28	small
Content	K2.1 Understand the nature of science/ mathematics	3.86	1.12	4.09	1.01	0.23	-0.10	0.21	small
	K2.2 Identify 'Big' ideas, key concepts and theories	2.43	0.78	3.00	1.00	0.57	0.22	0.64	medium
	K2.3 Explain the goals of teaching the subject	2.06	1.33	2.86	1.24	0.80	-0.09	0.62	medium
	K2.4 Sequence and connect between concepts within subjects and across grades	3.06	1.14	3.14	1.33	0.09	0.20	0.07	Negligible
Teaching and Learning	K3.1 Evaluate resources for multiple forms of representing content	3.71	1.23	4.03	0.92	0.31	-0.30	0.29	small

Category	Theme	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Change in Mean	Change in SD	Cohen "d"	Effect size
	K3.2 Select instructional strategies to support multiple forms of student engagement	3.86	1.17	3.91	1.27	0.06	0.10	0.05	Negligible
	K3.3 Choose multiple tools of assessment to encourage multiple modes of expression	2.83	0.98	2.94	0.91	0.11	-0.08	0.12	Negligible
	K.3.4 Relate to the contexts of school, local issues and the regional/ national educational system	2.71	1.43	3.23	1.35	0.51	-0.07	0.37	small

SD-Standard Deviation

3.6 **Practice** (Assessment: Together of Lesson plans, reflections, and Observations):

Table 3.6: *Practice of the participating teachers in implementing the OER Algebra- Linear equation*

	Number of Participants			
Criteria	**0 – 0.5**	**0.6 – 1**	**1.1 – 1.5**	**1.6 - 2**
1. Learners				
P1.1 Promote inclusion and equity: Possible examples to look for a) Creates opportunities for students to participate; b) Pays attention to students who need help and have special needs c) Uses inclusive language d) Does not discriminate/exclude based on socio-economic and linguistic background and abilities	6 (17.14%)	2	10	17 (48.57%
P1.2 Build on students' prior conceptions	1(2.86%)	6	9	19 (54.29%)
P 1.3 Address misconceptions and areas of difficulties	9(25.71%)	4	9	13 (37.14%)
Subtotal	**16**	**12**	**28**	**49**
2. Content				
P2.1 Use processes in science and mathematics.	3 (8.57%)	6	11	15 (42.86%)

Possible examples to look for: Encouraging students to hypothesise or draw conjectures				
P2.2 Facilitate higher-order thinking Possible examples to look for: a) Defines scientific/mathematical terms and monitors use b) Uses correct explanations/ elaboration c) Facilitates problem-solving and reasoning d) Encourage students to hypothesise or draw conjectures e) Promotes conceptual understanding rather than just factual/procedural knowledge f) Making connections with other concepts, subjects, daily life experiences	1(2.86%)	2	18	14 (40%)
P2.3 Plan to build students' competencies to meet the goals of teaching science/ mathematics	1(2.86%)	3	12	19 (54.29%)
Subtotal	**5**	**11**	**41**	**48**
3. Teaching and Learning				
P3.1 Use instructional strategies for active learning. Possible examples to look for: a) Use of group work; b) Use of mixed-gender group work c) Use of mixed ability group work; d) Use open-ended questions e) Creates opportunities for students to ask questions f) Gives feedback to student's response; g) Probes students to elaborate/explain/justify their response; h) Builds on students' responses	2 (5.71%)	2	11	20 (57.14%)
P3.2 Use multiple representations of content. Possible examples to look for: a) Use of multiple representations (Use of resources- Nature, type and frequency); b) Use of examples and analogies; c) Use of games / Gamifying pedagogy – bingo; d) Use of surroundings/infrastructure e) Use of textbooks - for exercises? or activities? f) ICT - Interactives, simulations, audio-visual; g) Drawing, Pictures visual representations; h) Others _____	5 (14.29%)	4	12	14 (40%)
P3.3 Create opportunities for multiple modes of expression Possible examples to look for: a) Oral; b) Written test; c) Performance; d) Projects; e) Presentations; f) Open-ended; g) Interactive; h) Individual i) Collaborative; j) Task-based	2 (5.71%)	5	16	12 (34.29%)
P3.4 Use locally available materials	1(2.86%)	7	10	17 (48.57%)
P3.5 Link conceptual content to students' everyday life experiences and prior knowledge	7 (20%)	7	10	11 (31.43%)
Subtotal	17	25	59	74

Grand Total	38	48	128	171

Legend: **0 – 0.5 (Novice); 0.6 – 1 (Emerging); 1.1 – 1.5 (Proficient); 1.6-2 (Accomplished)**

3.6.1 Interpretations and conclusions

a. Learners

The "learners" mentioned here refer to the participating teachers who implemented select matter knowledge (SMK) of the OER module Algebra- Linear Equations in the intervention schools. Table 3.6 shows that of all the teachers who practised implementing the *promotion of inclusion and equity*, 48.57% of them are in the accomplished category, 17.14% are in Novice, and the rest of the teachers are in either category of proficient or emerging while no one is in the emerging category.

Similarly, of all the teachers who practised *building on students` prior conceptions*, 54.29% of the teachers are in the accomplished category, 2.86% are Novice , and the rest of them are either in emerging or in proficient category.

Interestingly, of all the teachers who practised *addressing the misconceptions and areas of difficulty*, 37.14% of the teachers were in the Accomplished category, 25.71% are in Novice category, and the rest of them are either in proficient or emerging category.

b. Content

The "content" refers to the Pedagogical Content Knowledge (PCK) used to implement the content on the subject matter knowledge (SMK) of the OER Algebra-Linear Equations by the participating teachers in the intervening schools. Table 3.6 shows that of all the teachers who *used processes in science and mathematics,* 42.86% are in the accomplished categories, 8.57% are in the novice category, and the rest are either in the emerging category or proficient category.

Similarly, of all the teachers who Facilitate higher-order thinking, 40% of them are in accomplished categories, 2.86% are in Novice and the rest are in either the emerging category or proficient category.

On the other hand, of all the teachers who *planned to build students' competencies to meet the goals of teaching science/ mathematics*, 54.29% of them are in the accomplished category, 2.86% of them are in the novice category, and the rest are in either emerging category or proficient category.

c. Teaching and Learning

The "Teaching and Learning" refers to the general pedagogical knowledge (GPK) applied by the participating teachers in the process of implementing the SMK of the OER PAP in the intervening schools. Table 3.6 shows that of all teachers who *used instructional strategies for active learning,* 57.14% of them are in the accomplished category, 5.71% in the Novice category, and all the rest are in either the emerging category or proficient category.

Similarly of all the teachers who *used multiple representations of content,* 40% of them are in the accomplished category, 14.29% are in Novice, and the rest are either in the emerging or proficient category.

Of all the teachers *creating opportunities for multiple modes of expression,* 34.29% of them are in the category of accomplished, 5.71% are in the Novice category, and the rest are either in emerging or proficient category.

Regarding the *use of locally available materials,* 48.57% of them are in the accomplished category, 2.86% in Novice, and the rest of them are either in emerging o proficient category

Lastly, in *linking conceptual content to students' everyday life experiences and prior knowledge,* 31.43% of them are in the accomplished category, 20% in the Novice, and the rest are in either in emerging or in the proficiency category.

3.7 Social learning in CoPs:

3.7.1 Frequency of posts

Table 3.7 shows that most posts were communicated by in-service teachers (55) and the Teacher Educators (56). The Research Fellow made no post. The posts are mostly centred around replies made to the posts of the teacher educators.

Table 3.7: *Frequency of posts by participants*

Role	Number of posts
In-service Teachers	55
Teacher Educators	56
Research fellow	0
Total	111

3.7.2 Frequency of posts

Of the 111 posts analysed, the majority were categorised under communication/administrative topics, comprising 87 posts. This was followed by posts related to technical aspects. In contrast, there were only 5 posts focusing on Universal Design for Learning (UDL) and none addressing the Pedagogical Content Knowledge (PCK). These findings are detailed in Table 3.8.

Regarding the nature of the posts, the analysis revealed that 70 of the contributions were text-based, making this the most common format. This was followed by 30 posts that utilised images. Additionally, some posts incorporated audio files or involved sharing external links, highlighting a diverse range of communication methods used by participants.

Table 3.8: *Frequency of posts by content and type*

Frequency of posts by content	
Type of Posts	**Number of posts**
PCK	0
UDL	5
Technical	19
Communication/ Administrative	87
Total	**111**
Frequency of posts by type	
Type of post	**Number of posts**
Text only	70
Images	30
External Links to other resources	9
Others	2
Total	**111**

3.7.3 Qualitative dialogues/ discussion threads

In Figures 3.1 and 3.2 below, some participants encountered instances where answers they believed to be correct were marked as incorrect by the computer during quiz exercises. Initially, they were observed discussing with their peers to verify the correct answers and later investigating the issue further. A few participants also reached out to the module coordinator to understand the problem. This demonstrates that the teacher participants possessed a strong foundational understanding of the subject matter and were genuinely attempting to analyse the questions, even though they had the option to repeatedly input answers until the system accepted them as correct.

InFigure 3.3, the module coordinator informed the teacher participants about a series of webinars on topics like i) trends in mathematics education and insights from a meta-review and bibliometric analysis of review studies, ii) understanding mathematical problem-posing processes & iii) equity in mathematics education to be hosted by the Mathematics Education Researchers (MER) community. Some of them responded, expressing their excitement to attend and their expectations of gaining valuable knowledge from these talks.

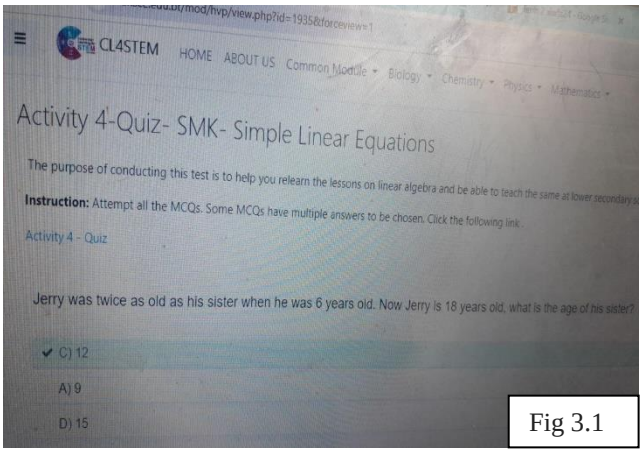


Fig 3.1

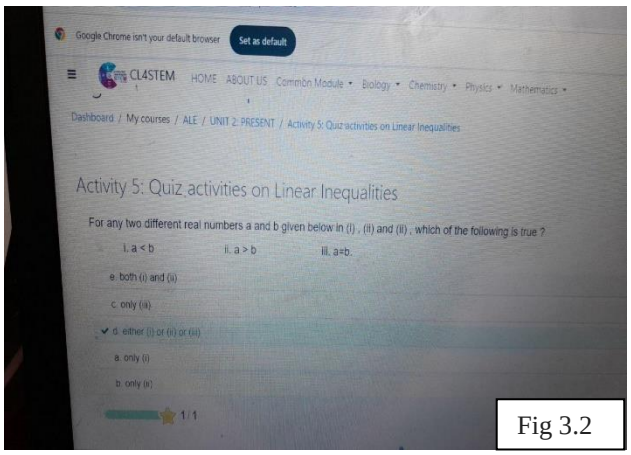


Fig 3.2

In Figure 3.4, one of the teacher participants shared that the online quiz on linear equations has proved to be highly effective on their learning. It provided an interactive platform for them to apply their knowledge and test their understanding of the concepts. The quiz encouraged active learning by presenting problems that required critical thinking and problem-solving skills. The teacher participants found the experience stimulating as it challenged them to explore different approaches to reach the correct answers. The instant feedback provided by the system helped them identify and address their mistakes, enhancing their learning process. The engaging format of the quiz kept them motivated and focused, making the activity enjoyable as well as educational.

In fig 3.5, a key discussion in the CoP forum revolved around participants sharing their course completion rates. Some of the teacher participants complained that despite completing the module, their completion rate didn't reflect 100%. Some also noticed that they were able to receive the badge even when their completion rate was below 100%. As a module developer, we had to immediately fix these issues and after several hours of adjusting the module settings, we successfully resolved the issues to the participants' satisfaction.

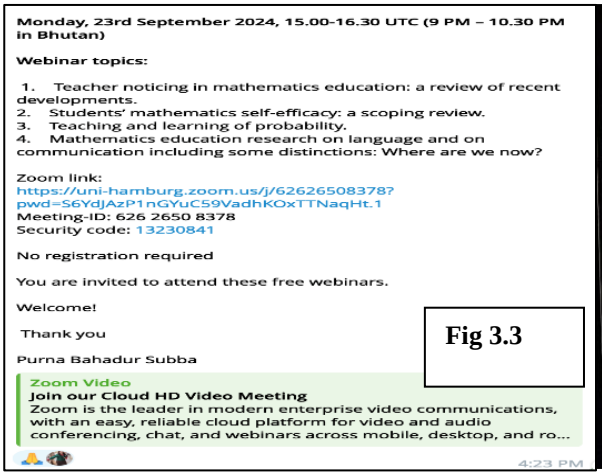


Fig 3.3

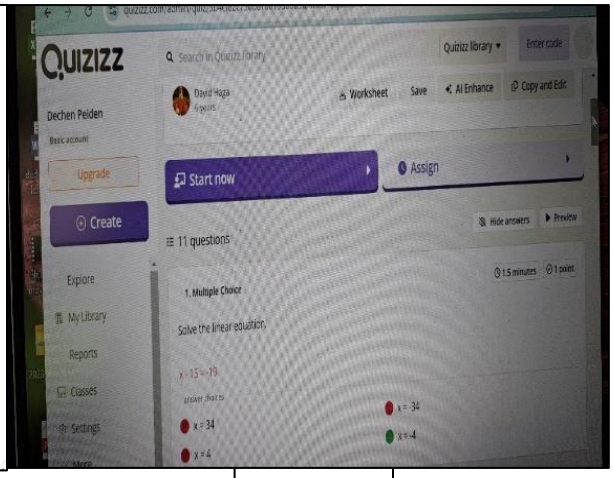


Fig 3.4

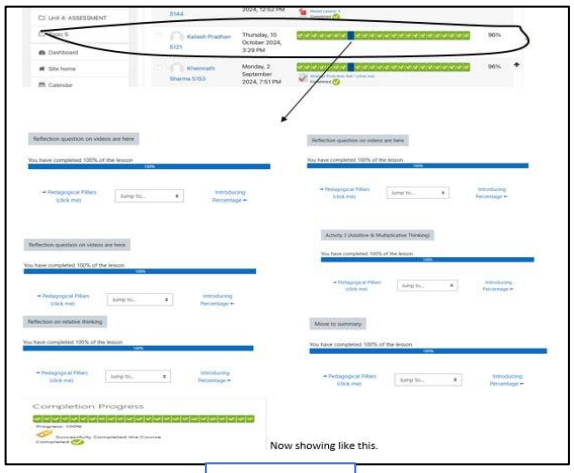


Fig 3.5

3.8 Teacher Educator's reflection on the overall implementation (Moodle and CoP):

3.8.1 Participation of teachers

To help participants stay on track with the module, we began sending reminders in their personal Telegram chats, encouraging them to complete their tasks. This strategy proved to be more efficient than sending the reminder in our common CoP group since we were able to see our participants immediately committing their time to the module. Many participants expressed that the course was rich with insights and valuable for improving their teaching skills; however, they struggled to find free time to work on it due to commitments at their workplaces. Despite these challenges, their dedication was evident, as they consistently responded to every question in the module. They also frequently reached out for hints and guidance, eager to solve the problems and fully engage with the material.

3.8.2 Challenges

As we worked on implementing the module, we faced several challenges along the way. A key issue was that some participants were slow in completing their tasks, requiring us to send multiple reminders to keep things on track. On top of that, technical problems cropped up often, with participants reporting issues like trouble accessing the platform or dealing with functionality glitches. These challenges point to the need for better support and stronger tech infrastructure to make the module run more smoothly for everyone involved.

3.8.3 Surprises

The online course was full of surprises, particularly in how participants managed their time and engagement. While some participants had to leave the course to puruse study or leave teaching profession, those who remained were impressively dedicated. Despite their demanding schedules in school, they worked hard to pursue the module, showing a surprising ability to balance their professional duties with their commitment to learning something new. It was evident through the numerous queries they raised about various course components, demonstrating a deep interest in fully understanding the material. They also engaged actively, contributing thoughtful responses and answers to many of the course's questions, further highlighting their passion for learning.

3.8.4 Any changes required in the module design

NA