tusome-d4dm-eda

October 26, 2018

```
In [1]: import pandas as pd
        import numpy as np
        import altair as alt
        from altair import datum, expr
        import matplotlib.pyplot as plt
        import datetime as dt
        alt.renderers.enable('notebook')
        pd.set_option('display.max_colwidth', -1)
```

```
In [2]: tchrs = pd.read_stata("../src/teacher_data.dta", convert_categoricals=False)
        csos = pd.read_stata("../src/cso_data.dta", convert_categoricals=False)
        dirs = pd.read_stata("../src/director_data.dta", convert_categoricals=False)
```

```
In [3]: print(f"The Teacher dataset contains {tchrs.shape[0]} records\nThe CSO dataset contains
```

```
The Teacher dataset contains 828 records
The CSO dataset contains 153 records
The Director dataset contains 247 records
```

The main questions we want to ask are documented in the analysis plan, which is an evolving document.

0.1 Teacher Instrument

Here we begin exploring the data we obtained from interviewing the teachers.

```
In [4]: # Counting teacher records
        tchr_ct = tchrs.shape[0]
```

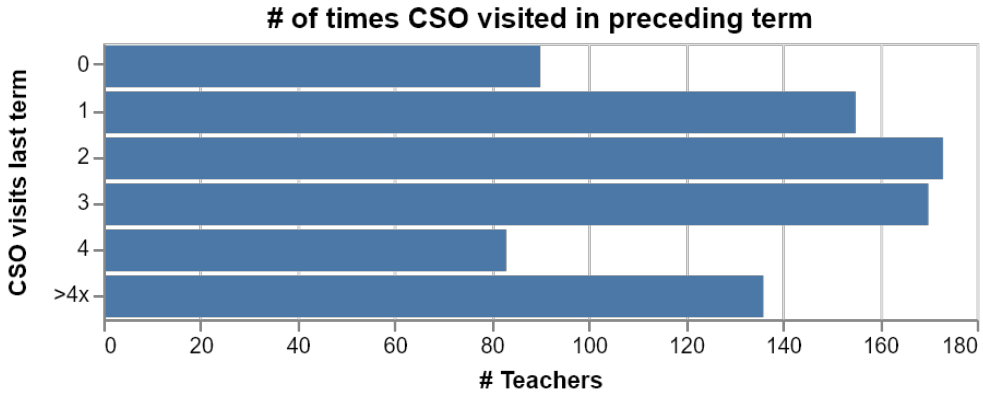
Our dataset contains interviews with 828 teachers.

0.1.1 Teachers visited previously by CSOs

The underlying assumption of most of the interview protocol is that the teacher has had a coaching interaction with a CSO. The first issue we should then address is the proportion of teachers who have received a visit from a CSO.

```
In [5]: # Counting teachers never visited
        never = 100 * ((tchr_ct - tchrs.vis_before.sum())/tchr_ct)
```

We see that 7.37% of teachers interviewed had never been previously visited by CSOs.



CSO Visits

0.1.2 Number of coaching visits in the last academic term

We have confirmed that the overwhelming majority of our teachers have been visited. We can have greater confidence in the responses they give us over the course of the interview if they have had a visit in the recent past. We therefore asked the teachers to tell us how many times they had been visited by their CSO in the preceding academic term (Term 2 of the Kenyan academic year, running from roughly May-July 2018).

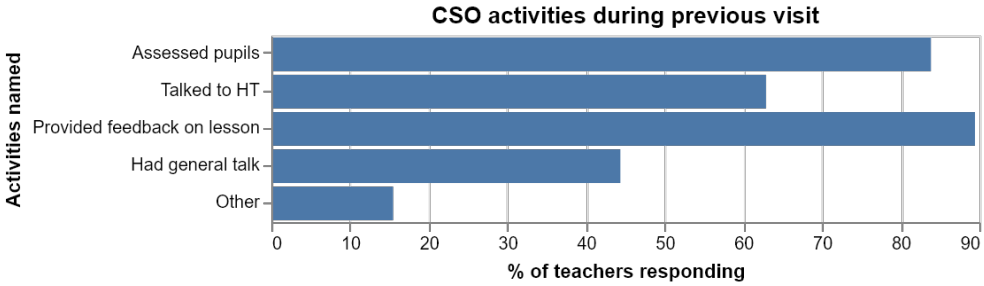
```
In [6]: # Generating CSO visit counts
        tchrs.vis_before_freq = tchrs.vis_before_freq.replace({55: ">4x"})
        viscount_df = pd.DataFrame(tchrs.vis_before_freq.value_counts(sort=False)).rename_axis
        viscount_df["pct"] = np.round(100 * (viscount_df.vis_before_freq / tchrs.vis_before.su
        more_than_monthly = viscount_df[viscount_df.prevterm_vis.isin([4, ">4x"])].pct.sum()
        csovisct_ch = alt.Chart(viscount_df, title="# of times CSO visited in preceding term")
            alt.Y("prevterm_vis:O", title="CSO visits last term"),
            alt.X("vis_before_freq:Q", title="# Teachers"),
            tooltip="pct")
        csovisct_ch.save("../img/csovisct_ch.png", scale_factor=2.0)
```

We see that roughly 11% of the respondents, while they'd been visited by a CSO in the past, had not been visited in the preceding term. However, roughly 64% of the respondents were visited between once per term and once per month. Roughly 28% of the teachers were visited by their CSOs more frequently than monthly.

0.1.3 CSOs' activities during last coaching visit

We are interested in knowing what CSOs are focusing on when they pay a visit to a school. Are they observing a lesson? Are they giving feedback to the teacher? Do they assess pupils' fluency rates? Do they take advantage of their presence at the school to meet with the head teacher (HT)? What kinds of things are they doing *besides* these activities?

```
In [7]: # Generating table of CSOs' activities during visits
        visact_df = pd.DataFrame.from_dict({"activities": ["Assessed pupils",
                                                           "Talked to HT",
```



CSOs' Activities

```
                                                    "Provided feedback on lesson",
                                                    "Had general talk",
                                                    "Other"],
                                        "tchrs_reporting": [tchrs[tchrs.vis_before != 0].v
                                                            tchrs[tchrs.vis_before != 0].v
                                                            tchrs[tchrs.vis_before != 0].v
                                                            tchrs[tchrs.vis_before != 0].v
                                                            tchrs[tchrs.vis_before != 0].v
visact_df["pct"] = np.round(visact_df.tchrs_reporting.apply(lambda x: 100 * (x/(tchr_c
visact_df
```

Out[7]:

	activities	tchrs_reporting	pct
0	Assessed pupils	688	83.84
1	Talked to HT	516	62.88
2	Provided feedback on lesson	734	89.44
3	Had general talk	364	44.36
4	Other	127	15.48

```
In [8]: # Generating the graph of CSOs' activities during the previous visit
csoprevvis_ch = alt.Chart(visact_df, title="CSO activities during previous visit").mar
alt.Y("activities:O",
      title="Activities named",
      sort = alt.EncodingSortField(field="tchrs_reporting", op="values", order="ascend
alt.X("pct:Q",
      title="% of teachers responding"),
tooltip = "tchrs_reporting")
csoprevvis_ch.save("../img/csoprevvis_ch.png", scale_factor=2.0)
```

Nearly 90% of teachers report that when the CSO last visited, s/he provided feedback on a lesson. A fairly comparable proportion said that the CSO assessed pupils. Neither of these is surprising, as those activities are key features of a "reimbursable" or "valid" lesson observation. If anything, it is interesting that these numbers are not higher, given that we have excluded from our denominator those teachers who said they had never received a visit from the CSO.

Of note is the relatively low proportion of teachers reporting the CSO had spoken with the HT. While Tusome encourages CSOs to speak with HTs as part of the standard protocol for visiting a school, it is not explicitly considered as a factor for reimbursement of transportation costs for visiting that school.

That said, it is also possible that teachers may simply not be aware of activities taking place outside of their classroom. They and their classrooms would have been the objects of the lesson observation and fluency assessment; they may not have as much visibility into what happened before or after the CSO entered their classroom.

A little over 15% of teachers reported the CSO conducted an activity that was not listed in the questionnaire. Below we have sampled 20 of the things that they reported which were not captured in the questionnaire.

```
In [9]: # Generating a list of the 'other' activities CSOs did when visiting
        print(tchrs[tchrs.vis_act_other_det.notna() & (tchrs.vis_act_other_det != "")].vis_act
```

```
384    She talked to other teachers about Tusome .She said Tusome should not be taken as progra
736    He asked for the lesson i was teaching ,he sat at the back of the class and observed my
95     I present the lesson as she observes the lesson
619    The CSO observes me teach,after the lessons I sit with her to discuss what I did well a
268    CSO checks all my professional documents
399    He always telles us through the Ht about his coming .He picks 3 pupils for assessment t
729    The CSO observed my lesson ,assessed three learners ,gave me feedback and advised me reg
154    Once attended the parents meeting and went with my class performance data to present to
525    The CSO first meets with all the teachers and plan how the classroom support visits sha
325    He observed lesson,he gave me feedback on areas of improvement
2      requests me to prepare for the lesson in adavnace and details of the lesson, boys and g
687    Cover the pupils' books
659    She assembled all lower Primary teachers and advised us on how to teach successful less
300    He sought information on book shortages and resources such as letter cards
208    Helped me on how to use the teachers guide because I was new to the system.
752    I saw him sit at the back,he checked pupils work and he checked pupils books
401    He spoke to headteacher,observed my class,assessed pupils and gave me feed back on my c
721    assesed children,spoke to head teacher and gave me feedback
730    The CSO observed my lessons (English,Kiswahili & Maths and gives me feedback on areas o
648    guidance on preparation of teacher documentation
Name: vis_act_other_det, dtype: object
```

0.1.4 CSOs using tablets or pen & paper during observation

The *Tangerine:Tutor* app was developed with the intent and belief that CSOs would use it *while observing* the lesson. However, Tusome staff report that not all CSOs find the tablet interface comfortable, and not all use it with ease. So we asked teachers to report whether CSOs use the tablets during the lesson observation, and also whether they use pen and paper.

Roughly 90% of teachers reported that the CSOs use tablets during lesson observation; roughly 81% of teachers reported the CSOs use pen and paper during the lesson observation.

```
In [10]: # Generating the table about usage of tablets and pencils
         tabs_n_pencils = pd.crosstab(tchrs.cso_usetab_yn, tchrs.cso_usepcl_yn)
         tabs_n_pencils = tabs_n_pencils.rename_axis("Uses tablet").rename_axis("Uses pen and
         tabs_n_pencils = tabs_n_pencils.rename({0: "No", 1: "Yes"}, axis="columns").rename({0
         tabs_n_pencils
```

```
Out[10]: Uses pen and paper  No  Yes
         Uses tablet
         No                  3   17
         Yes                 72  657
```

We see that the overwhelming majority of CSOs are using both tablets *and* pen-and-paper systems when observing the teachers' lesson. There have historically been some instruments/data that CSOs were tasked by TSC to complete that were not rendered in *Tangerine* format on the tablets; as of midway through Term 3 of the 2018 academic year, those instruments (mostly for the TSC's TPAD [Teacher Performance Appraisal and Development] project) are now in *Tangerine*. While the use of pen and paper does not appear to have come at the expense of using the tablets - indeed, it appears to be complementary, as nearly all CSOs are using both - Tusome should nonetheless follow up on these reports of CSOs' usage of pen and paper to understand the roots of the practice.

0.1.5 CSOs' usage of the tablets to assess pupils' performance

Tusome's coaching protocol requires CSOs to randomly select three children from the classroom at the end of the lesson to assess their reading fluency. The prompt the children are to read from is a laminated sheet of paper with a short passage printed on it; the CSOs are instructed to use the tablet to record the children's responses. The tablet is then able to calculate fluency rates and store those as data associated with that observation.

Approximately 88% of the teachers reported that CSOs use the tablets to assess children's reading fluency.

0.1.6 Teachers' experience of feedback, and CSOs' use of tablets during feedback

Tusome asked teachers whether the CSO gave feedback on the lesson last time s/he paid a visit, whether s/he used the tablet to do so, and whether the teacher was able to recall specific feedback the CSO provided.

```
In [11]: # Generating table of CSO use of tablets for feedback
         feedback = {"CSO gave feedback": tchrs.cso_gave_fdbk_yn.sum(),
                     "CSO used a tablet for feedback": tchrs.cso_usetab_fdbk_yn.sum(),
                     "Tchr remembers feedback": tchrs.cso_fdbk_remember.sum()}
         fdbk_df = pd.DataFrame.from_dict(feedback, orient="index", columns=["ct"])
         fdbk_df["pct"] = 100 * np.round(fdbk_df["ct"] / tchrs.shape[0], decimals=3)
         fdbk_df = fdbk_df.rename_axis("event").reset_index()
         fdbk_df
```

```
Out[11]:                              event     ct   pct
         0  CSO gave feedback               757.0  91.4
         1  CSO used a tablet for feedback  676.0  81.6
         2  Tchr remembers feedback         725.0  87.6
```

Below we have sampled 20 of the things that they reported which were not captured in the questionnaire.

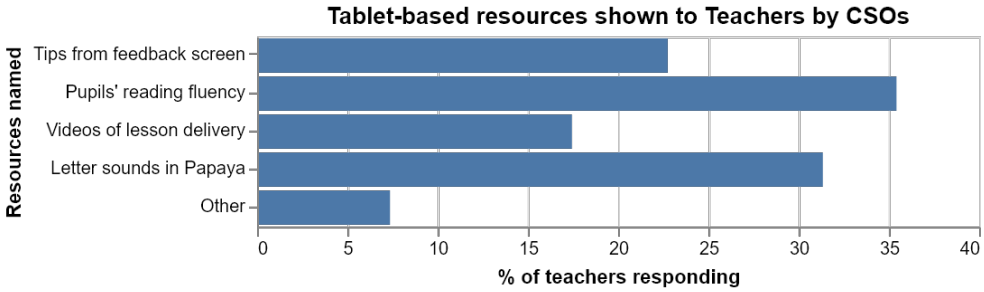
```
In [12]: # Sample of details regarding the details of feedback CSOs provided
         print(tchrs[tchrs.cso_fdbk_det.notna() & (tchrs.cso_fdbk_det != "")].cso_fdbk_det.samp
```

```
650    Advice to use correct speed to the learners. How to group slow learners
58     He asked me to cover all Tusome books .He also told me to keep time and limit lessons to
622    I was appreciated on time management and advised me to support non readers
778    To avoid using other languages in an english lesson but to use teaching aids to explain
273    I took a lot of time in teaching, CSO told me to maintain perky pace. He told me my pupi
652    Improve in pronunciation of sounds
686    create time and help slow learners in word blending
62     CSO told me the lesson was Ok, I was advised that pupils to read the story fluently
186    He told me am able to follow the Tusome steps of I do, We do, You do but in some areas a
183    He told me am improving and if I continue that way me children will be the best in the z
529    during sentence construction i should chose few pupils to give
668    The CSO guided on how to teach using the DIM and corrected me on the 'we do'.
380    he told me to improve my friendship with the learners and help them to be courageous
397    From the results of reading fluency compared to the previous vist I have observed improv
431    We discuscussed ORF- " I was told to ensure all pupils in my class are able to read as p
760    The CSO used the tablet to play for me the sounds that I had difficulty in pronouncing
748    He commented on time taken during the lesson and how to improve on direct instruction mo
204    The CSO observed that the pupils were not reading at the benchmark
638    The CSO told me i was audible enough, I had good pronounciation of the sounds, the learn
267    She showed me the number of words read by selected pupils during assessment
Name: cso_fdbk_det, dtype: object
```

The tablets come equipped with various aids that CSOs could use to help coach teachers. In addition to the contents of the auto-generated feedback, CSOs could use the *Papaya* application to model pronunciation of letter sounds, the videos demonstrating effective lesson delivery, etc. Of the teachers reporting CSOs provided feedback of some kind, 56% indicated that the CSO showed them something directly on the tablet.

```
In [13]: # Generating dataframe of feedback shown by CSOs to teachers
         fdbk_shown_df = pd.DataFrame.from_dict({"resources": ["Tips from feedback screen",
                                                               "Pupils' reading fluency",
                                                               "Videos of lesson delivery",
                                                               "Letter sounds in Papaya",
                                                               "Other"],
                                                 "tchrs_reporting":[
                                                     tchrs[tchrs.vis_act_fdbk != 0].cso_shw_tips.su
                                                     tchrs[tchrs.vis_act_fdbk != 0].cso_shw_fluency
                                                     tchrs[tchrs.vis_act_fdbk != 0].cso_shw_video.s
                                                     tchrs[tchrs.vis_act_fdbk != 0].cso_shw_lsnd.su
                                                     tchrs[tchrs.vis_act_fdbk != 0].cso_shw_other.s
         fdbk_shown_df["pct"] = np.round(
             fdbk_shown_df.tchrs_reporting.apply(
             lambda x: 100 * (x/visact_df[visact_df.activities=="Provided feedback on lesson"]
             decimals=2)
         fdbk_shown_df

Out[13]:                    resources  tchrs_reporting    pct
         0  Tips from feedback screen  167              22.75
```



Tablet Resources Chart

```
1  Pupils' reading fluency    260              35.42
2  Videos of lesson delivery  128              17.44
3  Letter sounds in Papaya    230              31.34
4  Other                      54               7.36
```

```
In [14]: # Generating chart of tablet-based resources shown to teachers
         tabres_ch = alt.Chart(fdbk_shown_df, title="Tablet-based resources shown to Teachers
         alt.Y("resources:O",
               title="Resources named",
               sort = alt.EncodingSortField(field="tchrs_reporting", op="values", order="ascen
         alt.X("pct:Q",
               title="% of teachers responding"),
         tooltip = "tchrs_reporting")
         tabres_ch.save("../img/tabres_ch.png", scale_factor=2.0)
```

Overall, fewer than 50% of teachers indicated that CSOs showed them something on the tablet as part of the feedback session. Where the CSO showed something to the teacher, it was most frequently pupils' reading fluency (at 35%), with Papaya letter sounds the next most common (at 31%).

N.B.: Update cell w literate programming re: which activity is in the lead. (Abstract one level further.)

Below we have sampled 20 of the things that they reported which were not captured in the questionnaire.

```
In [15]: # Printing sample of teachers' feedback re: things CSOs showed them on the tablet
         print(tchrs[tchrs.cso_shw_other_det.notna() & (tchrs.cso_shw_other_det != "")].cso_sh
```

```
42     During training he showed us videos from the tablet
720    Downloaded the letter sounds on my smart phone
546    pronounciation of a word in the dictionary
506    He only showed us during the training
480    pronounciation of a word in the dictionary
106    Installed Papaya application in phones during trainings which I use whenever I had chal
467    After the lesson is over he shows me the reading outcomes.
369    he showed me the text which the pupils read during the pupils assessmenet
224    He showed me the words that were read incorrectly by the three learners that were selec
781    The CSO showed me the feedback comments
```

```
447    The pupils assessment reading and how the tool counts the average number of words read l
127    Time management- The time I took to conduct the lesson
577    the feedback on the tablet
549    pronounciation of a word in the dictionary
785    I was shown the time the lesson took
614    The CSO ocassionally shows me pupils fluency rates and advises on how I should help the
507    He only reads to me eg he reads the sections on how I needed to conduct the lesson or pu
820    Mostly, I get the support from the head teacher who advises me on the areas i need to pe
63     He showed me a video of a teacher teaching thumbs up/down
514    He showed me a video of a teacher teaching silent blending
Name: cso_shw_other_det, dtype: object
```

0.1.7 CSOs' use of feedback visit-over-visit

Tusome's theory of change stipulates that smaller, more frequent, and more targeted coaching interactions will shift teacher behavior more effectively than larger-scale, episodic training events that cover a broad range of topics. This is the reason Tusome invests so heavily in supporting CSOs to provide coaching support to teachers in the span between large-scale training events.

Teachers, like most people, will be more likely to alter their behavior if feedback is timely and consistent, and the teachers' response to it is monitored rather than assumed. In this survey, roughly 63% of teachers indicated that when CSOs visited the school and observed the teacher, they follow up on feedback from earlier visits.

T.D.: Update cells so definitions of variable `literate programming` inputs are visible.

0.1.8 Teachers self-reported improvement in response to coaching

Effectively measuring the quality of instruction or lesson delivery is a very, very difficult task. (**T.D.**: Provide citations, examples of various approaches.)

The current study was not able to directly assess the quality of teachers' lesson delivery, although Tusome is working on various other studies which attempt to do so. However, we asked teachers whether they felt the coaching received from CSOs had improved the quality of their teaching. We first posed the question in regard to the teaching of reading in Kiswahili and English, and then asked them whether the coaching had improved their teaching in other subjects as well.

```
In [16]: # Generating dataframe of teacher's self-reported improvement due to coaching
         better_tchr_df = pd.DataFrame.from_dict(
             {"subject": ["Kiswahili & English reading",
                          "Other subjects"],
              "tchrs_reporting": [tchrs[(tchrs.vis_act_fdbk != 0) &
                                        (tchrs.vis_before != 0)].cso_fdbk_better_tus.sum(),
                                  tchrs[(tchrs.vis_act_fdbk != 0) &
                                        (tchrs.vis_before != 0)].cso_fdbk_better_nont.sum()]}
         better_tchr_df["pct"] = np.round(
             better_tchr_df.tchrs_reporting.apply(
             lambda x: 100 * (x/tchrs[(tchrs.vis_act_fdbk !=0) & (tchrs.vis_before != 0)].vis_
             decimals=2)
```

```
bttr_tus_pct = better_tchr_df[better_tchr_df.subject=="Kiswahili & English reading"].p
bttr_nont_pct = better_tchr_df[better_tchr_df.subject=="Other subjects"].pct
better_tchr_df
```

Out[16]:

	subject	tchrs_reporting	pct
0	Kiswahili & English reading	732.0	99.86
1	Other subjects	706.0	96.32

Encouragingly, 99.86% and 96.32% - effectively all - teachers have indicated that the feedback they receive from CSOs has enabled them to be better teachers.

Below we have sampled 20 of the examples teachers gave for how their teaching has improved as a result of the feedback.

```
In [17]: # Printing sample of things teachers say they do better
         print(tchrs[tchrs.cso_fdbk_better_det.notna() & (tchrs.cso_fdbk_better_det != "")].cso
```

```
585    The CSOs feedback on how to teach prediction has helped me to improve in my teaching eve
115    I use the I do we do and you do in other classes not in lower
386    How to manage and use the chalkboard and improve on partner work.
207    Yes because I am able to use the Tusome methodology to teach other subjects. The part o
815    time management and involvng learners at different levels
758    he told me to teach vocabulary words very clearly because they are the same words used
419    I was asked to work closely with slow learners and none readers so that they are not le
28     How to use to prediction in teaching health and education .
426    She gave me feedback on how to involve learners in the lesson to make it more learner c
516    The CSOs feedback on infusing competency based curriculum aspects in Kiswahili and Engl
612    The infusion of CBC in Tusome lessons in Grades 1 and 2 has now become earsier for me t
513    The feedback helped me in infusion of competency based curriculum aspects in other subj
76     I demonstrate, the we do togethe wit the pupils and i let them do alone when teaching E
339    I use DIM to help slow learners get information clearly
471    You have improved sound articulation, use the same to support learners in other subjects
790    Use of real items when teaching in the other subjects to make it easier for the pupils
461    How to help learners reading at slow pace.
822    during "get ready to read/vocabulary- I have been using the advice CSO gave me on follow
529    adviced me to monitor pupils work
73     When he told me to practice sounds and syllables i tried to apply the method andmy pupil
Name: cso_fdbk_better_det, dtype: object
```

0.1.9 CSOs' discussion of pupil fluency

The ultimate goal of Tusome is to improve reading outcomes in grades 1-3. Whether the project has been successful is determined by the pupils' reading skills (with an emphasis on *oral reading fluency*, or ORF, and reading comprehension) as demonstrated by their performance on an early grade reading assessment (EGRA).

For a CSO's visit to be considered *complete* or *valid*, one of the criteria is that it include an assessment of the reading skills of three randomly-selected pupils. These pupils are then provided a stimulus that contains a brief reading passage of ~50-100 words. As they read aloud from the

stimulus, the CSO uses the *Tangerine* application on the tablet to make note of any inaccurately read words. When the child has finished reading - or when 60 seconds elapses, whichever comes first - the assessment is complete. The child's fluency is then calculated using the formula

$$\frac{\text{\# of correct words}}{\left(\frac{60 - \text{time remaining (s)}}{60}\right)} = \text{correct words per minute}$$

The *Tangerine* software calculates the average fluency in *cwpm* across all three pupils and reports it as part of the lesson feedback. The CSO is able - but not required - to bring up the pupils' fluency as part of their feedback session.

```
In [18]: # Generating dataframe CSOs' discussions of fluency
         fluency_disc_df = pd.DataFrame.from_dict({"response": [
             "CSO discusses fluency in feedback session",
             "Teacher finds discussion of fluency useful"],
             "tchrs_responding": [
                 tchrs[tchrs.vis_before != 0].cso_fdbk_discfluency.sum(),
                 tchrs[tchrs.vis_before != 0].cso_fdbk_flu_useful.sum()]})

         fluency_disc_df["pct"] = np.round(100 *
                                  fluency_disc_df.tchrs_responding.apply(
                                      lambda x: x / (tchrs.vis_before.sum())), decimals=2)

         flu_cso_disc = fluency_disc_df[fluency_disc_df.response=="CSO discusses fluency in fe
         flu_disc_use = fluency_disc_df[fluency_disc_df.response=="Teacher finds discussion of
         fluency_disc_df
```

Out[18]:

	response	tchrs_responding	pct
0	CSO discusses fluency in feedback session	706.0	92.05
1	Teacher finds discussion of fluency useful	710.0	92.57

It appears the overwhelming majority of CSOs (92.05%) discuss the pupils' fluency with the teachers, and the teachers overwhelmingly (92.57%) find it a useful discussion. But how do teachers make use of that insight?

Below we have sampled 20 of the examples teachers gave for what they do with knowledge of their pupils' fluency rates.

```
In [19]: # Printing a sample of teachers' responses re: what they do with knowledge of fluency
         print(tchrs[tchrs.cso_fdbk_flu_dowith.notna() & (tchrs.cso_fdbk_flu_dowith != "")].cs
```

```
315    it helps me identify the weak learners and develop a plan to support them and this has
162    It helps me review on how to assist slow learners improve in their reading levels
606    I decide what to do with the pupils based on the results given by the CSO.
806    i write the words that learners are unable to read for more practise
369    it encourages me involve learners in reading so has to improve the fluency rates
666    i assist them on activities that will help them improve on speed
730    The information helps me to be a better teacher in teaching Tusome
471    It heps me strategies on how to improve in literacy in my class by using groups of mixe
620    I am able to correctly guide my learners to prounce and read at the correct speed for b
```

```
542    I use it to encourage slow learners to practise for improved reading speed.
682    it has made me to provide more time for reading especially for slow learners
630    I now give more attention to the learners who were said to be slow readers
637    When i compare the previous results given and the results now, i am able to tell my impr
505    i use it to support those identified improve in reading
45     It helped me to know the ability of the learners and started assessing them.
334    Whatever he tells me i try to put it in practice in class
100    It enables me to teach sounds and word blending to help learners to read words.
579    I do rmedial teaching to the pupils who have been identified by the CSOwith reading dif
423    To help weak learners in class
312    Implement in more for improvement
Name: cso_fdbk_flu_dowith, dtype: object
```

0.1.10 Disruption caused by tablet use

Pupils are easily distracted by the presence of unfamiliar adults in the classroom. However, if the adult sits quietly and unobtrusively in the rear of the classroom, the children rapidly become acclimated to the visitor's presence and are able to focus on the lesson.

For many children in rural schools, however, tablet computers are an unfamiliar sight. Tusome was interested to know whether the CSOs' use of tablets to conduct the classroom observation or assess the pupils' fluency is perceived as disruptive.

```
In [20]: # Generating dataframe re: pupils' distraction due to tablet use
         tchr_dist_df = pd.DataFrame.from_dict({
             "case": [
                 "CSO tablet use for observation",
                 "CSO tablet use for feedback"],
             "distracting": [
                 int(tchrs[tchrs.vis_before != 0].cso_tab_distract_yn.sum()),
                 int(tchrs[tchrs.vis_before != 0].cso_tab_fdbk_distrac.sum())]})

         tchr_dist_df["pct"] = 100 * np.round(tchr_dist_df.distracting.apply(
             lambda x: x / tchrs.vis_before.sum()),
                       decimals=2)

         distracting_tab_obs = float(tchr_dist_df[tchr_dist_df.case=="CSO tablet use for obser
         distracting_tab_fdbk = float(tchr_dist_df[tchr_dist_df.case=="CSO tablet use for feedb

         tchr_dist_df

Out[20]:                              case  distracting  pct
         0  CSO tablet use for observation  34           4.0
         1  CSO tablet use for feedback     16           2.0
```

Reassuringly, very few teachers responded that they find it distracting when the CSO used a tablet during observation or during feedback (4.0% and 2.0%, respectively). It is worth considering why they found the tablet use distracting; because the numbers are so low, the lists below present all responses rather than just a sample.

```
In [21]: # Printing the reasons teachers think the tablets are distracting during observations
         print(tchrs[(tchrs.cso_tab_distract_why != "") & tchrs.cso_tab_distract_why.notna()].
```

```
1      Pupils get attention of the tablet
13     at times it is distracting when the CSO takes a photo using the tablet. This mostly affe
26     some learners look at the CSO at the back of the class as he he uses tablet hence distra
47     The curious one always keep on looking at the tablet instead of listening to me
89     Some of the children sitting next to the children get distraccted and stop looking and t
108    N/A s
113    N/As
132    Because the pupils keep on looking at the CSO and not the teacher when am teaching
148    N/A
165    N/A
224    Sometimes the learners try to look behind but i control them.
231    sometimes the pupils are atrracted by the tablet as the CSO type
264    N/A
273    N/A
278    Pupils are glued to the tablet.
284    The kids concentrate on the tablet
297    My pupils are eager to find out what the CSO is keying in the tablet
298    My pupils would be interested to know more about the tablet and hence poor concentratio
324    helps me put those with difficulties in reading under remedial
341    N/A
387    I m not used to it
596    Some pupils tend to concetrate at the CSO using the tablets behind the class while am te
625    Sometimes my learners become interested in what the CSO is doing
654    It creates curiosit to my learners
676    sometimes the learners turn to see what the CSo is doing, for me its not
728    The table diverts the learners attention and they will not concentrate on the lesson i a
774    This is because i have a class of 71 learners and the ones who were near the CSO, were l
Name: cso_tab_distract_why, dtype: object
```

```
In [22]: # Printing the reasons teachers feel the tablet use during feedback is distracting
         print(tchrs[(tchrs.cso_fdbk_tab_diswhy != "") & tchrs.cso_fdbk_tab_diswhy.notna()].cso
```

```
35     it arouses curiosity therefore disrupt concentration of the learners
50     I am distracted because i don't know what he will tell me
176    Because i am not aware what he is doing with the tablet but if both are looking at it, i
206    My thinking is that the CSO is recording me and can be used in other places
241    When he is giving me feedback find it distracting that the CSO has to keep on looking or
423    N/A
522    No
749    N/A
Name: cso_fdbk_tab_diswhy, dtype: object
```

While these results are encouraging, it may be that CSOs' tablet use is more distracting when it is the pupils themselves who are the object of the CSO's attention. We asked teachers whether

they were present during the assessment of pupils' reading skills, and if so, whether it was their sense that pupils were distracted by the tablet use.

```
In [23]: # Generating dataframe re: pupils' distraction due to tablet use during assessment
         pupil_dist_df = pd.DataFrame.from_dict({
             "response": [
                 "Teacher observed the assessment",
                 "Pupils found the tablet distracting"],
             "tchrs_responding": [
                 int(tchrs[tchrs.vis_before != 0].cso_pres_ass_tab.sum()),
                 int(tchrs[tchrs.vis_before != 0].cso_pup_distract_ass.sum())]})

         pupil_dist_df["numerator"] = [
             int(tchrs.vis_before.sum()),
             int(pupil_dist_df[pupil_dist_df.response=="Teacher observed the assessment"].tchrs

         pupil_dist_df["pct"] = 100 * np.round(pupil_dist_df.tchrs_responding / pupil_dist_df.

         tchrs_obsd_assmt = int(pupil_dist_df[pupil_dist_df.response=="Teacher observed the ass
         pupils_distracted = int(pupil_dist_df[pupil_dist_df.response=="Pupils found the tablet

         pupil_dist_df
```

Out[23]:

	response	tchrs_responding	numerator	pct
0	Teacher observed the assessment	449	767	59.0
1	Pupils found the tablet distracting	98	449	22.0

Roughly 59% of the teachers said they had observed the CSO's assessment of the pupils' reading skills. Of those, 22% thought the pupils found the tablet distracting. This may suggest a need for Tusome to provide additional training or orientation to CSOs on best practices in assessment administration.

Below we sample 20 of the reasons teachers provided for why they thought pupils found tablet use distracting during the assessment.

```
In [24]: # Printing a sample of the reasons teachers think pupils find the tablet distracting
         print(tchrs[(tchrs.cso_pup_dist_why != "") & tchrs.cso_pup_dist_why.notna()].cso_pup_
```

```
244    The pupils were getting distraced initailly because they would focus on the tablet but
212    Because most of them tend not to concentrate on what they are reading and get themselve
826    "the rest of the learners who havent been selected for the reading activity keep on pee
317    THEY ARE NOT USED TO THE GADGETS
827    N/A
102    N/A
220    Some pupils were shy
66     Children were reading from the tablet and not from stimuli
97     The CSO called me to encourage a pupil who was shy
739    some of them fear when a tablet is used during assessment session
633    When the others were reading some of the pupils were carried away by the use of the tabl
63     i find the CSOs use of the tablet to assess learners create fear or anxiety among learne
```

```
322    some learners are attracted to know what is being done
741    pupils get interested in seeing the tablet rather than concetrating in reading the words
647    they are excited to see a visitor and the concetration is low
229    The pupils read from the tablet.
768    When some of the leaners see the tablet they are attempted to touch it thereby distracti
202    The learner is used to reading on paper, so when the CSO asked them to read on the table
533    When he was taking the photograph
824    they are curious and want to know more about the devices, this makes them not to co ncet
Name: cso_pup_dist_why, dtype: object
```

0.1.11 Teachers' ongoing assessment of pupil fluency

Teachers are fully capable of assessing their pupils' reading fluency without recourse to a tablet. However, RTI has experimented with an Android-based pupil performance tracking tool that might be of use to teachers. Therefore we were interested to understand the extent to which teachers are already assessing pupils' fluency, what tools they are using for the task, whether they have access to phones on which such a tool could be deployed, and whether they would want to use it if so.

```
In [25]: # Calculating proportion of teachers who assess their pupils' fluency
         tchrs_assessing = 100 * np.round(tchrs.tchr_ass_pup_flu_yn.sum() / tchrs.shape[0], dec
```

Roughly 91% of teachers we spoke to indicated they assess their pupils' fluency. When asked to specify what tools they use for the task, they specified the following.

```
In [26]: # Printing sample of tools teachers use to assess pupils' fluency
         print(tchrs[(tchrs.tchr_ass_pup_flu_yn != 0) & (tchrs.tchr_ass_pup_tools != "") & tchr
```

```
529    write words and call one by one to read for me
358    I time using a watch while pupils read selected text
579    I use my phone
34     I use the supplimentary readers and theTusome books to assess pupils in my class
413    tusome books
790    Show them sound cards for each pupils to read, read a passage as I time and mark.
338    I use my phone to time
433    I use my phone to do the timing
474    I use an already set story to assess their reading levels as i time
157    I normally ask individual learners to read to me a story in the afternoon.
15     I usually call each pupil to read for me, i use the text books.
620    My tools include Tusome text books during normal lessons,at their free time they read wo
264    I check speed of pupils reading using my phone's stop watch. I use short passages from v
82     I use storybooks. I can call a pupils and ask him/ her to read or write a story on the b
569    I WRITE A STORY ON THE BOARD THEN I CALL THEM ONE BY ONE
219    I give them a story to read then I time them. I also use speed tests
735    I selected words to be read from Tusome books and wrote them on the board for individual
782    During exam time, I give them passages to read. I assess them one by one
35     passage in the text
384    I usually call individual pupil and give them Tusome books in the afternoon and ask them
```

```
Name: tchr_ass_pup_tools, dtype: object
```

```
In [27]: # Generating dataframe of teachers' access to phones and interest in a tool
         tang_tool_df = pd.DataFrame.from_dict({
             "response": ["Teacher has a phone",
                          "Phone is an Android",
                          "Teacher would like a tool"],
             "tchrs_responding": [
                 tchrs.tch_mob_phone.sum(),
                 tchrs.tch_has_android.sum(),
                 tchrs.tch_wants_assess.sum()]})

         tang_tool_df["pct"] = 100 * np.round(tang_tool_df.tchrs_responding.apply(lambda x: x /
         tang_tool_df
```

Out[27]:

	response	tchrs_responding	pct
0	Teacher has a phone	814.0	98.0
1	Phone is an Android	654.0	79.0
2	Teacher would like a tool	813.0	98.0

Nearly all teachers interviewed indicated they have access to a mobile phone; nearly 4 out of 5 teachers indicated their phone is an Android. Nearly all teachers - even those who don't have an Android - said they would like to have access to a tool that would provide them sample assessments they could do with their pupils.

0.2 CSO Instrument

Here we begin exploring the data we obtained from interviewing the CSOs.

0.2.1 Length of experience using tablet-based Tangerine

When did you first receive a tablet from Tusome or PRIMR?

We want to convert the year/month CSOs provided into a number so we can work with it easily. We'll make the simplifying assumption that the tablet was received on the first day of the month they provided, and that this interview was conducted on the first day of the month. Neither of those are true, but the marginal days are unlikely to make a practical difference in a CSO's facility with the tool.

```
In [28]: now = dt.datetime(2018, 10, 1)
         csos["tab_usage"] = pd.to_timedelta(now - pd.to_datetime({"year": csos.recd_tab_yr, "
```

We'll also want to convert the duration to months, since that will be easier to digest, and filter out any missing values.

```
In [29]: tab_usage = pd.DataFrame(csos[csos.tab_usage.notna()].tab_usage / 30)
         # tab_usage
```

```
In [30]: alt.Chart(tab_usage, title="Distribution of CSO tablet usage, months").mark_bar().enc
             alt.X("tab_usage:Q",
                   bin=alt.BinParams(step=1), title="# Months has had a tablet"),
             alt.Y("count()", title="# of CSOs"))
```

```
<vega.vegalite.VegaLite at 0x22fd521a898>
```

Out[30]:

We see that the majority of our CSOs have had their tablets for roughly 41 months (3.5 years). This is in keeping with the beginning of the Tusome program, and is as expected. CSOs who have had their tablets for longer are likely veterans of the PRIMR program (Tusome's predecessor); those who have had tablets for fewer months may have assumed their roles more recently. (CSO turnover due to retirement, promotion, maternity leave, etc. is an issue which Tusome is constantly needing to manage.)

0.2.2 Proportion of CSOs reporting use of each application

Which applications do you use frequently when supporting teachers? ...After recording unprompted responses, read the list of options and record responses. + Tangerine Tutor + Papaya + Tusome Books (in Adobe Acrobat) + Tusome Videos (in MX Player)

The CSOs' tablets come equipped with several tools meant to support their efforts as instructional coaches. These include the *Tangerine:Tutor* application, the *Papaya* application, PDF versions of Tusome's instructional materials (pupil's books and teacher's guides), and videos that model effective instructional delivery.

We are interested in which of those tools CSOs use, and how frequently. We will provide an analysis of their unprompted free-response answers to the question above. For the moment, we note the tools they said they use when we explicitly prompted them with the list of tools available.

```
In [31]: app_users = {"tutor": csos.freqapps_tt_promp.sum(),
                     "papaya": csos.freqapps_papaya_promp.sum(),
                     "books": csos.freqapps_bks_promp.sum(),
                     "videos": csos.freqapps_vids_promp.sum()}
         app_usage = pd.DataFrame.from_dict(app_users, orient="index", columns=["ct"])
         app_usage["pct"] = 100 * np.round(app_usage["ct"] / csos.shape[0], decimals=3)
         app_usage = app_usage.rename_axis("app").reset_index()
```

```
In [32]: alt.Chart(app_usage, title="Proportion of CSOs reporting tool usage").mark_bar().enco
             alt.Y("app:O",
                   title="Application",
                   sort = alt.EncodingSortField(field="pct", op="values", order="ascending"),
                   ),
             alt.X("pct:Q", title="% of CSOs reporting usage"),
             tooltip="pct")
```

```
<vega.vegalite.VegaLite at 0x22fd54b4cc0>
```

Out[32]:

The overwhelming majority of the CSOs report using all of the applications. That said, the videos and books are used less frequently.

0.2.3 Proportion of CSOs who refer to Tangerine to provide post-observation feedback

Do you refer to Tangerine when giving teachers feedback after observing a lesson?

The *Tangerine:Tutor* application analyzes the pattern of the CSO's responses to the observation items and surfaces actionable feedback that could be share with the teacher to improve her or his instruction. While the auto-generated feedback is intended as a tool to help CSOs give more effective guidance to teachers, it can be quite extensive and is not prioritized. We were interested to know whether the CSOs make reference to the application's auto-generated feedback when they hold their post-observation debriefing session with the teacher.

```
In [33]: 100 * np.round(csos.ref_tang_fdbk.sum() / csos.shape[0], decimals=3)
```

```
Out[33]: 96.7
```

Again, the overwhelming majority of CSOs report using the auto-generated feedback when holding their debrief session with the teacher. We will separately provide an analysis of their open-ended answers regarding *what* they refer to and what they find most useful.

0.2.4 Proportion of CSOs who use Tangerine to plan their work

*Do you refer to Tangerine to help you plan your work when you are **not** either observing a teacher or giving the teacher feedback?*

Version 3 of the *Tangerine:Tutor* application features a screen which allows a CSO to see schools they have visited and which they have not. We were interested to know whether the CSOs are leveraging this feature—or others, such as the pupils' fluency rates, which are reported in the feedback—to make decisions about which schools to visit in the future.

```
In [34]: 100 * np.round(csos.refer_tang_nonobs.sum() / csos.shape[0], decimals=3)
```

```
Out[34]: 59.5
```

Fewer than two-thirds of CSOs refer to Tangerine to plan their work. A sampling of their reasons is provided surfaced below:

```
In [35]: pd.set_option('display.max_colwidth', -1)
         csos[csos.tang_nonobs_nowhynot.notnull() & (csos.tang_nonobs_nowhynot != "")].tang_no
```

```
Out[35]: 149    i use my notebook to record my intended activities
         101    I normally use it for the observation and writing reports
         87     I ussually don't have enough time for that despite knowing it's the right thin
         21     Yes Tangerine has schools visited or not visted hence useful for programming a
         123    I have a lot of tasks to look into that are not so much related to the Tusome
         79     I support two zones with too many schools so I only refer to it when observing
         102    N/ A
         115    I do not know how to use tangerine to refer for planning purposes. Am still ne
         60     I use my work schedule to monitor my school visits
         98     N/ A
         Name: tang_nonobs_nowhynot, dtype: object
```

This result surfaces a few issues Tusome might consider addressing next time CSOs receive a refresher training on Tangerine's use. 1. A lack of awareness of how the information provided by the tablet (schools visited and not visited) could be operationalized 1. A fear that they would be accused of falsifying observation data, rooted specifically in a misunderstanding of the application's GPS-capture functionality 1. A mental compartmentalization of Tangerine as being a Tusome-specific tool, not for use in broader contexts

Other reasons given suggest that the need which Tangerine might fill is already being addressed separately. 1. The CSO keeps a personal record (outside of the tablet) in which they track school visitation 1. The CSO has prepared a work schedule, and uses that as their guide until the month's activities have concluded.

0.2.5 Frequency with which users refer to the application

[If the CSO refers to the Tangerine for planning purposes], *how often do you reference the data?*

```
In [36]: tchk_freq = csos[csos.freq_refer_tang_plan.notna()].freq_refer_tang_plan.sort_values()
         tchk_freq = tchk_freq.rename_axis("frequency").reset_index()
         tchk_freq["frequency"] = tchk_freq["frequency"].replace({
             1: "Daily",
             2: "Weekly",
             3: "Monthly",
             4: "Termly"})
         tchk_freq["sort_order"] = tchk_freq.index
```

It appears that among the CSOs who check the application, it is most common to check it at least weekly.

```
In [37]: alt.Chart(tchk_freq, title="Tangerine app checking behavior").mark_bar().encode(
             alt.X("ct:Q"),
             alt.Y("frequency:O", sort = alt.EncodingSortField(field="sort_order:Q", op="value
             color = "frequency")
```

```
<vega.vegalite.VegaLite at 0x22fd54b45c0>
```

```
Out[37]:
```

0.2.6 CSO reference to the Tangerine Dashboard

In the last term, how often did you look at the Tangerine Dashboard?

The data that is generated by the CSOs' lesson observations is uploaded to the cloud and reported on the Tangerine Dashboard. This Dashboard is reviewed by senior management within the Ministry of Education: the Principal Secretary, his Directors, and their deputies. It is also sent to the Directors of MOE and TSC at the County level. As these latter personnel oversee the CSOs, the Dashboard may have an effect ...