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Bridging Knowledge to Practice: Development of Lesson Observation Analysis Protocol (LOAP) Tool

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Abstract

This article presents the development of the Lesson Observation Analysis Protocol (LOAP) tool, designed to bridge the gap between theoretical knowledge and practical teaching in mathematics education. The tool supports structured observation of lessons by capturing instructional activities and evaluating alignment with learning objectives. To validate the tool, it was piloted with six in-service mathematics tutors from Rwandan Teacher Training Colleges (TTCs). The LOAP tool offers a practical framework for capturing real-time teaching practices and supports data-driven reflection and professional development.

Keywords: Knowledge, practice, classroom observation, analysis protocol, analysis tool, S-T graph, students, teachers

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Research context

A field research was conducted to explore how mathematical knowledge for teaching (MKT) is applied in Rwandan Teacher Training Colleges (TTCs) (Habiyaremye, Ntivuguruzwa en Ntawiha, 2022;

Byukusenge *et al.*, 2024). Over a six-month period, the study focused on lesson planning and the implementation of individualized teaching strategies among selected TTC mathematics tutors. The primary aim was to assess whether a newly developed observation tool—the Lesson Observation Analysis Protocol (LOAP)—could contribute to enhancing the practical application of MKT, from lesson planning through to classroom execution.

Throughout this process, the research team revisited every component of the instructional planning cycle. Elements such as the teaching schedule, learning objectives, content coverage, pedagogical philosophy, materials, and evaluation methods were reexamined. It became clear that clearly defined learning objectives were central to both instructional delivery and student assessment. Drawing from a reflective review of how students learn and how tutors teach mathematics in TTCs, new instructional objectives were crafted to align closely with the classroom activities of both tutors and students (Habiyaremye, Ntivuguruzwa en Ntawiha, 2023; Habiyaremy *et al.*, 2024).

To better understand the realities of mathematics instruction in TTCs, the study began with a contextual analysis. This included reviewing curriculum frameworks, analyzing lesson plans, and observing classroom teaching practices. These insights informed the creation of the LOAP tool—a structured observation instrument designed to document specific teaching and learning activities. The tool aimed to capture how planned instructional objectives were enacted during lessons (see Figs. 1–6).

Aligned with Rwanda's Competence-Based Curriculum (CBC) (Ndihokubwayo *et al.*, 2019), tutors are expected to frame learning objectives around five components: the audience (who is learning), behavior (observable action), condition (learning context/tools), degree (performance level), and content (subject matter). To test the tool, six tutors were asked to independently formulate instructional objectives for the same mathematics topic. These initial versions revealed inconsistencies in how tutors interpreted learning goals.

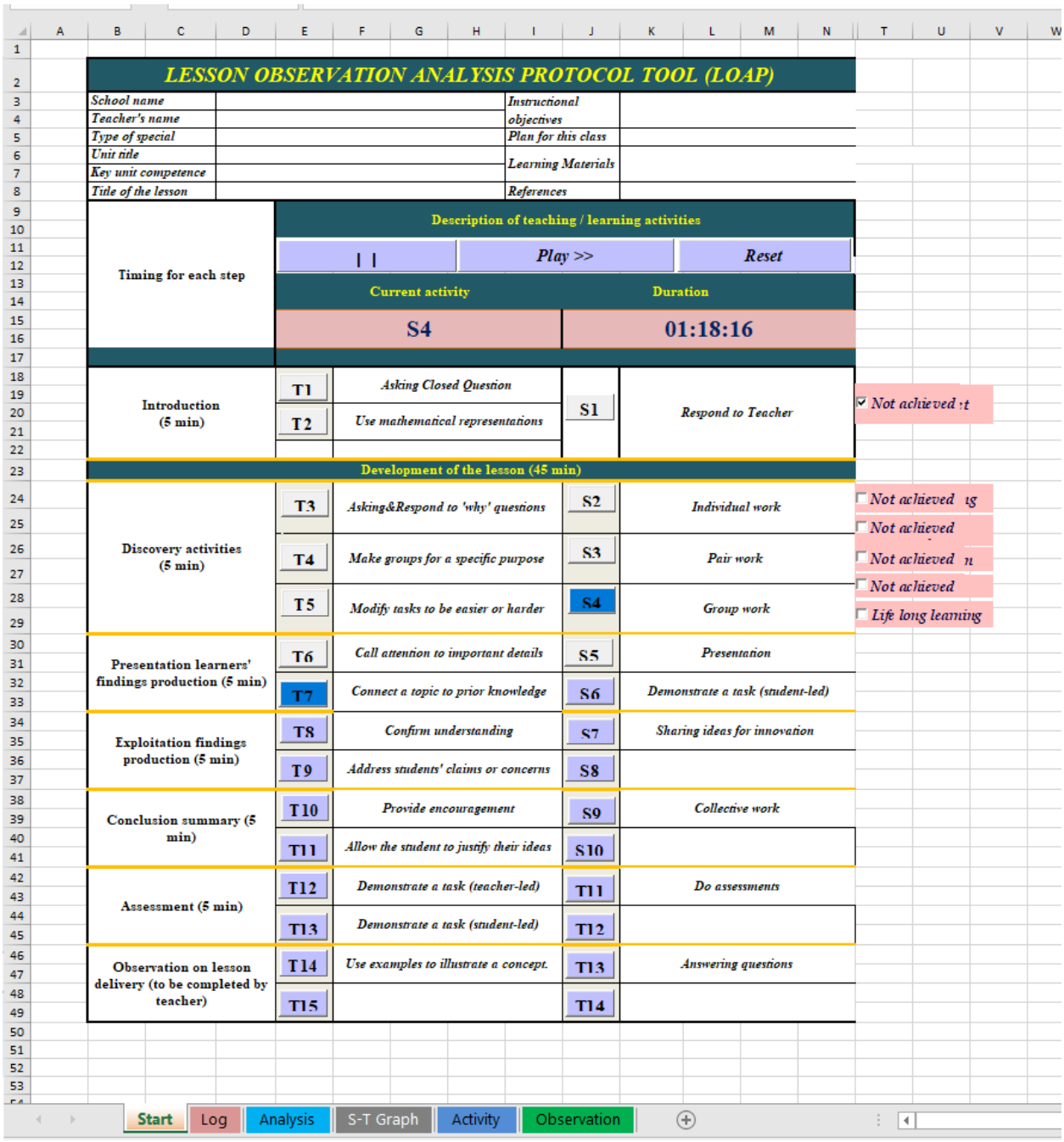
Subsequently, three model mathematics lessons were jointly planned and refined through three rounds of revision. The final version, agreed upon by all six tutors, served as a common standard for implementation. This collaborative process laid the groundwork for validating the LOAP tool's ability to capture key elements of effective mathematics instruction in TTCs.

Tool Development Process

The LOAP tool was developed through an iterative process grounded in instructional design principles and feedback from educators. The development began by identifying core components of effective lesson delivery in mathematics, particularly aligned with Rwanda's Competence-Based Curriculum (CBC). These include clearly defined learning objectives, active teacher and student engagement, and structured lesson phases. A prototype was initially tested during classroom observations, capturing teacher and student activities across various phases of the lesson. Revisions were made following successive rounds of feedback and use.

LOAP Tool Components

The LOAP was developed with six icons. **The Start icon key** is a key function that enables record-keeping of all the activities performed by both students and teachers during a lesson implementation (see Figure 1). It records all the activities and displays the current activity being recorded for each step of the lesson plan being implemented. By clicking on T1 or T2, for example, the tool in timely manner records the first or second activity of the teacher, respectively, and these activities are also applied to their students' activities.



LESSON OBSERVATION ANALYSIS PROTOCOL TOOL (LOAP)

School name		Instructional objectives	
Teacher's name		Plan for this class	
Type of special		Learning Materials	
Unit title			
Key unit competence		References	
Title of the lesson			

Description of teaching / learning activities

Timing for each step | | Play >> | Reset

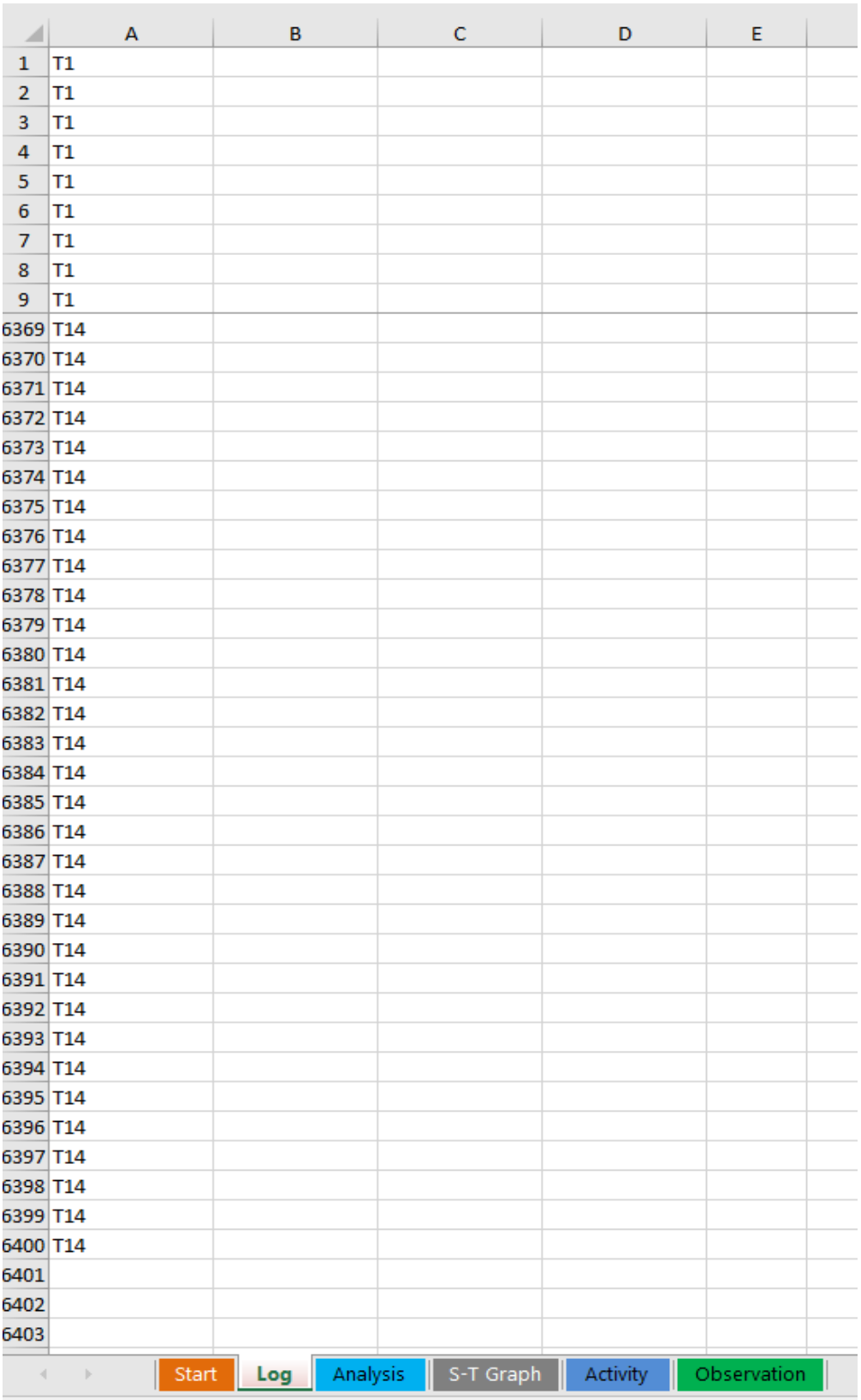
Current activity: S4 | Duration: 01:18:16

Introduction (5 min)	T1	Asking Closed Question	S1	Respond to Teacher	Not achieved :t
	T2	Use mathematical representations			
Development of the lesson (45 min)					
Discovery activities (5 min)	T3	Asking&Respond to 'why' questions	S2	Individual work	Not achieved tg
	T4	Make groups for a specific purpose	S3	Pair work	Not achieved Not achieved n
	T5	Modify tasks to be easier or harder	S4	Group work	Not achieved Life long learning
Presentation learners' findings production (5 min)	T6	Call attention to important details	S5	Presentation	
	T7	Connect a topic to prior knowledge	S6	Demonstrate a task (student-led)	
Exploitation findings production (5 min)	T8	Confirm understanding	S7	Sharing ideas for innovation	
	T9	Address students' claims or concerns	S8		
Conclusion summary (5 min)	T10	Provide encouragement	S9	Collective work	
	T11	Allow the student to justify their ideas	S10		
Assessment (5 min)	T12	Demonstrate a task (teacher-led)	T11	Do assessments	
	T13	Demonstrate a task (student-led)	T12		
Observation on lesson delivery (to be completed by teacher)	T14	Use examples to illustrate a concept.	T13	Answering questions	
	T15		T14		

Start | Log | Analysis | S-T Graph | Activity | Observation

Figure 1. LOAP recording practices

The Log icon key keeps track of all data recorded by the Start icon. It arranges all data under each activity recorded and is followed by an analysis key function that displays all recorded data for the time interval.



	A	B	C	D	E
1	T1				
2	T1				
3	T1				
4	T1				
5	T1				
6	T1				
7	T1				
8	T1				
9	T1				
6369	T14				
6370	T14				
6371	T14				
6372	T14				
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6396	T14				
6397	T14				
6398	T14				
6399	T14				
6400	T14				
6401					
6402					
6403					

Figure 2. Log button that shows activity recorded

The Analysis icon key provides a comprehensive overview of all data captured over a 30-second interval or longer, depending on the duration of the activity being recorded. This feature facilitates the identification of the amount of time allocated for each task and helps educators pinpoint which activities consume a larger portion of time. Furthermore, it allows teachers to evaluate whether they adhered to their predetermined timing for each lesson plan step. The utilization of this function enables educators to make data-driven decisions and modify their instructional strategies, accordingly, leading to improved learning outcomes for students.

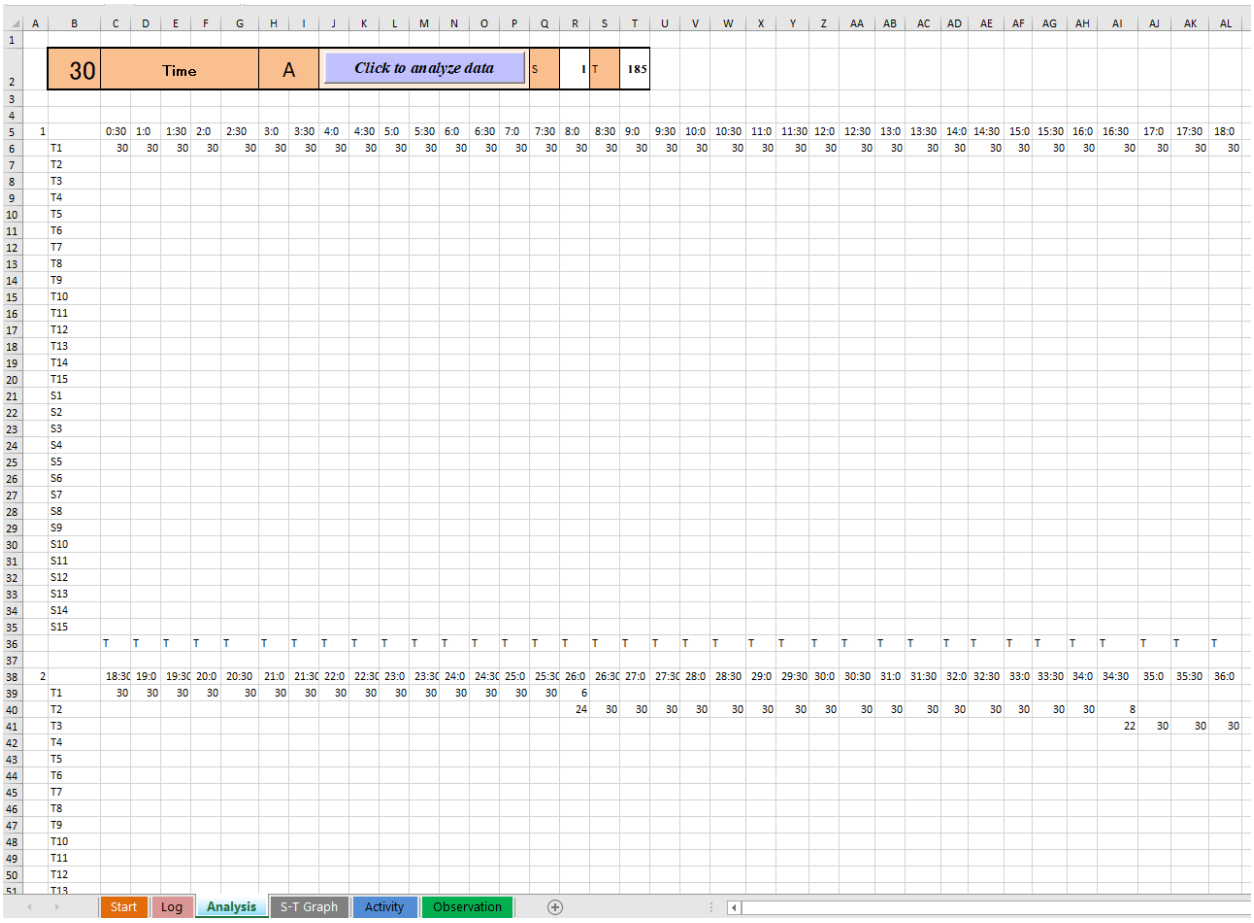


Figure 3. Analysis button on LOAP

The S-T (student-teacher) Graph icon key is designed to focus on the ratio between teacher and student talk during classroom discourse. It presents a Cartesian graph that visually represents the classroom's discourse in a graphical format. This graphic format is used to provide a clear and concise representation of the classroom discourse that educators can easily interpret. Additionally, the S-T Graph icon key is an essential tool for analyzing and improving classroom discourse as it quantitatively

represents the teacher and student talk ratio. Its graphical format is highly effective in presenting data in a professional and academic format.

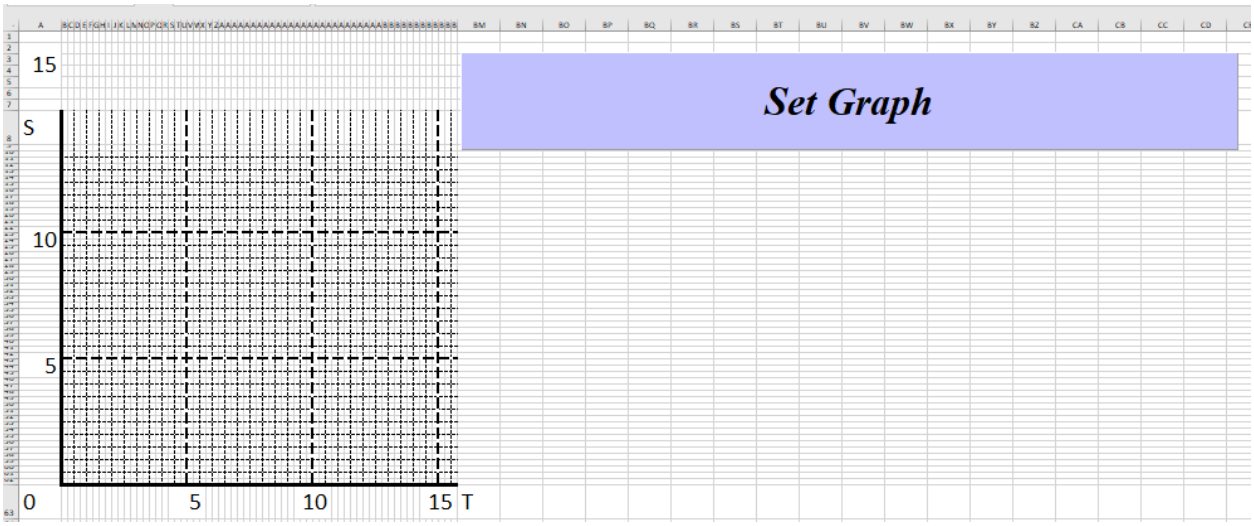
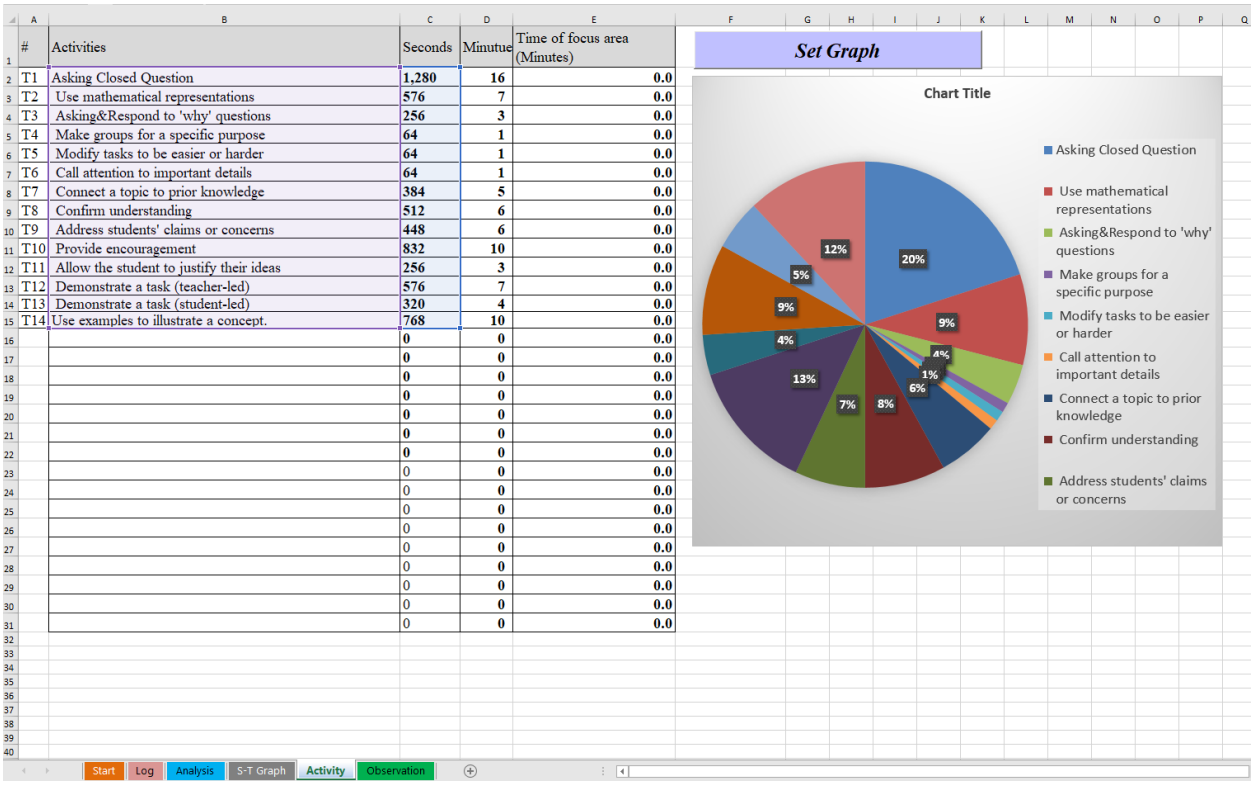


Figure 4. ST Graph that shows the teacher and student talk ratio. Note that we did not display this feature, as we only presented the tutor's practices.

The Activity icon key is a time-focused area for each activity recorded. It displays all students' and teachers' activities in frequencies. The icon key denoted as 'Log' records all data on activities initiated via the 'Start' icons. It systematically arranges all data for each activity recorded and is further accompanied by an analysis key function that exhibits all recorded data under the time interval.



#	Activities	Seconds	Minutue	Time of focus area (Minutes)
T1	Asking Closed Question	1,280	16	0.0
T2	Use mathematical representations	576	7	0.0
T3	Asking&Respond to 'why' questions	256	3	0.0
T4	Make groups for a specific purpose	64	1	0.0
T5	Modify tasks to be easier or harder	64	1	0.0
T6	Call attention to important details	64	1	0.0
T7	Connect a topic to prior knowledge	384	5	0.0
T8	Confirm understanding	512	6	0.0
T9	Address students' claims or concerns	448	6	0.0
T10	Provide encouragement	832	10	0.0
T11	Allow the student to justify their ideas	256	3	0.0
T12	Demonstrate a task (teacher-led)	576	7	0.0
T13	Demonstrate a task (student-led)	320	4	0.0
T14	Use examples to illustrate a concept.	768	10	0.0

Figure 5. An activity button that shows time spent on each activity. Note that this sheet shows 14 tutors' activities, but in the future, we will present more of their and students' activities.

The Observation icon key, still under development, presents a lesson plan that outlines a structured teaching session. This session begins with a five-minute introduction focused on checking homework and asking questions, or diagnosing the lesson if the topic is new. The lesson development includes discovery activities and individual, pair, and group work, aiming to achieve specific competences with target performance percentages. Presentation and exploitation of learners' findings follow, emphasizing innovation and idea-sharing. The conclusion involves collective work, and a five-minute assessment period concludes the lesson. The teacher actively facilitates, asks oral questions, and gives assessments, while learners are expected to respond and engage in various activities to meet the set learning objective.

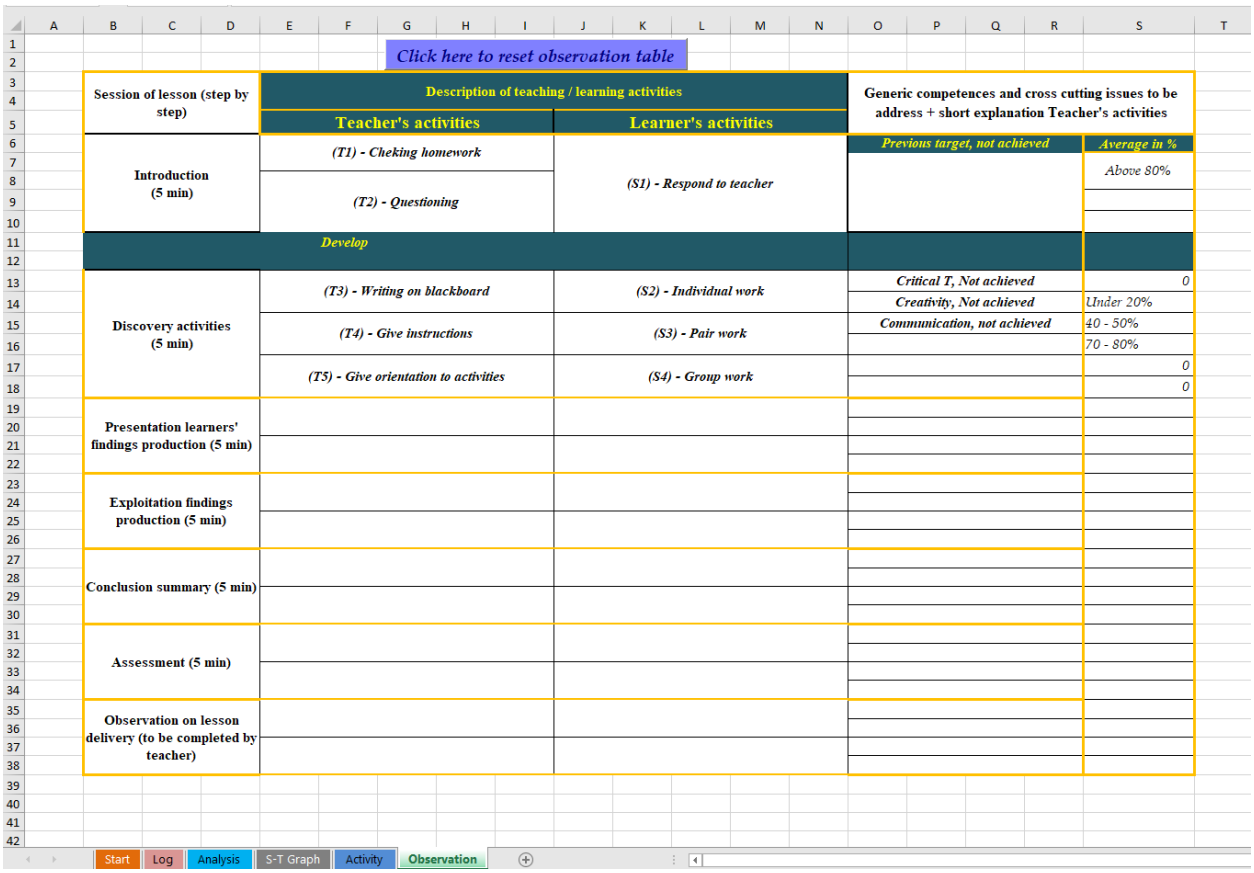


Figure 6. Observation icon representing activity performance

Tool Validation using Field Data

To validate the LOAP tool, six mathematics tutors from TTCs were engaged in lesson observations using the prototype. Three tutors received targeted support during the process. Lessons were collaboratively planned and implemented, with teaching activities recorded via LOAP. The data collected helped assess whether the recorded activities aligned with instructional objectives.

Following each observation, structured reflections were conducted. The feedback from tutors and researchers led to several revisions of the tool. Validity and reliability were iteratively improved, with final trials showing a high level of consistency (99%). The tool proved effective in supporting observation, self-evaluation, and instructional improvement.

Discussion and recommendations

The LOAP tool promotes evidence-informed decision-making by enabling educators to document instructional activities, analyze the alignment with learning objectives, and evaluate time allocation across lesson phases. Through iterative development and feedback from mathematics tutors in Rwandan TTCs, the tool demonstrated strong reliability and relevance to practical teaching needs. Its capacity to bridge the gap between theoretical instructional planning and real classroom practice marks a significant step forward in teacher professional development.

While a comprehensive, fully integrated model of professional development in mathematics education is still emerging, tools like LOAP can support its foundation. For professional development programs to be effective, they must integrate classroom-relevant experiences, reflective dialogue, and analysis of real instructional data—components that LOAP is well-positioned to facilitate. The LOAP tool is composed of six interactive components: *Start icon:* Initiates the recording of lesson activities based on pre-planned instructional objectives. *Log icon: Captures* and organizes all activities recorded during a lesson, categorized by timing and type. *Analysis icon:* Summarizes recorded data into time intervals, allowing educators to evaluate pacing and time allocation per activity. *S-T Graph icon:* Presents the ratio of teacher to student talk using a Cartesian graph, promoting analysis of classroom discourse. *Activity icon:* Shows the frequency and time spent on each recorded activity. *Observation icon:* Provides a structured lesson outline aligned with CBC phases—from introduction to assessment—designed to guide comprehensive lesson observation.

It is important to note that LOAP is still undergoing development. Current features focus primarily on capturing teacher activities, with future versions aiming to better represent student engagement and learning behaviors. Expanding its capabilities will strengthen its utility across various educational contexts and subject areas. In conclusion, the LOAP tool represents a promising advancement in supporting mathematics teacher development. By combining structured observation, reflective analysis, and alignment with competency-based instructional goals, it offers an effective means of enhancing instructional quality. We recommend that educational institutions and training programs adopt and further develop the LOAP tool to foster continuous improvement in mathematics teaching practices.

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