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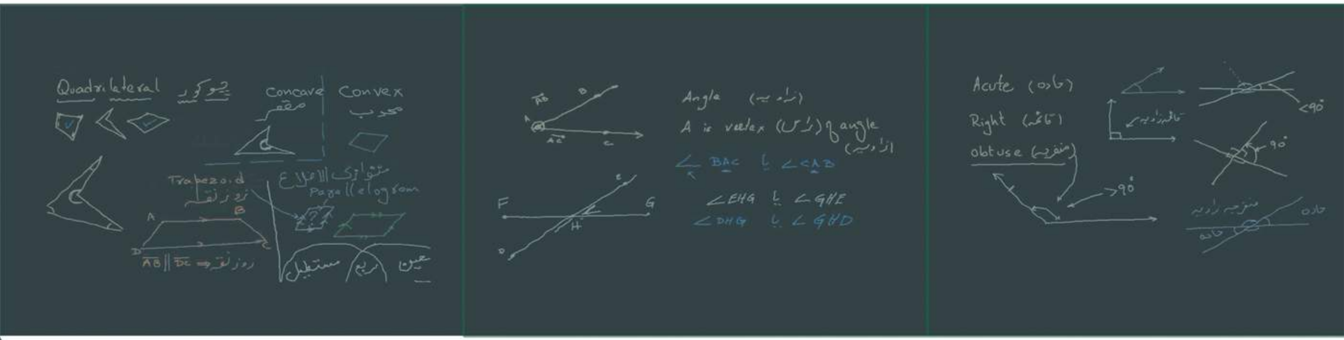

Using Innovative Media in Punjab's Primary Classrooms

Technology for Teaching

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Ayesha Awan, Muhammad Azhar & Abbas Rashid

Society for the Advancement of Education

The Society for Advancement of Education (SAHE) is a non- governmental organization established in 1982 by a group of concerned citizens and academics. It builds on the belief that educational justice entails not just access to school, but to quality education, for all children in Pakistan. SAHE works through an extensive network, the Campaign for Quality Education (CQE), to conduct collaborative research and evidence-based advocacy on key issues to influence educational reform. It has sought such evidence in the realm of data related to school inputs and student outcomes, budgetary analysis, public sector reform and privatization, teacher professional development, language as well as citizenship education.

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Abbas Rashid
Executive Director, SAHE

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Abbreviations

B.Ed.	Bachelor of Education
CPD	Continuous Professional Development
CT	Certificate in Teaching
CTSC	Cluster Training and Support Centre
DSD	Directorate of Staff Development
DTE	District Teacher Educator
HD	High Definition
ECE	Early Childhood Education
IT	Information Technology
KA	Khan Academy
LTE	Lead Teacher Educator
MCQ	Multiple Choice Question
M.Ed.	Master of Education
OEQ	Open Ended Question
PEAS	Punjab Education Assessment System
PEC	Punjab Examination Commission
PST	Primary School Teacher
PTC	Primary Teaching Certificate
SAHE	Society for the Advancement of Education
SLO	Student Learning Outcome

Executive Summary

Teachers in Pakistan suffer a content knowledge deficit that has serious implications for quality of teaching and learning. The state of the content knowledge deficit among teachers in Punjab is evident from the fact that close to 30,000 primary school teachers have been identified by the Directorate of Staff Development (DSD) as needing remedial instruction. This deficit affects the learning achievement of students as is evidenced by student assessment results.

To address the content knowledge deficit, Society for Advancement of Education (SAHE) in partnership with the DSD initiated the pilot project *Technology for Teaching: Using Innovative Media in Punjab's Primary Classrooms*. The initiative made use of the growing trend to use technology in the classroom as an aid for teaching and learning.

Technology in the classroom is not a new phenomenon. Saettler (1990) refers to the 'audio-visual movement' as "ways of delivering information used as alternatives to lectures and books." This goes back to the 1930s. Much more recently, Salman Khan, who heads the well-known Khan Academy, wrote that in developing short teaching videos he hoped to regenerate among students 'the excitement of learning'. Yet, among the problems faced by teachers in introducing technology in the classroom the most cited are inadequate infrastructure, lack of training and personal expertise and weak technical support (Kazu, 2011). These and other obstacles are to be encountered in Pakistan as well.

Given the challenges to introducing technology in the classroom the project sought to develop a sustainable design. In Punjab, DSD—the apex institution in the province with responsibility for professional development of all public school teachers—has developed a Continuous Professional Development (CPD) framework for a continuous engagement with teachers. DSD's interest in the use of innovative media in its CPD program presented the project with a unique opportunity to ensure the delivery of these videos to a large number of primary school teachers and students. The well-known Khan Academy (KA) has developed thousands of freely accessible high quality videos designed for self-learning, which the project sought to make use of as an aid in addressing the content deficit. Finally, the availability of portable pocket size projectors that run on battery power along with regular multi-media projectors, provided an opportunity for introducing videos in the classroom.

A working group from SAHE and DSD comprising subject experts was formed to review all key aspects of the project. The project approach was as follows:

1. *Technology selection*: The most viable option based on price, availability, quality output and public school context was chosen: a combination of portable and regular sized projectors.

2. *Video selection and adaptation:* The area of geometry in mathematics was chosen and 20 videos from Khan Academy and other sources based on alignment with National Curriculum, textbooks and DSD teacher guides were identified. Videos were then adapted to local context and translated into Urdu with efforts made to ensure integrity of the material.

3. *Video dissemination and teacher support*: The project identified 12 elementary and high schools in 3 districts (Chakwal, Lahore, Vehari) for the treatment group on the basis of weak content knowledge of teachers, student assessment scores, location, and student enrollment. A group of 12 schools with similar characteristic were selected for the control group. Through the CPD framework teachers were trained on the use of instructional videos in the classroom and support provided at regular intervals along with an instructional manual.

4. *Research on Innovative Media*: A student assessment survey comparing performance of treatment and control group students and teacher and student satisfaction survey was conducted to document experiences of the pilot.

The assessment analysis provides us with these results: where instructional videos were used there is better performance particularly amongst medium and low performing students (treatment group mean score is 52% as opposed to 44% for the control group). This is to be expected since weaker students are more likely to benefit from additional support. The improved performance appears to be most pronounced amongst low performing boys followed by medium performing girls with gains being 28% and 17%, respectively. We find trends of movement towards higher performance in the treatment group particularly amongst low and medium performers.

The experience of taking technology to the classroom indicates that the regular multimedia projector was found to be the best option in a public sector classroom context, even though these are just about suitable for class strength of 40. Providing continuous support to teachers enables teachers to gain familiarity with technology and encourages greater enthusiasm in use, thus proving to be a critical component of the initiative.

By means of a satisfaction survey we found mostly positive perspectives from students and teachers with regards to the innovation. Nearly 64% students and most teachers considered the videos highly effective as a learning tool. Many students (71%) and most teachers agreed that the videos provided a means for repeating concepts covered in class, leading to improved comprehension.

With regards to video type, the views of teachers and students were somewhat divergent. Khan Academy videos generally covered multiple topics and drew simple lines on blackboard and non-Khan Academy videos covered single topics and used drawings. Teachers found KA type videos are better designed for explaining the concepts, on the other hand the majority of students preferred the videos with drawings and found multiple and single topics equally preferential. This has implications for the kinds of videos that may be suitable for each group.

In terms of carrying this initiative forward, DSD should develop its own video production capacity as well as seek to adapt a wide array of available resources. KA videos are better suited for teachers at the primary level while less complex videos, which deal with only one concept, are more fruitfully employed for students. Given cost considerations, for now at least, it would only be feasible to take the videos to the students at institutions such as high schools or some elementary schools that have computer labs. The DSD should focus on teachers simultaneously by introducing projection equipment at the cluster level, making such an intervention a regular part of teacher professional development.

Introduction

When it comes to the quality of education, the role of the teacher is critical. This is one of the reasons why there is so much emphasis on teacher training programs. But where the base of general education is weak, as is often the case in Pakistan, teachers suffer a content knowledge deficit that has serious implications for the quality of teaching and learning in the context of the school. The state of the content knowledge deficit among teachers in Punjab is evident from the fact that close to 30,000 primary school teachers have been identified by the Directorate of Staff Development (DSD) as needing remedial instruction to remove the gaps in their subject matter knowledge. This deficit affects learning achievement of students as well. According to Punjab Education Assessment System (PEAS), in 2011 only 27% of the students were proficient in mathematics.

To address the content knowledge deficit amongst students as well as teachers, the Society for Advancement of Education (SAHE) in partnership with the DSD initiated the *Technology for Teaching: Using Innovative Media in Punjab's Primary Classrooms* pilot. The initiative made use of the growing trend to use technology in the classroom as an aid for teaching and learning and builds on the availability of innovative instructional videos, low cost technologies in Pakistan as well as the presence of a mechanism of Continuous Professional Development (CPD) enabled by the DSD in Punjab.

Technology as Teaching Tool

The use of technology in the classroom is hardly a new enterprise. Saettler (1990) refers to the 'audio-visual movement' as "ways of delivering information used as alternatives to lectures and books." This goes back to the 1930s when some educationists argued that media, such as slides and films, could be used to deliver information in the classroom more effectively (Robyler and Edwards, 2000). It is only over the last quarter of a century that technology in education has become essentially equated with the computer. Nevertheless, media technology remains an important teaching aid and even more so in the context of less developed countries where we simply cannot assume anything even close to universal access to technology.

So, how does media technology enhance learning in the classroom? At the very least it helps in the essential task of getting the attention of the learner, the visual and interactive resources seem to help focus students' attention and encourage them to spend more time on learning tasks (Robyler and Edwards, 2000).

Much more recently, Salman Khan, who heads the well-known Khan Academy, wrote that in developing short teaching videos he hoped to regenerate among students 'the excitement of learning.' Videos on topics that are relatively more difficult to comprehend can be repeated without unduly taxing the teacher who is then free to spend time more usefully elaborating the particularly complex aspects of the topic (Khan, 2012).

In Pakistan, too, there is now increasing interest in the use of technology for advancing education within and outside the classroom. For instance, the Punjab government has adopted a policy of providing all high and higher secondary schools with computer labs. A number of primary schools now have a 'kids room' equipped with a television and DVD projector. Thousand of laptops have been distributed to students under a government initiative. Government institutions such as DSD have shown an interest in developing an audio-visual wing for accessing and producing videos that can be integrated into teacher training. Elite private schools encourage computer use from an early age. NGOs are experimenting with using mobile phones to advance literacy.

Technology, however, whether by reference to media or computers, is not a magic wand that can ensure learning. It is important to recognize that, to be useful, it needs to be integrated within the broader curriculum. For this, “we need more teachers who understand the role technology plays in society and education, who are prepared to take advantage of its power, and who recognize its limitations. In an increasingly technological society, we need more teachers who are both 'technology savvy' and 'child-centered” (Robyler and Edwards, 2000, p.12).

Sustainable use of technology in any case poses special problems in the context of the developing world. Among the problems faced by teachers in introducing technology in the classroom the most cited are inadequate infrastructure, lack of training and personal expertise and weak technical support (Kazu, 2011). These and other obstacles are to be encountered in Pakistan as well. This is even more so in the public sector schools that cater to the less well-off but majority of Pakistan's children. The schools for the most part lack adequate facilities including the assured and continuous supply of electricity and even the better teachers in these schools frequently lack the training and the expertise to properly integrate any audio-visual material into the curriculum in order to enhance learning.

Still, a beginning has to be made and DSD has taken the bold step of facilitating this pilot initiative. This report discusses the nature of this initiative, the modifications required for using technology in the classroom in the local context, the collaborative role of the DSD and its ownership of the enterprise, the responses of the students as well as the teachers to this enterprise and our recommendations keeping in view the findings of the study by way of the intervention's potential and limitations.

Taking Technology to the Classroom

The piolt initiative *Technology for Teaching: Using Innovative Media in Punjab's Primary Classrooms* sought to improve the quality of teaching and learning in the subject of mathematics in selected primary schools of Punjab through the innovative use of instructional videos and introducing these videos in the DSD Continuous Professional Development (CPD) program by using relatively low cost, easily transportable projection technologies. This section describes how the innovation was designed as well as the implementation process, the constraints faced and learning at each stage. All these have implications for expansion and further work on this initiative.

Designing the Innovation

Contextual Elements

Given the challenges to introducing technology in the classroom, the project sought to develop a sustainable design, by making use of key elements in the context to do so.

A mechanism for regularly reaching teachers in Punjab: DSD—the apex institution in the province with responsibility for the professional development of all public school teachers—has developed a CPD framework for continuous engagement with Primary School Teachers (PSTs) in Punjab. Under CPD, a cluster of 15-20 primary schools are associated with a centrally located Cluster Training and Support Centre (CTSC) where a District Teacher Educator (DTE) provides teachers with professional development in pedagogy and content areas, support materials, and on-site mentoring and instructional coaching. Currently, DSD has developed an extensive network of over 3000 DTEs and 90 Lead Teacher Educators (LTE) to support the DTEs as well. DSD's interest in the use of innovative media in its CPD program presented the project with a unique opportunity to ensure the delivery of these videos to a large number of primary school teachers and students.

High quality instructional videos: The well-known Khan Academy (KA) has developed thousands of freely accessible high quality videos designed for self-learning. The video content is delivered in 10-20 minute 'digestible chunks' displayed on an electronic blackboard, using a conversational style as opposed to conventional instructional approach. International recognition of the utility of the videos has included endorsement of the Khan Academy's work by Gates Foundation (Tan, 2013). Several experts such as the New School's Venture Fund Ted Mitchell think that it would be important to measure KA's videos impact by looking at changes in the distribution of test scores, observing that these videos would be a success if low-performing kids move ahead and "shift the bell curve to the right," (Kronholz, 2012). The project sought to make use of these tried and tested videos as a valuable aid in addressing the content deficit in teachers and students.

Low-cost portable technology: The availability of portable pocket size projectors which run on battery power, along with the more familiar multi-media projectors, in the local market provided an opportunity for introducing instructional videos in the classroom.

Approach

The project adopted the following approach to implementing the project:

- Technology selection: Exploring the projector options available in the market and choosing the most viable option based on price, availability, projector quality output and public school context.
- Video selection and adaption: Choosing one topic in Grade 5 math and covering it in its entirety; aligning the videos with the primary level Student Learning Outcomes (SLOs) identified in the National Curriculum, incorporated in textbooks and the newly introduced DSD teacher guides; and adapting the content to preserve the integrity of subject matter while making it accessible to children in a particular setting.
- Video dissemination and teacher support: Collaborative planning with the DSD to disseminate the videos to a selected number of primary school teachers in three districts through CPD framework; developing an instructional manual to assist teachers in delivering lessons with the help of innovative media; and training DTEs who then in turn trained the selected teachers on the use of instructional videos in the classroom.
- Research on Innovative Media: Diligently documenting and assessing the implementation of all aspects of the initiative through a student assessment and student and teacher satisfaction survey.

Intended Impact

The innovative pilot project sought to increase the learning achievements of students in math subject of Grade 5 in classrooms where instructional videos were used. It also sought to develop a set of high quality and free instructional videos in the selected content area of math and instructional manuals linking these instructional videos with Punjab Textbook Board Grade 5 exercises, lesson plans and the academic calendar developed by DSD. The beneficiaries of the program include: (1) 8 DSD Trainers who received training on how to make use of instructional videos in training teachers; (2) 12 Primary school teachers (PST) in selected schools who received training on delivering lessons with the help of innovative media; (3) 447 Primary school students who learned geometry with the help of instructional videos.

Technology Selection

Process

SAHE in consultation with technology experts evaluated the projectors available in the market, cell phone projectors, portable projectors and regular projectors. The former two were initially preferred due to their reliance on batteries, rather than an unreliable power supply. Apart from the main considerations of price and availability and the projector's display quality and output, the following aspects related to the public school context were taken into consideration during the review: classroom environment such as light, space and average class size, power outages and ease of use by teachers. Based on these criteria the cell phone projector was deemed inappropriate for the nature of the initiative and the following types of projectors were chosen: (1) Portable projectors with SD cards and battery-operated speakers; and (2) Regular multimedia projectors using electricity input and DVD players.

Constraints & Learning

From the pilot experience it appears that regular projectors seem to be the more suitable option with portable projector having greater constraints and cell phone projection not being a realistic option at all. Further details have been provided below.

Projector availability and limitations: Portable projectors, particularly the latest versions, were not readily available in the local market as compared to the regular multimedia projectors. Given that the portable projectors accessed the video content through SD cards, there was a limit on the types of video formats it could play in this manner. As a result it was not possible to use high resolution video formats (such as avi or mp4) and a lower quality video format (xvid) had to be used with this option. This was not an issue with the regular projector, which accessed the videos from the DVD through the DVD player.

Classroom environment: Portable projectors are not conducive to large class size where the number of students exceeds 20 as the display output is limited. Poor visibility from a certain distance, spacious and luminous classrooms were problematic in cases of large class size. Even regular multimedia projectors are only suitable for a class size not exceeding 40 students.

Ease of use: Initially many of the primary school teachers were less amenable towards using either kind of projector due to lack of familiarity with such technology. With time this situation improved. More importantly the issue of setting up the equipment had implications for time management. In many instances it consumed over 10 minutes of potential teaching time to properly setup the projector and in large classes to move the students to create needed space. Installation time also varied by gadget; portable projectors took less time to install than regular projectors.

Equipment security: Loss of equipment and theft is a common problem in schools due to absence of safekeeping cabinets. In schools where head teachers were keen to introduce the innovation and ensure security of the equipment, the project faced fewer difficulties in implementation.

Availability of electricity: Portable projectors were partly helpful in the case of power outage, but at the expense of display and output quality as compared to regular multimedia projectors. In any case, even portable projectors required electricity supply at some point for charging purposes.

Video Selection & Adaptation

Process

The process consisted of several stages all of which were reviewed by a working group of experts from the DSD and SAHE. The first stage entailed choosing a mathematics topic, one that students appeared to require assistance in. Topic selection was also based on the availability of KA videos relevant to curricular SLOs and the project timeframe i.e. the topic would have to be covered towards the end of the year. The topic eventually chosen was geometry. The next step was to match the videos to the national curriculum SLOs of Grade 5 for geometry. In this regard 20 KA videos and 5 videos from other sources were selected.

The second stage entailed the adaptation of video content to the local context as well as translation from English to Urdu and voice over. Difficult words were written in Urdu next to English words. Such an exercise was aimed at creating customized version of videos for the pilot project. All videos were then reviewed by the working group for purposes of quality and alignment with the textbook, DSD teacher guide and SLOs.

Constraints & Learning

The process of developing videos and using them in the class revealed issues with the instructional videos available that will need to be considered for scale-up. For example, the two different video sources have different limitations. A detailed list of the limitations experienced is as follows:

Limited content for primary level: Khan Academy has a greater focus on the higher grades and a limited number of videos on the subject matter for Grade 5 mathematics. As a result the available videos could not always be easily integrated with the DSD teacher guides and textbook and required extra resources.

Instructional style: Even for those videos that deal with primary level content, a majority of KA videos focus on more than one concept at a time and adopt a style that is often difficult for Grade 5 students to grasp. In contrast it appeared that most students preferred videos accessed from non-KA sources, which focused on a single concept.

Vocabulary: Easy to understand language for students of Grade 5 was a prerequisite in the process. Despite taking care of specific mathematical terms in translation, comprehension on the part of students proved to be an obstacle. Further testing out of terminology in this area is required.

Matching content: The content used in the adapted videos in some cases did not match the actual level at Grade 5. This is because there is still a disconnect between the DSD Teacher Guides which are based on the 2006 curriculum SLOs and textbooks which in the case of math are still based on the older version of the curriculum.

Video Dissemination & Teacher Support

Process

SAHE and DSD collaboratively planned video dissemination in 12 schools in 3 districts; selection was done as follows:

- District selection: Three districts were selected for project implementation to ensure geographical representation within Punjab: Chakwal (north), Lahore (central), Vehari (south).

- Cluster selection: In each district, a cluster-level approach was adopted in which the project linked the innovation to the CPD model. Selection criteria for the cluster depended on ensuring that clusters: (a) were in geographically similar areas (rural in Chakwal/Vehari and urban in Lahore); (b) have an average student performance (based on DSD assessment for May 2012).

- School selection: The following criteria were taken into account: (a) School level at least elementary or high to ensure adequate facilities and adequate security for the projection technology; (b) Gender; and (c) Minimum enrolment of at least 20 students.

In order to support teachers in incorporating instructional videos into their lessons, the project through its working group developed an instructional manual. In this the instructional videos were integrated with the DSD teaching guide, indicating to teachers what videos to use in which lesson or activity. The guide also provided information on how to setup and use the projectors.

Teachers were then trained, making use of the structure underlying the CPD model. First the DSD LTEs trained its DTEs and then the DTEs trained the PSTs in their respective clusters on the use of videos and projectors in the classroom. Finally support was also provided in the classroom. In each district, the project engaged Monitoring Managers to extend support to teachers and monitor them by scheduling weekly visits. This was in addition to regular visits of DTEs under the CPD framework, which also focused on the innovation.

Constraints & Learning

The project's focus on students and the short timeframe, meant that sufficient attention could not be accorded to the teachers, even though teachers did serve as a critical component of the initiative.

Familiarity with technology: During district and cluster level trainings, it appeared that female teachers were hesitant in presenting their model lessons using the technology due to lack of familiarity with it.

Attitude toward innovation: Initially there was resistance from some of the schools in taking ownership of the equipment, using the instructional videos and committing to taking the innovative media to level of classroom. Initially a majority of teachers took this intervention as an additional burden to their normal routine work. Fortunately, the CPD framework made them accountable to DSD so they made an effort and after trying the innovation their attitudes changed. Also there were fewer difficulties at school sites where the teachers had support from head teachers.

Continuous support: Consistent support through engaging monitoring managers and DTEs proved to be a key element in making the intervention a successful enterprise. Due to positive role of DTEs, the momentum was attained through motivation and encouragement of PSTs. With added effort, teachers attained familiarity with gadgets and instructional videos, which later induced interest of teachers and students in the geometry topic. So, eventually, working with the teachers paid off.

Understanding Performance & Perceptions

The research component sought to understand how the innovation project had influenced teaching-learning quality by documenting the experience and possible impact of the innovative media on primary school student learning in the area of geometry. For this purpose a treatment-control group comparison was setup and student assessments in geometry were conducted at the beginning and the end of the project. In addition to this, to understand the experience from the perspective of students and teachers, a small-scale satisfaction survey was conducted.

Research Methodology

A first step in designing the research was to establish comparability between treatment and control group students, it was important to match the characteristics of the two groups as much as possible. One level of matching was done at the level of the school (during school selection). Control group schools were selected in geographically similar locations to those in the treatment group. The second level of matching was done at the level of the student. For this students were sorted into performance groups (high, medium, low) based on baseline assessment performance for comparison with students of the same performance level group at a later stage.

Prior to the project implementation the project conducted a baseline assessment on Grade 4 geometry learning outcomes in order to establish a means for comparability between the two groups. The data from the baseline was used to sort students into performance groups. The project then conducted an endline assessment, right after project implementation, to determine student's competence in Grade 5 geometry skills. The satisfaction survey was carried out immediately after the completion of implementation and endline assessments.

Tools

The baseline and endline assessment tools were designed in accordance with subject based SLOs, textbooks and DSD teacher guides as well as the adapted videos for the respective grades. Both consisted of 16 multiple choice questions (MCQ) and 4 open-ended questions (OEQs) covering the main topics in geometry, i.e. angles, triangles, quadrilaterals and perimeter. The items once developed by SAHE were reviewed and translated by a working group of subject specialists in the DSD and piloted in 3 schools in Lahore. The pilot provided an opportunity to ensure the content validity of the test items. The results of the pilot analysis were used to finalize the items in the tool.

In addition to the assessment tool, a background tool for the school was developed. This sought to collect basic information with regards to the school, the Grade 5 class and teacher.

The satisfaction survey tool was designed to understand the actual process followed in using videos in the classroom as well as perceptions regarding video use, usefulness of videos as a teaching tool, quality of videos used and video preferences. The tools consisted of primarily closed-ended questions, rating the degree of agreement to a particular statement or ranking questions, and a few open-ended questions.

Sample

The sample for the assessment and satisfaction survey was based on the overall project sample. In each of the three selected districts, one cluster for treatment schools was selected and one or two clusters were selected for control group schools. Cluster selection depended on ensuring that clusters were in geographically similar areas (rural in Chakwal/Vehari and urban in Lahore) and had an average student performance. Finally school selection took into account school level, gender, and a minimum enrolment of 20 students. In each district 4 treatment and 4 control group schools were selected for a total of 12 treatment schools and 12 control group schools.

In these schools a total number of 783 students were assessed of which 327 were male and 456 female (there were approximately equal amounts of students in treatment and control schools).For the satisfaction survey, all teachers in the treatment schools (a total of 12 teachers) and a randomly selected group of 10 students per school (for a total of 120 students) were surveyed.

Teacher profile: The vast majority of teachers in the selected schools are class teachers; very few are specifically math teachers. About 10 of the teachers have 5 years or less of teaching experience; the remaining 12 have many more years of experience. There is a mixture of academic qualifications: 9 have matriculation/intermediate

Table 1: Teacher Academic Qualifications

Qualification	Treatment	Control	Total
Matriculation	3	2	5
Intermediate	2	2	4
B.A.	3	1	4
B.Sc.	1	2	3
M.A.	3	3	6
M.Sc.	0	2	2

Table 2: Teacher Professional Qualifications

Qualification	Treatment	Control	Total
None	0	2	2
CT	1	0	1
PTC	6	4	10
B.Ed.	5	5	10
M.Ed.	0	1	1

qualifications and 15 have bachelors and masters' level degrees (refer to Table 1). Finally about half of the teachers have B. Ed. and above and the rest have PTC/CT in their professional qualifications (refer to Table 2). Only 3 teachers actually have special qualifications in Math.

Students profile: The school profile shows that the grade five classes in the selected schools ranged from an enrolment of 20 to 60 students. The average age of the students in Grade 5 was approximately 11 years.

Basic data on student socio-economic status was collected through use of proxy indicators on the availability of certain items in their household. As can be seen in Table 3, over 90% of students have fans and a phone in their homes, 76% have a television, and close to 60% have a motorcycle and fridge and bicycle. Less than 30% have a computer, car, AC and tractor. The variations across districts can be seen with households in Lahore having a higher percentage of most items as compared to households in Vehari and Chakwal which have a lower percentage of several items.

Table 3: Items in Student Household

Item	Total	Lahore	Chakwal	Vehari
Fan	96%	38%	36%	26%
Bicycle	58%	37%	25%	38%
Refrigerator	67%	48%	35%	17%
Mobile	94%	38%	35%	27%
Television	76%	44%	31%	25%
Computer	29%	57%	34%	9%
Air Conditioner	15%	61%	28%	11%
Motorcycle	64%	41%	33%	26%
Car	17%	43%	48%	9%
Tractor	13%	18%	57%	24%

Data Collection

For both the assessment and satisfaction survey the researchers were first trained on using the tools. The assessment team consisted of two persons to distribute and collect materials as well as invigilate the assessment. The satisfaction survey tool was filled by a field researcher experienced in collecting qualitative information and a coordinator who provided guidance and monitored the process. In both cases monitors visited the research teams to conduct spot checks on quality of data collection.

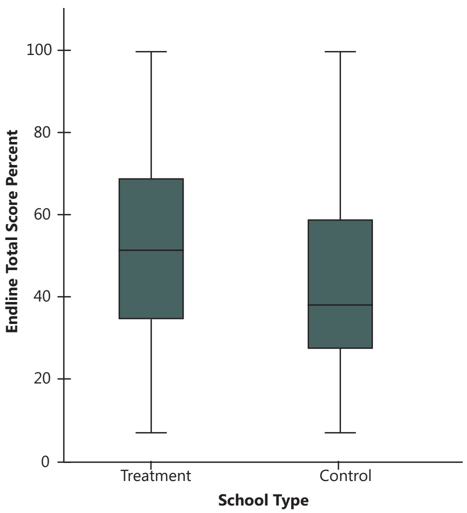
Student Performance

This section provides a comparative analysis of student performance in treatment and control groups on Grade 5 related geometry concepts to understand the impact of instructional videos on student performance.

Overall Performance

The overall mean score for the endline assessment is 48% with a standard deviation of 21.5. The standard deviation indicates that student scores are fairly dispersed from the average, which is to be expected given the varying abilities of students and the diversity in regions in which the assessment was carried out. Looking at the treatment and control groups we find a higher mean of 52% (SD 20.9) for the former than the latter with 44% mean score (SD 21.4). Figure 1 shows the distribution of scores for each group with the boxes representing the scores for 25-75% of the students. This shows that the bulk of student scores in the treatment group are on the higher end as compared to the control group. It appears that use of instructional videos in the classrooms are likely to have contributed to the higher scores in the treatment group.

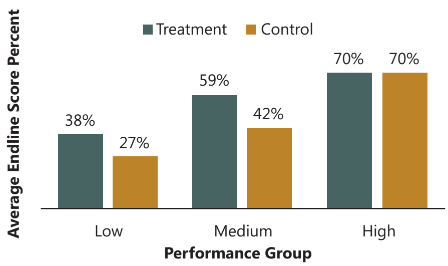
Figure 1: Endline Scores by Treatment and Control Group



Comparison by Performance Groups

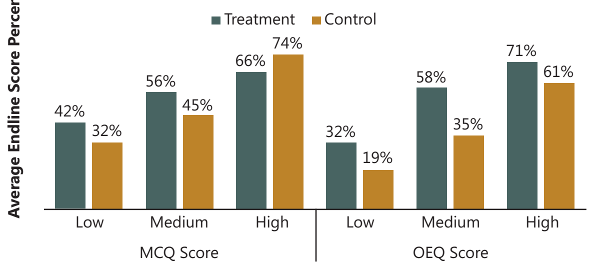
We find there is greater difference between treatment and control groups in the medium performance group with a 17% difference in mean scores (refer to Figure 2). This is followed by the low performing group with an 11% difference in mean scores. There is almost no difference between high performing students in the treatment and control groups with mean score of about 70% in both. This is to be expected since weaker students are more likely to benefit from additional support and it appears from this data that they have.

Figure 2: Treatment vs. Control Endline Scores by Performance Group



We explored endline scores further by looking at performance by question types, multiple choice questions (MCQ) and open-ended questions (OEQ) (refer to Figure 3).

Figure 3: Treatment vs. Control Endline Scores by Question Type & Performance Group

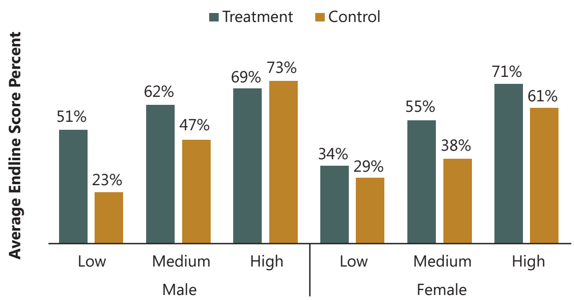


As with the overall scores, on MCQs there is better performance amongst medium and low performers, approximately 10% difference in both groups. The trend is the same with OEQs, but more pronounced with all three groups performing better and medium performers having 23% better scores. This could be due to the fact that open-ended questions dealt with construction of triangles and angles, which is a topic that is not often taught well in classrooms. Also it appears, from the satisfaction survey, that the videos for this topic (from non-Khan Academy sources) were particularly appreciated by students and therefore likely to have been well understood by them.

Comparison by Performance Groups and Gender

Exploring the assessment results in terms of gender (refer to Figure 4) we find that treatment group girls consistently perform better than control group girls across the performance groups, with the most difference found in the medium performance group (17% difference in mean scores between the groups). Treatment group boys also perform better than control group boys: medium performance group (15% difference in mean scores) and low performance group (28% difference in mean scores). From this it appears then that low performing boys have benefited the most from the use of instructional videos in the classroom.

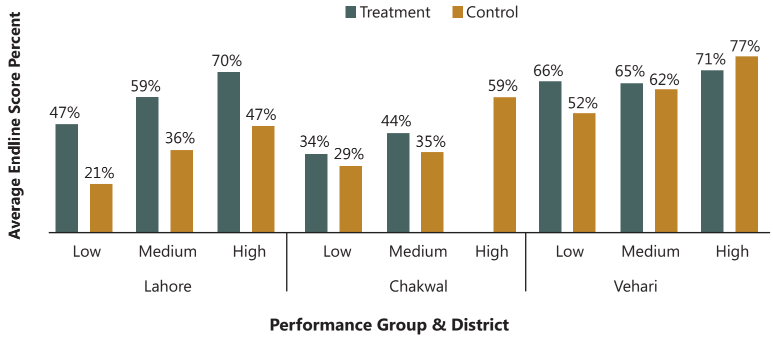
Figure 4: Treatment vs. Control Group Endline Scores by Performance Group & Gender



Comparison by Performance Groups and District

Looking at the assessment results in terms of districts (refer to Figure 5), we find that the greatest difference between treatment and control group is in Lahore, with an approximately 24% difference in mean scores across the performance groups. It is possible this is due to the slightly greater number of monitoring visits by both the project team and DSD in Lahore and also what is likely to be better quality of DTEs and teachers in this district.

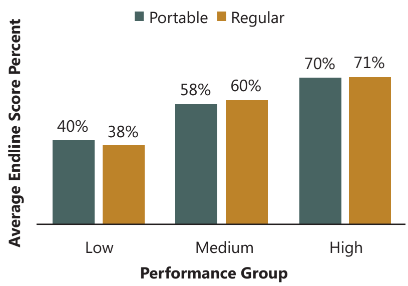
Figure 5: Treatment vs. Control Group Endline Scores by Performance Group & District



In Vehari we find treatment-control group difference is greatest amongst low performers, there is a 14% difference in mean scores. We find nominal differences in performance amongst medium and high performers in this district. Finally in Chakwal, differences in treatment-control group are very small with 8% and 5% difference amongst medium and low performers respectively.

Comparison by Performance Groups and Projection Type

Figure 6: Endline Scores by Projector Type



The influence of the two different types of projectors in the classroom has been explored as well. The two technologies include a 'portable projector' which runs on batteries (i.e. no electricity needed) and relatively smaller output in terms of image size and a 'regular projector' which needed electricity but had a relatively larger output in terms of image size. There does not appear to be any discernible difference in student performance mean scores of the two groups using different types of technology (refer to Figure 6).

Movement between Performance Groups

Using student performance in the baseline as the starting point, we explored movement between performance groups in the endline. We calculated the percentage of students who moved performance groups in the endline, comparing treatment and control groups.

For those students who were low performers in the baseline, we found that more than 50% of students in the treatment group rose to medium and high performance group in the endline as opposed to fewer students, 24% in the control group (refer to Figure

7). Conversely fewer students in the treatment group, 48%, remained as low performers as compared to 76% of the control group students.

For those students who were medium performers in the baseline (refer to Figure 8), in the treatment group 37% rose to high performance versus 8% in the control group. And conversely 32% of control group students dropped to low performance as opposed to 10% of treatment group.

Finally amongst those students who were high performers in the baseline (refer to Figure 9), about 60% of students in both treatment and control group stayed high performers. The remaining students for the most part fell into the medium performance group. Again trends are similar for both groups.

Overall then the assessment analysis provides us with positive results, that namely where instructional videos were used (treatment group) there is better performance particularly amongst medium and low performing students. The improved performance appears to be most pronounced amongst low performing boys followed by medium performing girls with gains being 28% and 17%, respectively. In terms of location it appears the performance improvement is most pronounced in Lahore with an approximately 24% difference in mean scores across the performance groups. We find trends of movement towards higher performance in the treatment group particularly amongst low and medium performers. This reflects the trends in the comparative analysis as well. The next section will shed more light on students and teacher experience by exploring the results of the satisfaction survey.

Figure 7: Performance Change for Low Performers

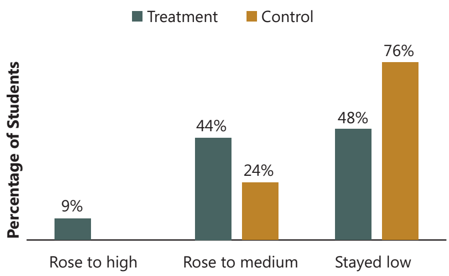


Figure 8: Performance Change for Medium Performers

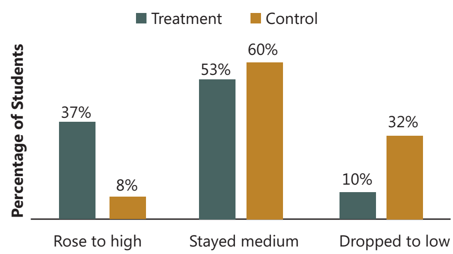
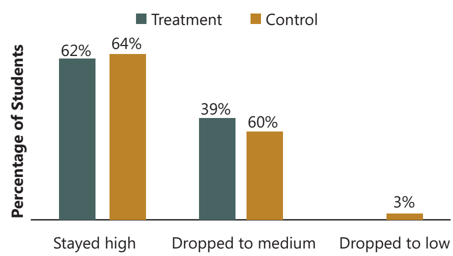


Figure 9: Performance Change for High Performers



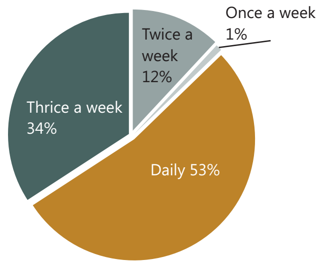
Teacher & Student Satisfaction

As mentioned earlier the purpose of this survey was to understand the experience from the perspective of teachers and students, namely what they thought of the use of videos as a teaching tool and the quality and content of the videos used. This section provides the results of this survey.

Delivery of Instructional Videos[1]

Video use and frequency

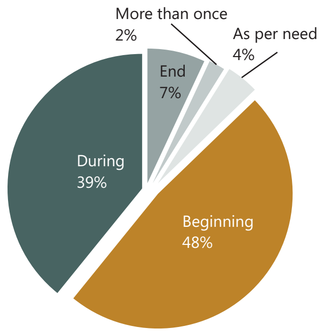
Figure 10: Frequency of Video Use



The survey first sought to verify whether projectors had been provided and if students had viewed the instructional videos on geometry. Responses were positive across the board (refer to Figure 10). In terms of frequency of video use, 53% students and more than half of the teachers report daily use and the remaining report use between twice to thrice a week. The latter scheme of use was more popular amongst teachers in Lahore and Vehari. With regards to recalling the last topic covered using instructional videos, the majority of teachers and students were able to recall the most recent video, indicating that they had viewed them.

When and how video are used

Figure 11: When Videos were used in Lecture



To support teachers in making use of the videos during teaching, the instructional manual provided directions on when and how to incorporate the videos into the lessons. These questions were used to understand to what extent teachers followed these guidelines (refer to Figure 11). About 50% of teachers played instructional videos at the start of the lecture, highlighting a heavy reliance on the instructional videos. Close to 40% of teachers played instructional videos during the lecture, which was the suggested method in the instructional manual. Only a few teachers i.e. 7% played instructional videos after delivering the lecture. Adherence to the instructional manual was highest in the district of Chakwal, followed by Lahore and Vehari. In district Vehari teachers have heavily relied on the instructional videos with 75% of teachers preferring to use videos at the start.

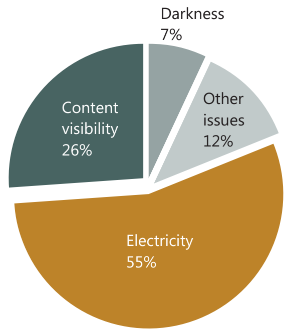
Issues encountered viewing videos

Students and teachers were asked about the issues faced while viewing videos (refer to Figure 12). Frequent power outages appears to be a major issue for more than half the teachers and students, even in case of portable projectors—which can run on battery. This is despite the fact that the intervention was held during winter when power outages tend to be low. A district-wise analysis shows that power outage has been the most disruptive in Vehari, followed by Chakwal and then Lahore.

[1] Data in this section refers to students responses unless otherwise noted.

This was followed by issues related to content visibility, about 26% of students mentioned bright classrooms as a reason where it is often difficult to shut out the light, or they pointed to the quality of the projection itself. Poor visibility seems to have affected students in Lahore more as compared to those in Chakwal, where as none pointed out this issue in Vehari. Other issues mentioned related to lack of familiarity in using technology or setting up the projectors.

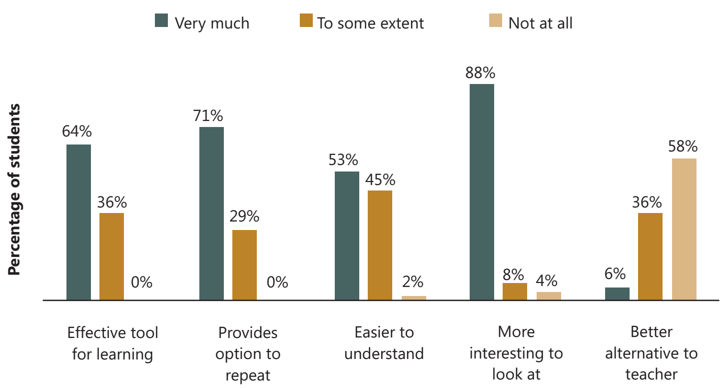
Figure 12: Issues Encountered Viewing Videos



Video as a Teaching Tool

The survey sought to understand teacher and student perspectives on the usefulness of instructional videos as a teaching tool in general (refer to Figure 13). A large portion of students (64%) and most teachers ranked the videos as highly effective as a learning tool and the remaining students and teachers marked it as somewhat effective.

Figure 13 : Effectiveness of Videos as Teaching Tool



How the videos helped improve understanding was further explored as well. For example the vast majority of students (88%) found them interesting to look at. Many students (71%) and most teachers agreed that the videos provided a means for repeating concepts covered in class, leading to improved comprehension. And about half of students strongly agreed that the different manner of explanation provided in the videos made it easier to understand the concepts and another 45% agreed that this was the case to some extent. Finally, with regards to whether the videos were a better alternative to teachers, the responses are quite clear that most students (close to 60%) did not agree with this statement, indicating that teachers guidance and support is still very much needed.

In a later discussion the majority of teachers and students found that videos were helpful in generating student-teacher discussion on geometry topics, something often missing in public school classrooms.

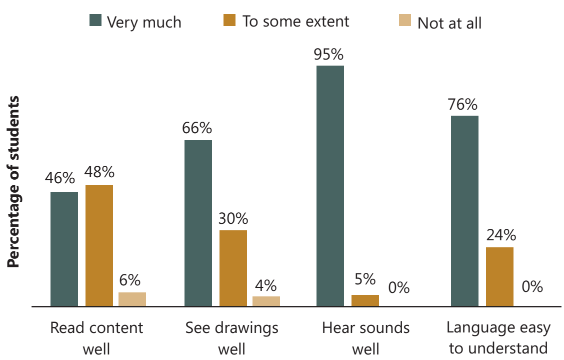
Effectiveness of Geometry Videos

The survey explored the perceived effectiveness of the specific geometry videos used in the pilot.

Quality of Videos

First the quality of videos was explored (refer to Figure 14). It appears that the vast majority of students and teachers did not experience difficulty in hearing the sound in the videos. Similarly the majority (76% of students) reported that the language used was easy enough to understand (this includes translation from English to Urdu). However, when it comes to visibility, fewer students (66%) and about half of teachers agreed they could see the drawings well. And even fewer students (46%) and teachers completely agreed that they could read the content well. These differences could be explained by the lower quality of output in the portable projectors. Across the districts it appears that students in Chakwal had more difficulty in reading content (65% responded to some extent) and seeing drawings (40% responded to some extent).

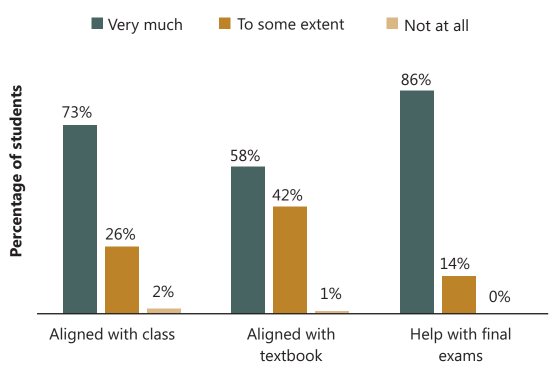
Figure 14: Video Visibility, Sound and Language Quality



Alignment with textbooks, lesson guides & exams

In terms of alignment of instructional videos with topics covered in Grade 5 mathematics class, three-quarters of students and most of teachers have noted that there is great deal of alignment (refer to Figure 15). In terms of alignment of instructional videos with topics covered in the textbook of Grade 5 mathematics chapter on geometry, only 58% of students

Figure 15: Video Alignment and Usefulness



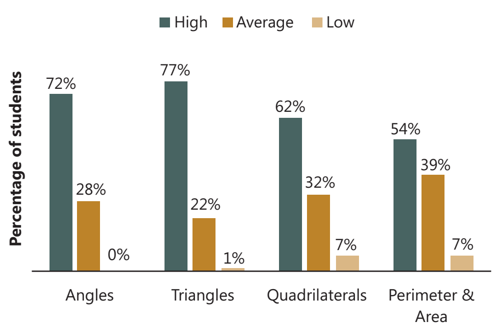
felt there was strong alignment. This could be due to the fact that the textbooks have yet to be updated to match the SLO based curriculum upon which the videos have been developed.

A large majority of students, 86%, and most of teachers have expressed that instructional videos have helped students with the final PEC exams. Previously, geometry topics were often skipped, owing to poor content knowledge of teachers and paucity of time. However, the instructional videos provided in this project appear to have helped teachers in preparing students on this topic for the large-scale provincial PEC exams. In effect, a large number of students were encouraged to attempt questions on geometry that were often considered difficult in the past.

Video Types

Two types of instructional videos, the popular Khan Academy videos and those from other sources, were used in the innovation project. The KA videos consist of an electronic blackboard where the narrator explains the concept and writes and/or draws on the blackboard to support the explanation (similar to the way most teachers make use of the blackboard in the classroom). These videos often include working out problems and explaining related concepts. In contrast the non-KA videos, mostly on triangle construction, consist of videos in which an individual actually draws the shape on paper while explaining the procedure. These typically focus on one concept, and are in some ways simpler to look at.

Figure 16: Video Quality Ratings by Topic



The survey sought to understand which videos by topic and type were preferred most (refer to Figure 16). With regards to topics, student[2] and teacher responses varied. It appears that videos on angles and triangles were viewed as having a higher quality for both students (70% and above rated high) and the majority of teachers. Given that most of the triangle videos were from non-KA sources, it appears that this type of video was preferred too. With regards to quadrilateral and perimeter and area, the responses were less favorable, a greater percentage of students (more than 40%) rated them as average or low quality. Of these it seems that more students in Lahore and Vehari rated the quality of videos for the latter two topics as lower, whereas teachers had a more favorable view, with more teachers rating them as high in quality.

With regards to video type, separate questions gauged preferred style of instructional videos for example whether respondents preferred videos that used drawings made by

[2]About 25% of students did not respond to this question, therefore the numbers calculated are from a smaller group of students.

geometrical instruments rather than simply writing/drawing on an electronic blackboard and whether they preferred videos that covered single or multiple topics. Taken together these give us a sense of their preferences with regards to Khan Academy videos (generally multiple topics and use simple lines on blackboard) and non-Khan Academy videos (single topics and use drawings). The teachers' response was that KA type videos are better designed to explain the concepts than the other type and more than half the teachers preferred the multiple topic style, which was predominant in the KA videos, rather than the single topic style videos. On the other hand, the vast majority of students (83%) noted that they preferred the videos with drawings, i.e. non-KA videos and were almost equal in preference for multiple and single topic videos. It appears then that the video preferences of teachers and students were somewhat divergent with regards to video type and style, which has implications for the kinds of videos that may be suitable for each group.

Future Interventions

Expressing interest in instructional videos, a significant number of students (95%) and teachers have termed this initiative useful to enhance conceptual understanding in the subject matter of geometry and suggested it as an ongoing process. A large number of students suggested introducing instructional videos in other important topics of Grade 5 mathematics such as unitary methods and common fractions and teachers suggested average and natural numbers as well. With regards to extending the scope of the project to other subjects, students and teachers agreed that it was needed and suggested the development of instructional videos in Science, Social Studies, English and Urdu language.

Teachers further suggested that a designated place, for the use of educational technology, such as computer/IT labs recently established in high schools or the ECE room in case of primary schools would be useful. In the absence of these facilities at the school level, sufficient budget for educational technology should be sanctioned to the head of the institutions for purchasing the needed equipment may fill this gap. Also, it was suggested that the DSD should be more pro-active in the role of a manager and change agent in jointly establishing a technology in education policy plan.

Reflections from the Field

Case Study One

Samina works as a primary school teacher at a school in Lahore. She has completed Bachelors in Education and Masters in Political Science and has seven years teaching experience. Her fifth grade class consists of 34 girls and 19 boys.

The concept of using videos as a teaching tool was entirely new for Samina. She had never even heard about the Khan Academy. Initially, even after the introductory training provided to all teachers, she was hesitant to introduce the technology in the classroom for fear of damaging the equipment, particularly due to absence of support from her school. However, with support from the project team after school hours, she acquired the confidence she needed to effectively use this new method of teaching. During our visits to the school, we found students were excited to start their geometry lesson and learn in this new fashion. This experience has taught Samina about the benefits of using technology in the classroom, namely that it helps enhance understanding, initiate discussion as a facilitator and increase student learning. In her own words:

> *"....this initiative and increased level of student's interest, teaching has become a passion... darkening of the classroom is a challenge and resources at the disposal of public sector schools are limited......I can illustrate a concept with explicit examples."*

Samina has also become a role model for other teachers. In her own capacity, she regularly visits the Khan Academy website to upgrade her knowledge. Following her path and looking at the level of interest by students, teachers of other grades have also started accessing this popular resource. She intends to carry forward this initiative by emphasizing the need to include drilling and practice exercises in the instructional videos. Samina is also keen to extend the scope of Khan Academy type videos to other difficult topics of mathematics and science and has even suggested making use of the Virtual University, an easily accessible television resource, as a means for accessing instructional videos.

Case Study Two

Zahid is primary school teacher as well as the mathematics teacher at a school in Vehari. He has completed his M.Ed. and has 24 years of teaching experience. His fifth grade class has 38 boys. Being a high school, the school has an IT lab for Grade 9 and 10 students but not for primary level students.

For Zahid this sort of intervention was not difficult to implement. He was already familiar with educational technology so he faced no problem in introducing the technology in a public school classroom environment, despite the lack essential facilities. Zahid also had the support of the school which greatly facilitated the process.

When he introduced innovative media in his classroom, Zahid's way of teaching attracted his fellow teachers. Being a mathematics teacher, he was teaching other grades as well, so he introduced the videos to Grade 4. Then he purchased relevant videos for Grade 9 and 10 mathematics from the market and played these on the equipment provided, an initiative highly appreciated by the students. Due to Zahid's efforts the school began to get some attention at the community level. As a result, some parents visited the school and showed an interest in enrolling their children.

Private schools located in the vicinity have even started to consider this school as their competitor. So technology in this context has been beneficial on many levels.

Zahid is enthusiastic in wanting to extend the scope of KA type videos for other topics of mathematics and science. To this end, he regularly visits Khan Academy website as well as easily accessible resources in the market.

Reflecting on his experience with innovative media, Zahid stated that:

> *"...... Khan Academy adapted videos have strengthened the geometry topic knowledge base. And the educational technology has paved the way to avail this resource for other grades and subjects as well....I have learnt advanced techniques of teaching which has given me self-confidence and unimaginable popularity.....Now, I know how best use of technology can be made in public school classroom circumstances."*

Conclusion

To recap, the initiative took as its point of departure, the poor content knowledge of teachers and the low level of student performance at the primary level in Punjab. In our view the quality of teaching was a major factor responsible for this situation. So, improving student outcomes meant also improving the quality of teaching. In other words, the teacher was a part of the problem but equally, the teacher could be a part of the solution. Initially, our focus was on the teachers but subsequently after deliberation with stakeholders it was decided that the target of the project would be teachers as well as students.

The Khan Academy videos, which have become well known globally for improving student outcomes, were deemed as a valuable aid not just for students *directly* – that being the idea originally – but also indirectly by helping teachers in pedagogy as well as content knowledge so that their performance in the classroom could improve. This trajectory was crucial in the context of Pakistan as there was absolutely no doubt that mediation by the teachers was essential in order to convey knowledge to the students.

Due to paucity of KA videos dealing with math at the primary level, other simpler videos were used and to good effect. In fact, the latter appeared to have more appeal for the students given that they dealt with one concept at a time and were easier to follow. The teachers on the other hand found the KA videos more helpful in terms of organizing their lessons and presumably addressing their content knowledge deficit though this was not necessarily stated in those terms.

The DSD with its comprehensive outreach among school teachers in Punjab was considered the ideal partner for gaining access to and ensuring teacher ownership of the enterprise. The partnership proved most fruitful with regard to achieving precisely that objective. A joint team of teachers and subject specialists nominated by the DSD on the one hand and SAHE on the other vetted each video for use in our classrooms. The participation of DSD specialists was most valuable in the task of developing an instructional manual for the use of videos in the classroom and in addressing the task of aligning the videos with the SLOs, textbooks and lesson plans.

Initially, the project sought to use low-cost mobile projection technology for the purposes of delivering the videos given the obvious potential of taking the project to scale. However, given the quality of the projection featured even in expensive mobile phones and the quality of the output in evidence in the average public sector classroom this option had to be dropped. Even portable projectors do not quite come up to scratch in the given conditions, leaving only regular sized projectors, with their own set of limitations, as the only viable option for a classroom of about 40, in terms of the requisite picture and sound quality.

One of the advantages of employing video technology in the classroom, mentioned by both students as well as teachers, was the facility of convenient repetition that was afforded in the event that a concept was not immediately clear.

Taking the Initiative Forward

Building on the learning from this pilot initiative and the enthusiasm that it has generated among students and teachers, it is clear that use of technology as a tool in teaching and learning should be taken forward in some manner.

Future interventions should focus more on teachers for two reasons: It would not be possible at this stage to take the technology to all the classrooms for reasons of cost. In Punjab's context, and presumably Pakistan's as well, student proficiency remains such that the teachers role in the classroom remains important and Khan Academy's concept of the 'flipped classroom' – children learning directly from the video at home and the teacher in school helping with any residual difficulty – is not going to become a reality in the average school in Pakistan any time soon.

Instructional videos can be used as a part of the continuous professional development and mentoring provided to teachers. A focus on teachers can be achieved by introducing projection equipment at the cluster level instead of the school, which would be equally beneficial for teachers and cost effective.

Given cost considerations, for now at least, it would only be feasible to take the videos to the students at institutions such as high schools or in some cases elementary schools that have computer labs or primary schools with kids' rooms that have audio-visual equipment already. In most cases primary school students do not have access to such equipment. DSD could arrange with the School Education Department to ensure such access. To begin with such an arrangement could be put into effect for the few weeks of revision.

As the experience of the KA videos illustrates, this intervention has been particularly useful elsewhere at the elementary and high school level. As such, DSD should consider repeating this intervention at a higher-grade level, possibly in other subject areas as well.

A two-tier approach at the primary level in terms of the video complexity seems feasible: KA videos are better suited for teachers at the primary level while less complex videos, which deal with only one concept, are more fruitfully employed for students in local classrooms.

Instructional videos need to be tailored to meet student requirements in terms of language and alignment with textbooks and DSD teacher guides. Therefore, sufficient time must be allocated for each video to pass through a comprehensive review process.

There is a need to convene deliberations to determine teachers concerns about implementing new technologies, keeping in mind the weak teachers' content deficiency areas. The most successful strategies involve teachers in early planning stages and then consistently seek meaningful teacher input and participation. As the experience in this project has also shown, such input from the teachers can be very meaningful and their participation goes a long way in ensuring ownership of the idea, thereby rendering effective implementation much more probable.

In order to ensure that teachers are comfortable in using the technology and have a clear sense of how and when to use it to best effect, DSD may design a professional development course for teachers on using audio/visual technology in the classroom.

Many have suggested that the videos should be employed for other subject areas as well, the DSD should develop its own capacity to produce videos in addition to making use of those already available, sometimes at very little or no cost.

To introduce technological innovation at the classroom level coupled with preparing instructional videos for students by grade is an ambitious and challenging task, which requires structural level reforms in teacher training. For this task, DSD's capacity needs to be strengthened by integrating strategies in curriculum planning with instructional videos, design of formative assessments and analysis of student outcome data. To this end, DSD would require additional technical support from technology experts, assessment specialists and other relevant personnel.

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