SELF-REGULATED LEARNING IN KENYAN CLASSROOMS: A TEST OF A PROCESS E-PORTFOLIO. UNDER REVIEW

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Self-Regulated Learning in Kenyan Classrooms: A Test of a Process e-Portfolio

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Self-Regulated Learning in Kenyan Classrooms: A Test of a Process e-Portfolio

Abstract

This study explores the feasibility of implementing an electronic process portfolio (XXXX) in a Kenyan school context and the impact of the tool on student learning outcomes. Four teachers and their students from two public secondary schools in Mombasa, Kenya participated in this research. The analyses of data of 137 students showed benefits for those who used XXXX to complete their class assignments. Their exam scores and self-regulation skills significantly improved over time when compared to their peers who hardly used the tool. More frequent and comprehensive use of the XXXX features translated into higher exam results. Summaries of students' XXXX work have been included to illustrate the use of electronic portfolios.

Keywords: electronic portfolio; self-regulated learning; secondary education; Sub-Saharan Africa; Kenya; technology uses for education

Introduction to the Problem

Recent international reports on the performance of secondary school students in Western, industrialized countries (e.g., OECD, 2016) have found that a significant number of students in every surveyed country lacked fundamental literacy, numeracy, and scientific reasoning skills. Findings from these reports imply that students may lack the sophisticated strategies for learning how to learn, strategies which may be increasingly important to succeed in the knowledge age. In addition to having substantial personal consequences, such gaps in essential competencies and skills also come at important costs both for society and the economy (Conference Board of Canada, 2016). Meanwhile, contemporary trends in education research indicate that when students become more active and engaged participants in their learning, thereby enhancing the extent to which learning is personalized, it is then that meaningful improvements in educational success will occur (e.g., Authors, 2013).

Countries of the developing world also increasingly express the need for their educational systems to enhance the capacity to develop active, autonomous individuals capable of advancing their national economies in the 21st century. For example, the Kenyan Ministry of Education's Vision 2030 introduced a student-centered, competency-based curriculum designed to foster "independent, confident, co-operative, and inspired learners" (KICD, 2017). Despite the growing interest, locally-designed pedagogical interventions targeting the development of such self-directed individuals are sparse (Stephen et al., 2018). To bridge this gap, we designed an intervention based on the Zimmerman's model of self-regulation (2000) using a digital portfolio tool (e.g., Meyer et al., 2010) that had been adapted to fit the landscape of Kenyan school reform and implemented it in Kenyan secondary classrooms. A brief summary of the research foundations to this study follows.

Self-regulated Learning

Defined as "self-generated thoughts, feelings and actions that are planned and cyclically adapted to the attainment of personal goals" (Zimmerman 2000, p.14), self-regulated learning (SRL) addresses both meta-cognitive and motivational aspects of learning that unfold through the cyclical phases of forethought, performance, and self-reflection. In the three phases, students activate and sustain cognitions, behaviours, and affects that systematically orient them toward the attainment of learning goals (Zimmerman & Schunk, 2011). In the forethought phase, goal setting and strategic planning is affected by learners' self-motivation beliefs in the form of self-efficacy, outcome expectations, intrinsic interest or value, and goal orientation. In the performance phase, learners participate in the processes of self-instruction, attention focusing, self-recording and self-experimentation and use task strategies, to yield vital information about how well they are progressing towards a goal. Finally, at the self-reflection phase, the processes of self-judgment and self-reaction are triggered as learners evaluate themselves relative to others, attribute their successes and failures, experience self-satisfaction, and activate adaptive-defensive responses to the achieved outcome. Constant monitoring and subsequent correction of one's own performance based on feedback about recent efforts enable the cyclical nature of the self-regulation process. It is important to note, that recently individual cognitive-constructive models of self-regulation have been extended (Hadwin et al., 2018) to include social forms of regulation such as co-regulation and shared regulation to reflect interactive learning contexts from which shared knowledge construction and collaboration emerge.

Existing empirical evidence suggests that self-regulation skills provide the foundation for lifelong learning critical to drive the development of the contemporary knowledge society (e.g., Sloep et al., 2011). In this regard, benefits that self-regulation brings to students' achievement, motivation to learn, and development of learning strategies, clearly argue in favour of designing self-regulation instruction. In two related meta-analyses, Dignath and Buettner (2008) and Dignath et al., (2008) found important effects of self-regulation on academic performance, learning strategies used, and the motivation of primary- and secondary-school students. The average effect size of SRL instructional programs on achievement outcomes was + 0.61 for primary schools and + 0.51 for secondary schools. For cognitive and meta-cognitive strategy use, the average effect size for primary students was + 0.72 and + 0.88 for secondary students. For motivation outcomes, the average effect size for primary schools was + 0.75 and + 0.17 for secondary schools. Both in primary and secondary instruction, the highest effect sizes were for mathematics. The greater effects were achieved when the instruction was delivered by researchers rather than regular classroom teachers.

SRL and Digital Portfolio

Grown from within the constructivist paradigm, the use of a portfolio is a meaningful way to document one's learning path and progress (e.g., Jonassen, 1991). Authors (2005) distinguished between process, showcase and assessment portfolios. All three types can be used to display selected work, enable learners to develop their metacognitive skills, reflect on how they meet the assessment criteria and edit their work based on the feedback. Yet, only the process portfolio offers embedded structures and strategies to support learning. As such, it

is a personal learning management tool meant to encourage and support individual growth and improvement and to yield a purposeful collection of work in one or more discipline areas that demonstrates a learner's efforts, progress and achievement (Barrett, 2007).

With the increasing accessibility of computer technologies, digital or e-portfolios added value to their traditional paper-based counterparts by keeping traces of learning, connecting ideas, relating information and feeding reflection processes, among other things. The evolution of web technologies was especially beneficial for the process portfolio. Primarily, the remote access of an e-portfolio encourages anytime and anywhere learning. Furthermore, a process e-portfolio engages a learner in knowledge construction by scaffolding processes of self-regulation including goal-setting, self-monitoring, and reflection, the key skills to drive lifelong learning. Finally, an e-portfolio enables input from peers and more knowledgeable others and aggregates these inputs into overviews of personal growth.

Although digital portfolios as knowledge tools have been used in instruction for over two decades, the evidence of their impact on the development of skills of self-regulated learning and student achievement remains quite sparse. For instance, a systematic review of e-portfolio interventions included only 17 experimental studies (Becker et al., 2016). Fourteen came from the context of tertiary education, whereas one and another two were completed in the secondary and primary education respectively. Relying on vote-counting, the review found positive effects of using process-oriented e-portfolios on students' self-regulation skills. In their review of 26 studies of e-portfolio interventions, Blaustein and Lou (2014) report important effects of e-portfolio on students' writing skills. According to Becker et al (2016) digital portfolios are most effective, when their use becomes part the instructional routine, when students are trained and offered scaffolds in the use of the portfolio, and, finally, when the portfolio software is designed to explicitly support major self-regulation facets.

Kenyan Context

Authorities of some developing nations express concerns over the capacity of their educational systems to promote quality learning. This phenomenon also known as the learning crisis, reflects the situation when important investments in extending access to education do not fully translate to the development of functional skills and knowledge needed for the workforce to advance developing national economies (Global Monitoring Report, 2016). To address the challenge of realizing education's promise to the nation (Republic of Kenya, 2013) initially expressed in Kenya Vision 2030 and the Constitution of Kenya, the Kenyan Ministry of Education has undertaken a massive reform of curriculum starting at the primary school level. The new competency-based curriculum aims at developing citizens capable of succeeding in the 21st century in line with the global move towards education that encourages human capital development. The shift of teaching paradigm towards student-centeredness is at the heart of the curriculum that is designed to foster "independent, confident, co-operative, and inspired learners" (KICD, 2017). Competencies and skills cut across the disciplines and enable students to be self-reliant, creative and innovative. The curriculum also targets the development of *lifelong skills of learning to learn* that will allow youth to work independently in order to satisfy their learning needs and upgrade their skills; in other words, to empower youth on their path to success. Recognizing that ICT offers potentially significant gains for educating future workforce

(e.g., digital skills), the government has made solid commitments to educational technology by starting the Digital Literacy Programme (DLP). The DLP initiative has successfully deployed technology (tablets, content servers and projectors) in Kenyan primary schools. Yet, the use of technology requires more than distributing computers to students. Teachers and students should have the skills to adequately use new curriculum-linked content so that technology helps realize the intended shifts in teaching and learning. Although the population of secondary students has not yet been targeted by this new curriculum, it will be soon and, therefore, there is a growing need for effective instructional programs to develop self-directed Kenyan learners (e.g., Stephen et al., 2018).

Given the above, the present study tested the feasibility and impact of implementing a student-centered e-portfolio (XXXX) designed to support the phases of self-regulation in Kenyan secondary classrooms. Previous XXXX research conducted in Canadian classrooms (Authors, 2013; Authors, 2010) suggested that implementation of XXXX, especially with a competency-based curricular context, would offer benefits for Kenyan students and their teachers. For instance, after having used XXXX in English Language Arts classes, the Canadian students improved in both writing skills (word choice, sentence structure, writing conventions) and self-regulation strategies (setting goals, selecting strategies for task completion and using feedback and self-observations to improve on work). Focusing on student-centered learning, XXXX also challenged the teachers into accepting classroom practices that go above and beyond teacher-centric forms of classroom instruction.

Together with exploring the practicality of implementing a process e-portfolio in the Kenyan secondary school context, this research studied whether and how the use of XXXX can help students' learning outcomes. Specifically, the following two research questions were addressed:

- *Does using XXXX frequently have effects on the change of secondary students' perceptions of self-regulation) and exam scores from pre- to post-test?*
- *Does use of XXXX predict the variation in students' learning outcomes as measured by their exam scores? Do students' self-regulatory beliefs contribute to this variation?*

Method

The following section summarizes how this research was completed and contains a brief description of the XXXX process portfolio, study design, instruments and measures and analyses used to generate the results. A short overview of the XXXX training and implementation context has also been included.

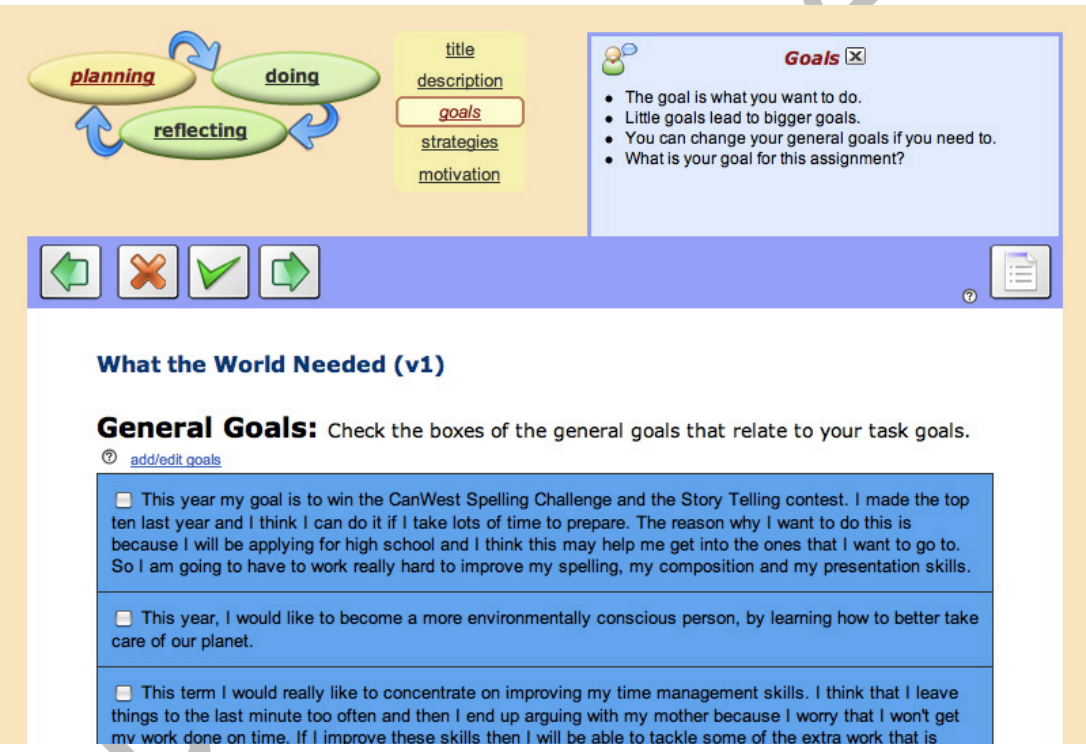
XXXX

Electronic Portfolio (XXXX) is a student-centered web-based process and showcase portfolio designed to foster and enhance student self-regulation along the three cyclical phases of forethought, performance and self-reflection (Zimmerman & Schunk, 2011). Three levels of XXXX are geared to students in early elementary (Level 1), late elementary (Level 2) and high

schools (Level 3). Level 1 is designed to introduce young students to the basic concepts of SRL. Levels 2 and 3 enable students to personalize their portfolio environment and develop their SRL skills further by addressing the following iterative phases:

(1) Planning: Setting general learning goals for a school term or year (see Figure 10) along with specific task goals, defining strategies that will be used to reach these goals, addressing motivation to complete a given task,
(2) Doing: Creating new or revising existing work. XXXX offers a text editor and an audio recorder for the creation of work. Students may also attach videos, slideshows, podcasts, scanned images or photographs of paper-based work as representations of their learning. They can edit work, save multiple versions, and send work to a presentation folder to store it through their school years and export it when needed.
(3) Reflecting: Reflecting on the original goals and strategies and on the level of satisfaction of their work and sharing it to obtain feedback from teachers, peers, and parents.

Figure 1. XXXX general goals



The XXXX environment offers multimedia support materials for teachers and students to develop a better understanding of the what, why and how of the self-regulation processes supported by the tool. The research team created a series of "jump start" lessons and a virtual tutorial to help support teachers' implementation of the SRL features within XXXX. Additionally, just-in-time supports are embedded within the software through help buttons that both students and teachers could access. They provide definitions of SRL terminology, sample responses, and hyperlinks to the virtual tutorial. The teacher materials demonstrate and model

student-centered skills and instruction, provide explanations of those skills, and elaborate the skills through additional support resources.

The XXXX software is available at no cost to educators and may be explored at http://www. /XXXX.html

Study Design

We designed this study in partnership with I Choose Life Kenya and conducted it in the secondary schools involved in the Jielimishe Girls Education Challenge initiative led by the organization. The study unfolded over two years, 2018 and 2019, as a nonequivalent two-group pretest posttest where two groups under observation, XXXX-users versus non-users, emerged from the same classes. Measurements were taken before XXXX instruction and then after it. The student exam scores became available after the students completed their school exams in the end of terms 1 and 3 of each school year. Since in 2018 the implementation unfolded in term 2, these served as pre- and posttest measures of achievement. In 2019, the implementation started in terms 1 and 2, therefore only term 3 exam scores were used. The 2018 student data on self-regulation were collected before the intervention in May and then again in October after the software was used for terms 2 and 3 of the school year whereas the 2019 surveys were collected once at the conclusion of the XXXX intervention.

Study Sample

The participation of secondary students and their teachers was secured after the partner staff approached the schools' headteachers and teachers for their willingness to be part of the project. Students were in secondary one in 2018 and secondary two in 2019. Their age varied between 14 and 19 with an average of 16.7 years old. Gender was split equally across the sample. There were important fluctuations in the number of participants throughout the study from year to year. By the end of 2018, of 140 student-participants from four classes the complete data were available for 79 students. In 2019, 172 students in four classes used XXXX as part of their instruction whereas 124 students who completed all the measures. Overall, 137 students completed some measures in both years and their data were used for analyses. Multiple reasons accounted for the fluctuations. For instance, in the first year of the pilot, one school decided to reduce the class sizes. In both years, some students were sent home and not allowed to complete their term exams for failing to pay school fees or other school-related expenses. Important turnover of students during the school year also contributed to the reductions in the sample.

The teacher-participants had a university undergraduate degree. Their teaching experience ranged from 1 to 19 years, with the average of 11 years. The teachers specialized in more than one subject area including English and Literature, Kiswahili, Physics, Biology, Chemistry, Geography, Business Studies and History.

Instrumentation

To measure a possible shift in students' perceptions of their use of self-regulated learning strategies between the pre- and posttests, the *Student Learning Strategies Questionnaire*, SLSQ version 3 (Authors, 2014) was used. As an update of the original SLSQ (Authors, 2008), version 3 reflects more comprehensively the dimensions of self-regulated learning. Rated on a four-point frequency scale, 37 items inquire of students (SLSQ) about their ability to set learning goals, monitor and correct their performance, and reflect on the learning outcomes. Specifically, the items reflect six underlying self-regulation constructs, such as (1) Planning (task analysis and self-motivation beliefs), (2) Doing (self-control and self-observations), (3) Reflecting (self-judgement and self-reaction), (4) Predicting one's success (self-efficacy), (5) Reasons to succeed (self-determination) and (6) Feelings about the task (task value).

The *XXXX Implementation Assessment Protocol* (Authors, 2010) was used to analyze student portfolios and to code the extent of XXXX use. The following codes were assigned: "1" for low use (e.g., student logged into XXXX, left some traces (e.g. personalized the front page) but did not work on an artifact), whereas "2" was assigned when one artifact was created with a task goal, and some reflection was added; and "3" was assigned to portfolios where multiple versions of an artifact or artifacts were created, including task goals, strategies and some form of reflection. These designations were made by considering the following items: number and/or versions of artifacts stored in the student portfolios, date range of use, and nature of XXXX use (for storage only or use of SRL features).

Kenyan exam scores were a measure of learning growth in the subject area where XXXX was part of instruction. Term 1 exam scores served to set a baseline and term 3 exam scores served as the post-test. In each exam (in each subject), a maximum score of 100 points can be achieved. The term exams are administered and scored by teachers in secondary schools. We created a composite variable which was a merger of scores students obtained in the subject where XXXX was used as part of classroom instruction. For instance, in 2019 this variable included students' scores in English, Business studies, Biology and Physics.

XXXX Intervention

A three-day XXXX training of the participating teachers unfolded early in the school year. The session focussed on the components of self-regulated learning (SRL), the importance of SRL development with schoolchildren, and XXXX use to support the development of SRL. Since the teachers were expected to use XXXX with lower secondary students, XXXX level 2 was the focus of training. One day of training was allotted to hands on activities on how to integrate the software in classroom teaching where teachers worked in pairs to prepare a lesson plan they could implement when they were back to their classrooms. In addition, the teachers were given access to a range of pedagogical material, including lesson plans, activities, job aids, and virtual tutorials demonstrating and explaining the self-regulation features of XXXX and helping integrate them into the instruction. Since authentic implementation of XXXX by classroom teachers was in the focus of the project, the decision to use these support materials was left at the teachers' discretion. The ICL trainers were expected to support their teachers by modeling instruction, team-teaching and holding thematic XXXX-related workshops. Each teacher was provided an XXXX account that allowed them to start their own portfolio in order to explore

and understand the portfolio features and how to integrate them in their instruction. Yearly, in term 1, one half-day training workshop was held at a partner's premises. In term 2, school visits were rendered to the two implementing schools to support teachers and students in using the software.

The implementation of XXXX varied from year to year and by class. The four classes used XXXX for different subjects: English Language and Literature, Business Studies, Biology, and Physics. In year one the students used the e-portfolio around four weeks of term 3. In year two, two of the four classes did their XXXX work for about 6 weeks in terms 1 and 2 and the other two classes worked on their portfolios only for three weeks in term 1. The problems with the school computer lab that was not functional during terms 2 and 3 of 2019 accounted for brief implementation. A handful of students from a participating class used XXXX level 1 the beginning level of process portfolio designed for early elementary.

Data Analyses

All student scores were entered manually using SPSS for Mac OS X (version 24) and verified for accuracy. Students' data were analyzed by year and those cases with missing data were excluded from the analyses. Six composite scores were created on the SLSQ data to reflect the underlying concepts of self-regulation. Data screening procedures suggested no marked departure from data normality. In addition to the descriptive analysis, Repeated Measures (RM) MANOVA and Hierarchical Multiple Linear Regression (MLR) analyses were run. Specifically, to analyze the 2018 pre- and posttest data, two RM MANOVA one-way models were used including testing time (pretest-posttest) as the within-subject variable and treatment (frequent XXXX versus little or no-XXXX) as the between-subject factors. The dependent variables were the set of six SLSQ aggregated scores and the exam scores. The two-block MLR model was run on the 2018 and 2019 data. Students' XXXX use and their perceptions of self-regulation were the predictors whereas the criterion variable was the exam scores that merged the results obtained in the subject where XXXX was used for classroom instruction. On 2019 posttest data the analysis of mean group differences was performed.

Results

The analyses yielded some important results which we present below to address each of the research questions that guided this two-year pilot study.

Student XXXX Use, Exams Scores and Self-regulation

First, we addressed the first research question: *Does using XXXX change secondary students' perceptions of self-regulation and exam scores from pre- to post-test when compared to students who barely used an e-portfolio for classroom learning?*

A summary of scores available in both years including means and standard deviations on each of aggregated SLSQ subscales and exam scores is presented in Table 1. The data suggest that after learning with XXXX, students (N_{2018}=28; N_{2019}=73) reported more frequent reliance

on the majority of self-regulation strategies and also scored higher on their end-of-the-year exams.

Table 1. SLSQ subscales and exam scores: means and standard deviations

Self-regulation & Exam scores	*2018*				*2019 (post-test)*	
	Frequent use of XXXX (N=28)		*Little or no use of XXXX (N=51)*		*Frequent use of XXXX (N=73)*	*Little or no use of XXXX (N=51)*
	Pre	*Post*	*Pre*	*Post*		
SLSQ: Planning a task	29.04*(1.86)*	31.4*(3.73)*	29.76*(2.95)*	31.76*(2.31)*	30.14(3.69)	29.81(3.32)
SLSQ: Doing a task	20.7*(1.97)*	23.19*(2.16)*	21.03*(2.19)*	20.92*(2.12)*	19.09(3.69)	18.5(3.17)
SLSQ: Reflecting	13.92*(1.56)*	14.16*(1.76)*	12.81*(2.27)*	13.05*(2.36)*	15.14(2.27)	14.55(2.30)
SLSQ: Predicting one's success in the task	15.76*(1.78)*	15.75*(2.75)*	15.52*(2.12)*	15.82*(2.43)*	16.45(2.94)	15.41 (2.84)
SLSQ: Reasons to succeed	10.14*(1.28)*	10.89(*1.22)*	10.66*(1.54)*	10.84*(1.21)*	10.54(1.41)	10.70(1.87)
SLSQ: Feeling about the task	21.59*(2.6)*	21.83*(3.01)*	21*(2.58)*	20.74*(3.21)*	22.36(2.19)	22.74(2.57)
SLSQ: Total score	112.58(7.23)	116.98(7.70)	110.78*(8.3)*	114.27*(7.76)*	113.73(11.34)	111.72(10.13)
Kenya exams	41.36*(14.84)*	52.78*(19.29)*	40.29 (*16.3)*	42.9*(17.76)*	45.26(18.59)	40.27(21.65)

Two two-way Repeated Measures models were run on the 2018 data including testing times as the within-subject variable and XXXX use as the between-subject factor. The statistically significant Pillai's trace criterion on a combined score of self-regulation perceptions overtime was F(6, 78)= 2.48, p= .03 and the partial eta squared of 0.16 indicated important difference between the students who used XXXX frequently and the students who hardly used XXXX to complete their tasks. The 2018 exam scores analysis also revealed the disparity between the students who frequently used e-portfolio (N=28) and those whose use of the portfolio was scarce or non-existent (N=51). On the combined exam scores, the over-time difference between the students in the two conditions was F(1, 77)=4.33, p= .041; partial η^2 = .05 favoring gains of the students who used XXXX to complete their class assignments.

By and large, the 2019 posttest results from 124 students echo the pattern of group differences captured in 2018. The average post-test scores of the students who learnt with XXXX are higher than those who hardly used XXXX albeit statistically non-significant. For the exam scores and the self-regulation total score, the group difference coefficients were F(1, 123)=1.03, p=.29 and F(1, 123)=1.89, p=.17 respectively.

Next, we addressed the second question: *Can the extent of XXXX use predict the variation in students' learning outcomes as measured by their exam scores? Do students' self-regulatory beliefs contribute to this variation?*

To answer this question, we built a two-step regression model where the end-of-year exam scores were the criterion variable whereas *XXXX use* was the predictor variable. The latter was the ordinal variable created for the students who completed some work in their portfolio (e.g., traces exist). As described earlier in this manuscript, for this end, we assessed students' XXXX work for the use of self-regulation features on a scale from 1 "low use" to 3 "high use". The six aggregated self-regulation scores were also added as the predictor variables into the model.

It is important to note that the proportion of high and low XXXX users changed over time; in 2019 the number of high and moderate users nearly tripled in comparison to 2018 whereas the numbers of low-end users declined two-fold. Specifically, in 2018 and 2019, the portfolios of 13 and 38 students were assigned the highest value of "3" respectively. As part of their class assignment, these students created multiple versions of one or more artifacts. They identified task goals, selected task strategies and also added some form of reflection. The value of "2" was given to the work of 12 and 35 students who created one artifact with the task goal and added some reflection to it. The lowest value of use "1" was assigned to 25 and 13 students' portfolios who logged into XXXX, left some traces (for instance, personalized their home page) but did not attempt to complete any task using the XXXX features.

The results of the multiple regression completed on the 2018 and 2019 data are presented in Table 2. In both years the extent of XXXX use was a significant predictor that alone accounted for the variation in the end-of-year exam scores explaining 15% and 9% of variance respectively.

Table 2. Summaries of the hierarchical regression models and predictor standardized coefficients

2018 (N=50)				*2019 (N=86)*			
Model 1 (1, 48)	$R^2 = .15$	$R^2_{change} = .15$	$F_{change} = 8.51^{**}$	Model 1 (1, 84)	$R^2 = .09$	$R^2_{change} = .09$	$F_{change} = 8.34^{**}$
$ß_{XXXX\ use} = .39^{**}$				$ß_{XXXX\ use} = .30^{**}$			
Model 2 (6, 42)	$R^2 = .44$	$R^2_{change} = .29$	$F_{change} = 3.67^{**}$	Model 2 (6,78)	$R^2 = .15$	$R^2_{change} = .06$	$F_{change} = .87$
$ß_{XXXX\ use} = .29^{*}$				$ß_{XXXX\ use} = .36^{**}$			
$ß_{planning} = .08$				$ß_{planning} = .21$			
$ß_{doing} = .48^{**}$				$ß_{doing} = .05$			
$ß_{reflecting} = -.02$				$ß_{reflecting} = -.03$			
$ß_{predict\ success} = -.16$				$ß_{predict\ success} = -.17$			
$ß_{reasons\ to\ succeed} = .14$				$ß_{reasons\ to\ succeed} = .14$			
$ß_{feel\ about\ task} = -.13$				$ß_{feel\ about\ task} = -.002$			

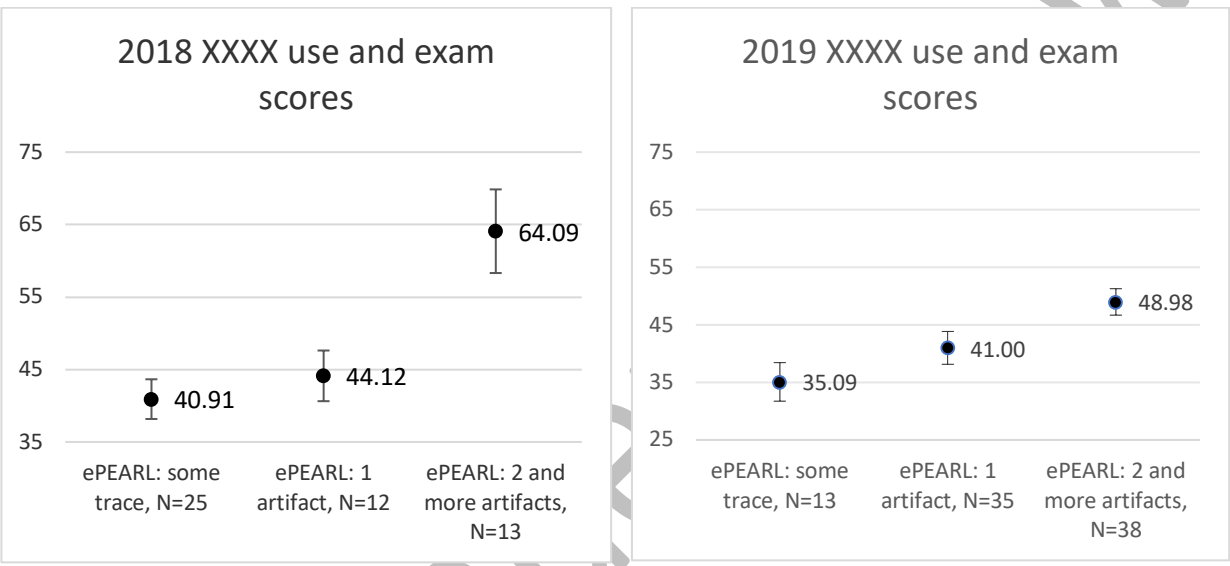
* < 0.05; ** < 0.01

When added to the regression model, a combination of the six self-regulation factors was a statistically significant predictor of the student exam scores in 2018 only. The pattern of results implies that together with the extent of XXXX use, students' perceptions of strategies they apply when performing the task were the strongest predictors of students' achievement.

Specifically, one-standard-deviation increase in the use of the portfolio and performance-monitoring strategies will lead to .29 and .48 standard deviation improvement in student end-of-year exam scores respectively.

To demonstrate visually that the extent of learning with XXXX consistently and significantly predicts students' performance, we added a graph where students' average exam scores in both years varied as a function of e-portfolio use. Graph 1 shows that the highest exam scores were obtained by the students who created more than one artifact and made fuller use of the XXXX features.

Graph. 1. Average exam scores by the extent of XXXX use



Students' XXXX Artifacts

In 2018, 50 grade-one students completed some work in their e-portfolio; of those 33 students continued using XXXX in the following year, whereas 53 grade-two students started their XXXX portfolio in 2019. Among students who worked in in both years, the majority created two and more artifacts. Some of these artifacts were versions of the same task. At a minimum, students formulated one task goal and identified a strategy they were to rely upon in order to compete the task. This section offers a summary of students' uses of XXXX to complete their assignments in Business Studies, English, Physics, and Biology and is organized along the three phases of self-regulation-- forethought, performance and reflection.

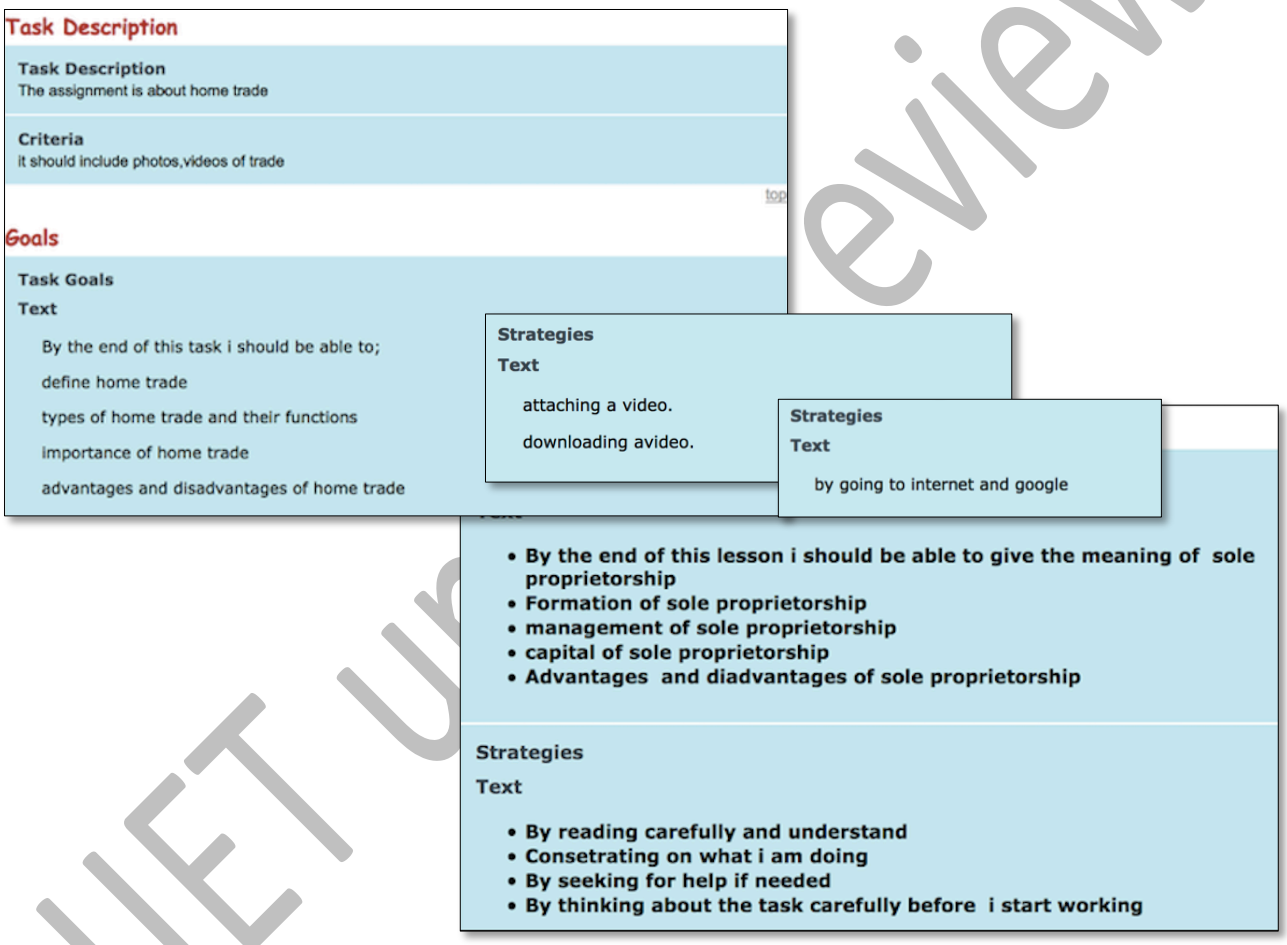
Forethought

In both years, students' planning activity was limited to setting task goals. It is important to note that students predominantly used XXXX to complete their class assignments that were

driven by simple questions requiring students to reproduce their existing knowledge (i.e., provide definitions, put together a list of items). The nature of the assignments is reflected in the task goals the students set in their XXXX. "Define the meaning of…", "identify the importance of…", "identify forms/types of…", "list advantages/disadvantages of ..." are the examples of verbs used by students for setting task goals.

The portfolio analysis shows that some students identified the strategies they intended to use to achieve the task goals. A few examples of task goals and selected strategies and criteria from both years are shown in Figure 2 below.

Figure 2. Task criteria, goals and strategies

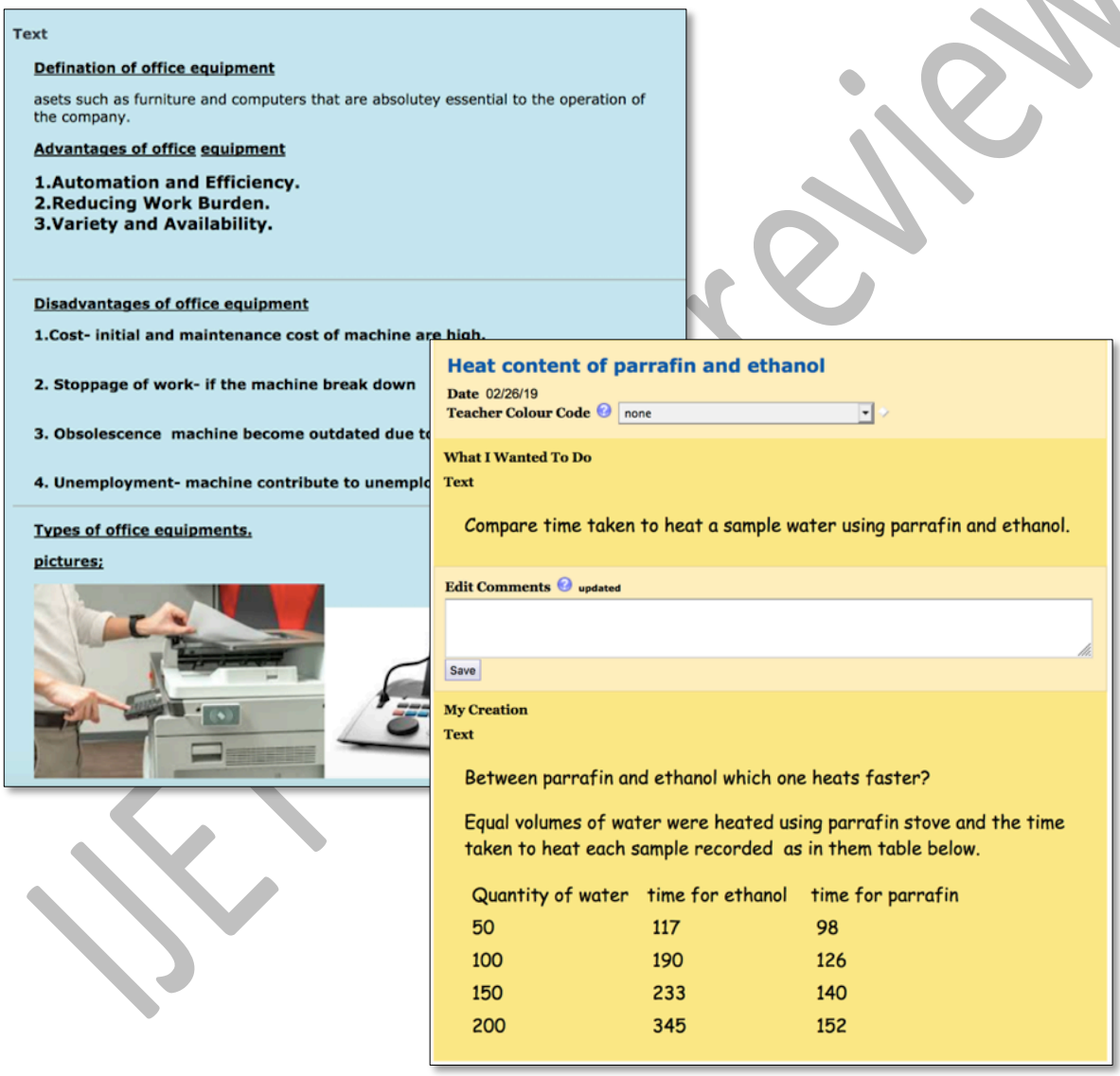


It is important to note that the type of strategies changed over the years. If downloading video and attaching photos was the dominant strategy for the task completion in the first year of the pilot, the following year strategies became more diverse and comprehensive. It appeared that many if not all choices at the planning phase were heavily guided by the teacher. For instance, the goals might have been teacher formulated, since their wording was similar the portfolios of different students from the same class. The selection of strategies and how these were worded directly reflected the task criteria set by the teacher.

Performance

It was natural that in order to comply with the teacher-set requirements, most students incorporated images and also attached audio and/or video files to their artifact(s). Every student artifact contained some text using the text-editor. In their writing, students relied on paraphrasing and summarizing but they seldom referenced the primary sources. Figure 3 offers examples of the students' creations using XXXX levels 1 and 2.

Figure 3. XXXX creations

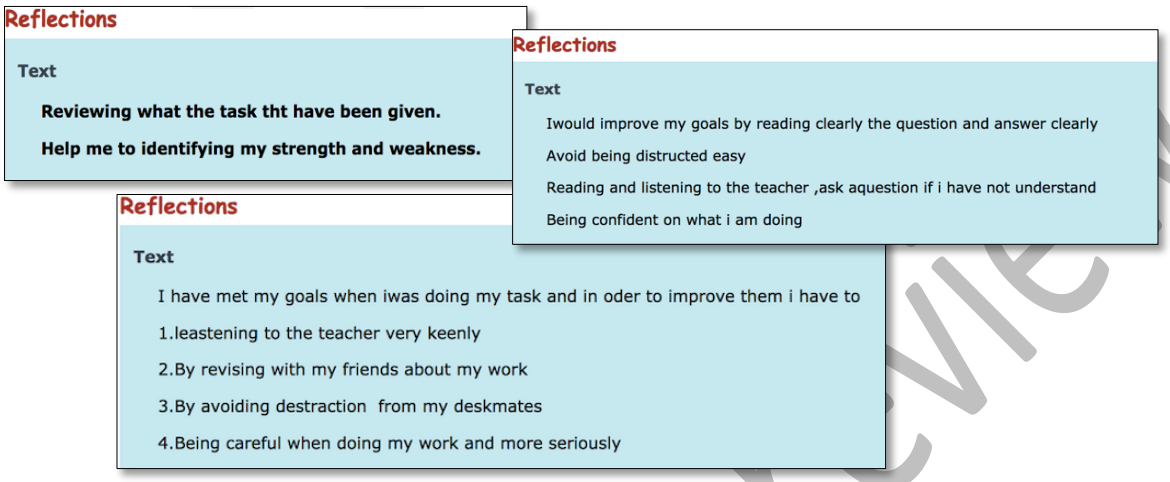


Reflection

The students left their comments in the reflection section of XXXX. In both years the reflection statements echoed the task strategies the students selected at the planning phase of

their XXXX work. Therefore, the deliberations were quite generic offering some thought on the facets of their work that could be improved and how these improvements could be achieved. A few examples of students' reflective comments can be seen in Figure 5 below.

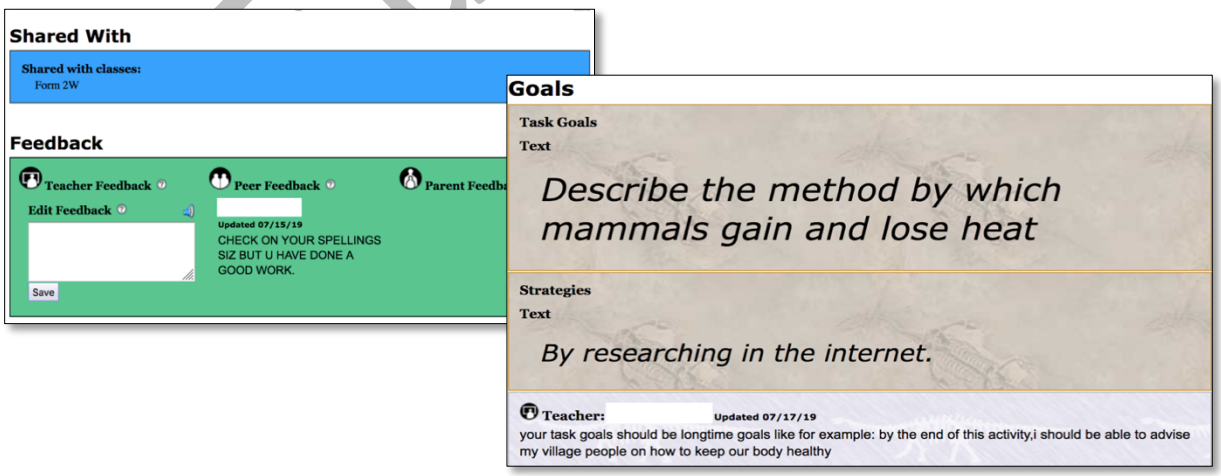
Figure 4. XXXX reflection



Other XXXX Features

All students shared their work either with the whole class or with a few selected peers. A few students moved their work to the presentation folder providing "[they had] done it well" as a justification. Despite sharing, few students commented on each other's work and when they did, the feedback was rather basic. Teacher feedback on the use of the XXXX features was only restricted to goal setting, even though there are many opportunities for the provision of feedback.

Figure 6. XXXX feedback



Discussion

The intention of this project was to test the feasibility and potential of using XXXX for instruction in the context of secondary public schools in Mombasa, Kenya. The results we obtained in this small-scale two-year study imply benefits for those students who used XXXX to complete their class assignments. After learning with XXXX, the students' achievement and perceptions of their self-regulation skills improved, when compared to their peers who hardly used the electronic portfolio tool or did not use it at all. More frequent and comprehensive use of XXXX features to complete a class assignment translated into higher student achievement in the respective subject area, as measured by the end-of-year exam scores. These encouraging findings from the software use in Kenyan secondary classrooms also complement the positive evidence of XXXX effects generated in Canadian late elementary contexts (e.g., Authors, 2013).

Viewing these results from a socio-cultural perspective may add value for the prospects of XXXX utility in Kenyan secondary classrooms. The research on cultural heterogeneity suggests that there exist cultural variations in how strongly people feel about their self and how these perceptions may affect their success in school and later life. For instance, in their study of cross-cultural differences Scholz et al. (2002) emphasized that collectivistic cultures tend to report lower self-efficacy beliefs because of the priorities given to group abilities rather than individual abilities. Mpofu (1994) explained that in collectivistic cultures such as those in Africa, Asia, the Middle East "private thoughts and feelings about the self and others are not considered pertinent to an individual's view of the self" (p. 342). Therefore, it might be that instruction developing individual self-concept and academic self-efficacy, might provide the critical leverage to boost academic performance and enable students' self-development in collectivistic contexts where prominence is given to family and group characteristics (e.g., Ansong et al., 2019; Ongowo & Hungi, 2014). From this standpoint, the results suggest that the use of XXXX might be an intervention that could help individual student aspire to succeed both within school and beyond, and advance along the lines of the national objectives set by Kenya Vision 2030. The fact that the software also draws on the broadened understanding of self-regulation including socially-shared self-regulation and co-regulation (e.g., Winne et al., 2010) may reinforce the contextual relevance of XXXX.

The findings of this study are also promising because they were obtained in the context of authentic instruction where the implementation of XXXX was driven and directed by the classroom teachers themselves. While systematic research found that self-regulation programs were most beneficial if the strategies were taught by researchers rather than by classroom teachers (Dignath et al., 2008), these results imply that XXXX can be effective in the hands of Kenyan regular classroom teachers. They were able to use the e-portfolio to support their students' learning in the real-world context of Kenyan secondary school where classes are large, turnover is high, support is low, technology is unstable and access to it is limited, and many teachers and students lack technology proficiency. Despite these challenges, the teachers persevered as they valued the XXXX pedagogy and anticipated it to be successful, as compared to seeing the challenges of implementing XXXX quite low. Indeed, according to the value-expectancy model (e.g., Authors, 2006), teachers' perceptions of the tool and its associated outcomes as worthwhile for themselves (professional development opportunity), and their students (improved achievement and attitudes) and teachers' expectations of success between the use of XXXX and the desired effects, might have overweighed the perceived physical and psychological costs of implementation such as preparation time, effort, etc. However, it also

might be that some teachers used the software to give a learner-centered feel to their instruction and thus believed their teaching became more aligned with the current educational trends in Kenya without significantly altering the ways they teach. For instance, in our study, oftentimes the teachers opted for tasks based on a simple question to complete which it was enough for students to reproduce existing knowledge. The students were driven by the teacher-set goals and modalities rather than articulated their own understanding of the task and selected ways of how to complete it as well as reflected on the process and its outcomes. Yet, the complexity of the processes that XXXX supports at all three phases requires that the tool should be used for important learning where the value of effortful expenditure of time is apparent. After all, XXXX was not designed for learning which is viewed by the learner as easy to accomplish, already well-learned but is best used when the task is moderately difficult, has an element of novelty, and is perceived as valuable to achieve (Author, 2010). Learners should see the added value that XXXX has on their learning and that the amount of time and effort invested is equal to the progress.

However, educational change takes time and we realize that even minimal shifts in teaching practice might be indicative of an important step forward on the way to lasting improvement in instructional practice. Given the impending curricular reform of secondary school in Kenya, many changes in teaching practice are imminent. Since teachers are at the center of any effort to produce positive effects on student learning, further strengthening of the professional development aspect of an intervention is critical so that teachers can fully embrace the pedagogical sophistication offered by the learning technology. We see the support system as the way to continue strengthening contingencies between XXXX implementation and student learning progress and reducing the perceived disincentives of teaching with technology. Since the capacity of teachers involved in implementation vary, addressing the teachers' needs in technical, pedagogical and content knowledge is critical (e.g., Mishra & Kohler, 2006). Specifically, in addition to helping teacher adopt computer technologies, the support should target teacher's understanding of the core principles of XXXX and raise their autonomy in applying these principles to instruction. Further, reinforcing the aspect of collegial support would create an opportunity for teachers to take ownership of their professional development and to sustain ongoing learning by peer coaching. For instance, helping establish and maintain connections between teachers implementing XXXX in different schools by means of technology (McAleavy et al., 2018) would be another hoped for outcome when the support system enables teachers to share and validate their ideas and approaches, obtain timely advise from a colleague – in other words, helps the creation of a shared knowledge base about their XXXX practices.

The strength of this research includes the integration of the tools as part of authentic, unscripted classroom practice, and the length of the project which was conducted over two years where we were able to replicate the year one results. This suggests that more frequent and comprehensive use of XXXX translated into higher achievement. The weaknesses of this research relate mostly to research design. Specifically, a planned quasi-experiment with control condition would allow us to avoid teachers priming their non-using students in their classes with self-regulation strategies and thus tempering the effects of XXXX. Student attrition and long-term failure of a school computer lab also affected the results. Although less controllable, when feasible, these factors could be moderated by make-up data collection and seeking

stronger commitment from the partner and schools to maintain their computer devices operational.

In conclusion, this initial small-size test of XXXX in Kenya showed that in teachers' hands technology for student-centered learning positively impacted student learning outcomes. This is especially encouraging as a first step as there are additional considerations that if implemented, could lead to further enhancements in both teaching and learning in low-resourced contexts.

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