Institute of Education

UCL

Math-Whizz evaluation in Aguascaliantes, Mexico

Executive Summary

1. Objectives

Funded by the Ministry of Education in Aguascalientes, we undertook a quasi-experimental study to evaluate the impact of one component of the Aguascalientes STEM program. The component in question was the introduction of the online virtual tutor Math-Whizz within primary school classes.

Although we considered the full implementation of Math-Whizz, from its beginning in February 2015 until the date of the evaluation in Sep-Oct 2016, we gave particular focus to Year 4 students (age 8-9). This focus allowed us to make use of the country-wide PLANEA tests that take place each September.

Our overarching question was whether Math-Whizz increases students' achievement and motivation in mathematics. Additional aims were to evaluate the process of the Math-Whizz implementation and to provide recommendations for the future development and evaluation of the wider intervention.

2. Methodology

This report relies on a mixed methods approach, and as such includes both qualitative and quantitative data gathered from a range of stakeholders. The qualitative analysis relies, firstly, on observation of classroom learning and teacher training sessions in a range of schools, and secondly on interviews with parents and teachers as well as students themselves.

The quantitative analysis relies on a **quasi-experimental design**, namely a non-equivalent control group study (Fife-Schaw, 2006). The two conditions were specified as follows:

(Math-Whizz condition) Classes within schools that were both implementing the Math-Whizz software and taking part in the teacher training program.

(Non-users condition) Selected range of schools which were neither implementing the Math-Whizz software nor taking part in the teacher training program at the time of evaluation.

We used the R software for data analysis (R Core Team, 2016; R Studio Team, 2015).

Although we considered the data of the whole implementation throughout Aguascalientes, the **participants** for the analysis reported here are considered to be only the Year 4 and primary school students, aged between 8 and 9 years old, from the schools in the Appendix (selected from a range of rural, suburban, and inner-city areas). 439 teachers took part in the online questionnaire.

3. Measures

We measured students' achievement levels using data from the national PLANEA test for reading and mathematics, which took place in September. Data was provided by the State of Aguascalientes.

The timeframe of our evaluation meant that we could not rely on a state-administered test to measure students' levels of achievement at the end of the intervention. Due to other factors, including the additional bi-monthly tests that students were taking, we also had a limited time window in which to apply a different test. As such, we modified PLANEA (with relevant permissions granted) and selected 10 questions from the 'numbers and counting' and 'addition' problems, as these were among the topics covered by Math-Whizz.

The students received one point for each correctly answered question and consequently an aggregated score. Internal consistency for the Oct test was Cronbach α=.76 and for Sep α=0.85. Note that Whizz Education did not make any changes to the Math-Whizz delivery algorithm, nor were they aware of the choice of a modified PLANEA test in advance.

We tracked usage of Math-Whizz via its internal system. The system logs data for each student whenever they use the virtual tutor, whether inside or outside the classroom. (Apart from usage data the system also logs student progress in terms of "Math Age", a Whizz Education term that defines the level of math ability for each student.)

In addition, we observed five schools/classrooms from different backgrounds and interviewed 10 teachers and five parents. We also interacted, using focus groups to gather the opinions of 20 individual children (four from each school), both during their use of Math-Whizz and retrospectively.

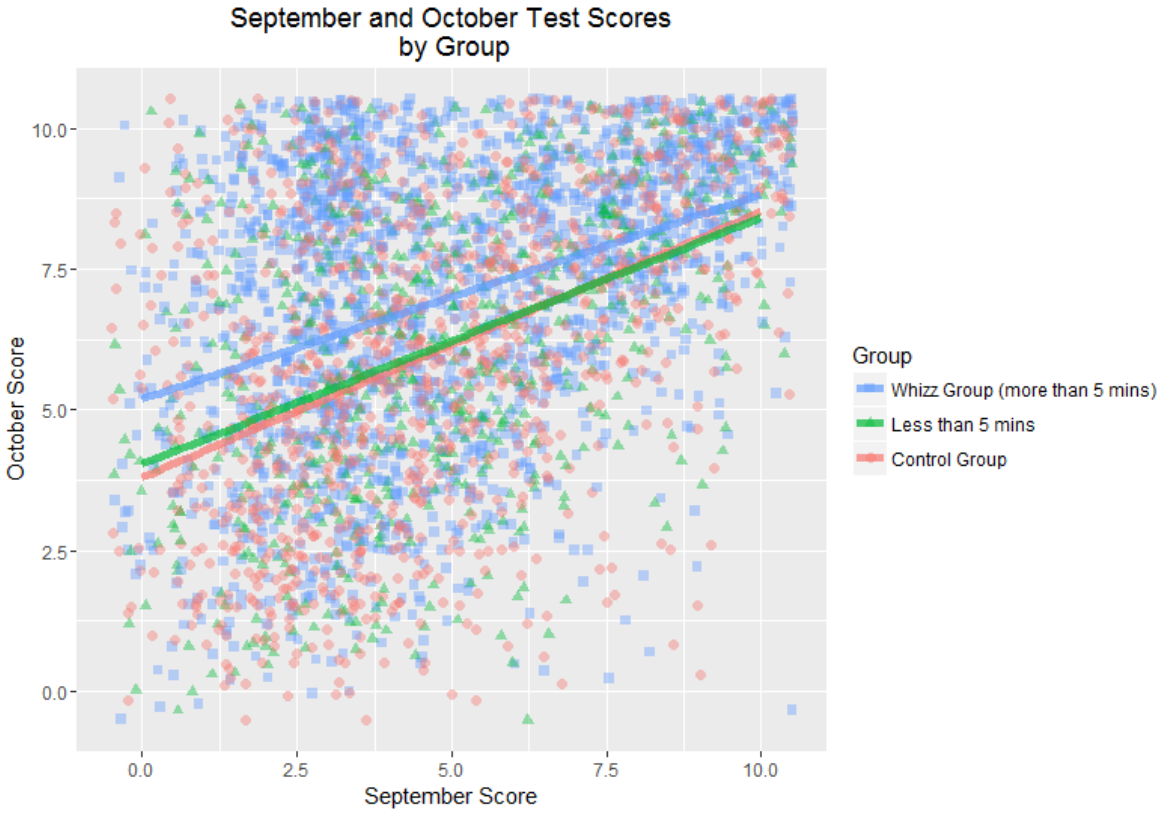
4. Summary of results

4.1 Learning performance

The detailed statistical analysis (see full report for regression analysis) of the 4th grade cohort ($N_{MW\text{-}condition}$ = 2188, $N_{control}$=1219) leads to the conclusion that the group that used Math-Whizz appears to have made more progress, between September and October, compared to the control group. Taking into account the differences in the September test results, the expected achievement for Math-Whizz student users in the sample is 0.659 points higher on a scale of 10 than that of non-Math-Whizz users. According to our regression model, and if the change is not due to unobserved variables, this significant difference in progress might be associated with the use of the software.

Splitting Math-Whizz users into smaller average usage groups (more than 45 min, between 34-44 min, 5-33 min and less than five mins) the observer relationship is further differentiated. The difference between non-users and the group of less than five minutes is insignificant (indicating the validity of the analysis) and the high usage group is associated with an additional 1.26 point progress). We calculate an effect size of about *d=0.22*, commensurate with other studies in the area (e.g. Roschelle et al. 2016). We also partialled out students' previous achievements, and we conclude that the positive relationship between usage and students' progress does not depend on that. These results should of course be read with caution in the context of the whole analysis and the limitations presented in the full report.


Mean Test Score by Group
Mean Test Score
6.5
6.0
5.5
5.0
September
October
Group
Non-User
Whizz User


September and October Test Scores
by Group
October Score
10.0
7.5
5.0
2.5
0.0
0.0
2.5
5.0
7.5
10.0
September Score
Group
Whizz Group (more than 5 mins)
Less than 5 mins
Control Group

4.1 Classroom observations, teacher and parent interviews

In general, all of the interviews and observations we conducted suggested that teachers overwhelming support the implementation of Math-Whizz. Parent interviews suggested similar levels of support, and highlighted the potential role of the parents themselves within the Math-Whizz implementation. All parents interviewed referred to their personal observation of a transformation in their children's behaviour and learning outcomes. Parents consistently referred to increased patience and diligence, reduced fear of mathematics and even enhanced motivation in carrying out other, unrelated homework. Some characteristic quotes are provided in Appendix 2.

Depending on their personal circumstances, the parents interviewed followed different strategies to support their children's access to Math-Whizz. Such strategies included buying new computers, lending children the parents' own devices (e.g. tablets) ot taking their children to use public computers at a library. We observed that the parents' mathematics background may determine their role at home. Most helped their children with particular doubts and seemed to understand the importance of not intervening, so as to allow the Math-Whizz system to adapt based on data from the child's interactions (a point emphasised during the parent and teacher training). One parent reflected on the opportunity provided for her to be more engaged in her child's activities, allowing her to learn or simply remember the mathematics involved in the tasks. This gives her the ability to help her daughter more. Two of the parents reported on the positive benefits of this opportunity to better connect with their child, and to feel involved in what happens at the school.

Classroom observations and discussion with teachers suggested overwhelming support for the Math-Whizz implementation, and gratitude among teachers for this form of support from the State of Aguascalientes. Teachers reflected on the role of the trainers who frequently visit their schools and help them analyze the reports provided by Math-Whizz, to identify the particular needs of each school. Beyond the technical support, two teachers focussed particularly on the pedagogical training opportunities that the implementation has provided, as the trainers provide further support with advice on how to integrate Math-Whizz into the classroom. We elaborate upon these findings in the next section, using the questionnaire data.

In general, we can summarise the findings by referring to the fact that both trainee and experienced Math-Whizz teachers identify similar potential strengths. This points to the quality of the training and the design of Math-Whizz features, which are easily appreciated. In addition, there was both a quantitative and qualitative increase in the type of response *after* teachers have experienced Math-Whizz in the classroom, in that teachers provided answers which relate to mathematical thinking and the potential for student motivation. This points to teachers' increased understanding of Math-Whizz post-implementation.

Concerning limitations of the implementation, the teachers mostly referred to infrastructure challenges such as internet and computer access, but some responses also highlighted the lack of deep integration of the monitoring tool in everyday practice. These latter responses suggest that, as the implementation gains momentum, a shift towards using the tools to identifying students' strengths and weaknesses might be a positive next step.

7. Recommendations

This section offers recommendations for the Institute of Education in Aguascaliantes and for Whizz Education in the implementation of Math-Whizz. These recommendations celebrate the positive start to the Math-Whizz implementation, and seek to leverage the success to further enhance the experience of students in mathematics. The first part is related to the initial implementation, with a focus on the teachers: the training they received and the way they use Math-Whizz. The second part relates to the infrastructure required to completely support the wider implementation of Math-Whizz. The full report also contains recommendations relating to the evaluation methodology and a more systematic impact study in the future.

7.1 Initial implementation

Recommendation 1.1: *Design and implement a second professional development opportunity to support a greater number of teachers to fully embed Math-Whizz into their practice and pedagogy.*

Ultimately, the professional development opportunity, whatever its format, should focus upon more use of the Math-Whizz monitoring and reporting tools as a formative assessment tool. The focus should be on encouraging more teachers to use it to identify students' strengths and weaknesses, to identify new tasks for the students and as a basis of discussion with parents. The professional development opportunity could take a range of forms, such as:

- a new workshop, providing an opportunity for teachers to address their specific concerns and to reflect on their current pedagogy in light of 'best practice'

- honing the role of Math-Whizz ambassadors in schools through specialist professional development, ensuring they are better-placed to support their colleagues using a cascading approach

- developing networks of schools (either in similar or in different contexts) whose teachers are able to support each other in implementation

7.2. Infrastructure

Recommendation 2.1: *Ensure all schools have sufficient hardware (computers or tablets) for every child in a classroom to be able to access Math-Whizz at dedicated times.*

Ensuring all students have access to Math-Whizz will enable a dedicated lesson to be undertaken. It will also demonstrate the school's commitment toward the inmplementation, while supporting areas other than mathematics.

Recommendation 2.2: *Ensure all schools have sufficient internet access for all children in a given class or group to be able to access Math-Whizz simultaneously.*

An internet connection that is stable and consistent, and that continues to work when all students are connected is necessary for continued use and commitment to the implementation.

Recommendation 2.3: *Ensure realistic contingencies are available for children and their families who do not have access to Math-Whizz at home*

Additional time on Math-Whizz seems to have the potential for a significant positive impact on students' learning gains. Therefore, it is important that students who do not have access at home are able to use the learning platform at other times as part of their homework.

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Appendix 1 - Estudios de caso ilustrativos

Parent of a fourth grader (9 year old)

Interviewer: As a mother, how has your experience of Math-Whizz been?

Parent: It has been gratifying, and surprising because D is a child who used to count with his fingers. He was not able to do basic maths without his fingers. It was suprising for me to see how very quickly D changed … now he doesn't use his fingers to count and this is one thing among many others he has improved since using Math-Whizz. He has improved a lot in problem solving, multiplication tables, adding, as well as many others. Now he can quickly solve all of this in his head in a much more efficient way.

While he was in Grade 1 and 2 he told me that he didn't like math because he didn't understand it, and now with this fantastic tool Math-Whizz, he actually enjoys math. It is much easier for him and now he gets wonderful grades. His maths grades have improved from a 6 or 7 to a 9 in a 10-point scale, that in first grade he didn't think he could get.

It has been very gratifying because he has improved in math and now he is not afraid to use technology. Before Math-Whizz he was a little cautious about technology and now the usage of computers and tablets is natural for him. I have seen this improvement in the last academic year and it is wonderful.

Principal from a pilot project school

The results gained through the pilot project were very positive, children improved a lot in their math knowledge. Children that were struggling with the traditional classroom approach got excellent results through Math-Whizz. We are greatly satisfied in this regard, children love to visit the computer lab in order to log in to Math-Whizz. Most of them also have the opportunity to access Math-Whizz at home, we only have a few exceptions who don't have internet.

During the pilot we had the support of a trainer, a tech-savvy young man with an academic background. He was there to support the teachers if they had difficulty with the platform, but I have to say that we didn't have many of these situations because Maths-Whizz is very easy to use, easy to manage and very user-friendly. He helped us by supervising the class while using Math-Whizz because we have large classes and it was great to have someone help the teachers.

Teachers experienced the improvement of the class, they could see that students now understood the exercises and explanations much faster and easier and children could get better outcomes thanks to Math-Whizz.