
Title	My math homework pal
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**THE NATIONAL RESEARCH FOUNDATION
RESEARCH AND DEVELOPMENT PROGRAMME ON
INTERACTIVE AND DIGITAL MEDIA IN EDUCATION**

EduLab Project - Final Report

Use this template to complete your final report and submit it for endorsement by the Director Office of Research, within three months from the end of project, prior to submission to EduLab PMO.

Section A

Please fill in the information below.

<p>Period of Report (mm/yy to mm/yy): 10/15 to 06/18 Project ID: NRF2015-EDU001-IHL10 Project Title: My Math Homework PAL Name of PI: TEO BENG CHONG Host Institution: NIE</p>

Section B

Please delete (only) the italicized instructions below and fill in the required information. If there are any sections/tables where you have nothing to report, please give a nil return instead of deleting that section/table.

1. Abstract of Final Report

Provide an executive summary of the progress of the project: its objectives, methodology, major accomplishments and other relevant information; highlight the value it offers to the education sector. Pay particular attention to how the project has impacted educational practices and/or benefited the larger educational community.

The aim of the project was to provide a computer software to help students to become better in solving math word problems. The approach is to use the software to guide the students to solve word problems in a systematic and structural way while providing enough scaffolds and helps when required. Also, when students cannot solve it correctly, it will pose a simpler yet similar problem for students to attempt. The process of posing simpler problems would allow the students to continue looking at and thinking of solving the problem instead of giving up. If students were to be able to solve the simpler problem correctly, they would then attempt the earlier problems to see whether they could do better. The rationale for this is to help students understand the problem better as well as boosting their confidence and competency over time. This approach would allow students to gain success experience while not giving up too quickly.

Although there was a long delay in hiring the software developer, the project team managed to complete the design and development of the software. The software together with the accompanied specially designed word problems were piloted with 2 groups of students from 2 schools in Nov 2017. The feedbacks were generally positive on the use of the software. In Jan 2018, 2 groups of students from 2 schools participated in the implementations with 9 homework assignments given over Term 1 and Term 2. Pre and Post tests as well as pre and post perception questionnaires were administered. Due to the small sample (n = 24) which followed through 1 whole implementation cycle and the short duration of using the software, data collected did not show any clear or significant changes in terms of students' attitudes, aptitudes and performances toward solving math word problems after using the software.

In summary, the software was developed as planned but with only 1 cycle of implementation involving a small group of participants being carried out. The original plan to execute at least two cycle of implementations did not go as planned because of insufficient time due to delay in hiring the software developer and the consequent late completion of the software. Data collected did not show significant impact of use of the software in helping students to solve math word problems better. Some contributing factors which influenced this outcome may be the lack of supporting mechanisms to sustain students' engagement, perception of students seeing these homework assignments as extra work and being lazy, and the strong prevailing belief by the students that they could not do word problems well by themselves.

2. **Main Report**

In no more than 15 pages (A4 size, Arial font size 10 or larger), elaborate on the following points:

(a) **Objectives** – *State the background and objectives of the project.*

In general, primary school students find solving math word problems to be difficult and many give up solving the problems too easily. The objective of the project is to help students in becoming better in solving word problems through the use of a special software which guides the students to solve word problems in a systematic and structural approach and to provide timely assistances where necessary so as students would not give up too soon. The aim is to use the software to build up student's confidence and competency in solving word problems on his own.

(b) **Achievements** – *Describe the extent to which the objectives of the research have been achieved and explain how it has helped project stakeholders to understand the impact and possible implications of implementing the innovation.*

The software and the accompany word problems were created, pilot tested and implemented as planned. Data were collected to see whether the use of the software helped student to solve word problems better. Due to some major delays, only a small group of students participated in the implementation. A lack of time also prevented multiple implementations for adjustment and improvement to the software and the approach. With only 1 implementation completed and a small number of students participated, the project team was not able to establish significant evidence to show effectiveness of the software and the approach through the data collected. However, all 3 teachers involved in the project concurred that the software and the approach were relevant, practical and useful in solving word problems.

Three lessons were learned after the post implementation review and reflection by the project team: (1) Using the software for homework alone is insufficient to create changes as students generally are lacking in motivation, have weak familiarization to the software (not use to), and apprehensions in solving word problem. Further supports need to be put in place to encourage continuous engagement. (2) More use of the software. For example, use it as a teaching tool in the classroom to demonstrate the thinking processes in solving word problems. With greater exposure and use of the software, students would be able to use the software better when they practice solving word problems on their own. (3) Some confusions between the model method and the use of the software as they are not quite the same. Further considerations are needed to see how the two can complement each other better. For example, to introduce the software approach earlier in P1 and P2 in helping students to develop a systematic and structural way in solving word problems.

- (c) **Findings** – *Provide a succinct account of the findings and results for the entire project duration with reference to the aims of your project (as indicated in your approved proposal).*

Our Approach:

- Follow the 4+1 steps in solving math word problem: Identify Data, Establish Facts, Derive New Information, and Write Solution; once the answers are determined, students will be asked to verify their solutions
- Provide scaffolding prompts and hints during the problem solving process
- When students failed to get the correct answer, they will be directed to solve the same problem but in a simplified version
- If students are able to get the correct answer to the simplified problem, they will be directed back to re-attempt the prior problem (to create successful experience)

Our Research Questions:

- Does the use of the software help a student to reinforce his behaviour and habit of checking his answers? (make less mistakes and errors)
- Does the use of the software increase student's awareness and confidence of his accuracy of his solution in solving word problem? (know what he is doing; become more confident)
- Does the use of the software change a student's views about solving math word problems? (willing to attempt; don't quit too easily)

Our Method:

- Conduct pre-survey and pre-test
- Collect students' artefacts (previous homework and exam scripts)
- 5 homework assignments per term for 2 terms
- Each homework will consist of 3 to 4 word problems of which 2 to 3 will be done through the software online
- The homework sheet will be given to students on Thursday/Friday and is to be collected back on the following Monday/Tuesday
- Students will attempt the online problems first; they will also need to write on the homework sheet their answers to all the questions (including those identical ones done online)
- Analyze students' solving patterns done online and written
- Conduct post-test and post-survey

Our sample:

School	Trial	Term 1	Term 2	Total
School 1	0	24 (P4)	24 (P4)	24
School 2	13 (P4)	5 (P4) + 11 (P6)	0	5 + 11
School 3	11 (P4)	0	0	0
Total	24			40

Due to the mixed levels involved and incomplete engagement in Term 2 at School 2, data collected are not used in the following tabulations. Data used below are from School 1 only.

Our findings:

- Does the use of the software help a student to reinforce his behaviour and habit of checking his answers? (make less mistakes and errors)

Survey Items	Pre Intervention	Post Intervention
said they'd checked their answers after they have solved it	83%	73%
said they'd re-do the math problem after they have solved it	30%	58%
said they'd ask for help when they were not sure whether their answer is correct	79%	58%

Pre and Post Tests results:

Performance Indicators between Pre-Test & Post-Test Pre-test (P3 questions) & Post-test (P4 questions)	%
Improved	33
No Change	17
Declined	50

Comparison between questions attempted online and paper:

Same Questions	Online (Tried)	Online (Not Tried)	Total
Paper (Tried)	22.7%	63.6%	86.3%
Paper (Not Tried)	2.1%	11.6%	13.7%
Total	24.8%	75.2%	100%

Same Questions	Online (Correct)	Online(Wrong)	Total
Paper (Correct)	58.2%	7.1%	65.3%
Paper (Wrong)	10.2%	24.5%	34.7%
Total	68.4%	31.6%	100%

New Questions	Online (Tried)	Online (Not Tried)	Total
Paper (Correct)	17.5%	33.3%	50.8%
Paper (Wrong)	12.7%	36.5%	48.8%
Total	30.2%	69.8%	100%

Conclusion: unable to establish direct link.

- Does the use of the software increase student's awareness and confidence of his accuracy of his solution in solving word problem? (know what he is doing; become more confident)

Survey Item	Pre-Intervention	Post Intervention
said they'd leave a question blank when they did not understand it	100%	17%
said they could understand the math word problem when they read it	92%	83%

said they have confidence in solving math word problems correctly	46%	35%
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Pre-test & Post-test Self-awareness Score: (knew “he was correct” and he was correct; knew “he was wrong” and he was wrong; knew “he was not sure he got the right answer” and he was wrong)

- Pre-test self-awareness score (62.5 %)
- Post-test self-awareness score (64 %)

Conclusion: no significant difference observed.

- Does the use of the software change a student’s views about solving math word problems? (willing to attempt; don’t quit too easily)

Survey Item	Pre-Intervention	Post Intervention
said they like to solve math word problems	58%	44%
said they have confidence in solving math problems correctly	46%	35%
said when taking math exam, they like Section C (word problem)	17%	28%
said they’d leave a question blank when they did not understand it	100%	17%

Conclusion: mixed results.

- (d) **Deviations** – Highlight the deviations from the objectives of the original proposal during the course of the project, if any. The reasons and justifications for the deviations should also be reported.

There is no deviation except the delays in schedules and the lack of time to iterate the implementation for adjustment and fine-tuning and for more data to be collected over longer engagement.

- (e) **Scaling and Sustainability**– Describe how the project findings and results could be scaled up and/or replicated at the same or other institution(s), and sustained. Also, describe the challenges that could be encountered in scaling up or sustaining the project and how these challenges could be overcome.

The project finding indicated that the software and approach is practical and relevant. Its potential usefulness and advantage can only be established with further testing and development. From POC perspective, we have shown that it can be done. Due to the lack of time, the project team could only implement once without having the opportunity to make adjustment and improvement through further iterations.

At this stage, the project is not ready for scaling. However, the sustainability of the software and approach is easily attainable once the evidence of its effectiveness has been established after further testing and study were made.

- (f) **Impacts** – Highlight the possible impact on the professional development of teachers, the overall ICT infrastructure and the education system. Also, highlight who and/or which subject/sector do you think the results of your research would make the biggest impact.

The current practice of using the model method to solve math word problems is practical but not perfect. To apply the method well, students must be able to first understand the problem fully and also be able to combine all the given facts onto the pictorial model correctly and then finally solve it. In general, students find it very hard to begin drawing the model on a blank paper. By using a systematic and structural approach, and by combining the use of pictorial representations and algebraic expression side-by-side, our software and its underlying approach could provide the scaffolding support and visual connection students needed to understand and solve word problems. With further research, the software and approach could be improved and fine-tuned to make it the standard way for teaching and learning of solving word problems in Primary Math for all schools.

- (g) **IP and Knowledge** – Highlight the potential intellectual property created and the knowledge transferred between all parties. Also, highlight the possible area for commercial exploitation.

The software created can be implemented and used at home, at school and at the system level easily. While the original design intent of using the software is to help students to practice solving word problems as homework, the software (with further improvements) can be used as a teaching tool for solving word problems in the classrooms. With further R&D efforts, the tool as well as its approach for solving word problems can be used to complement, enhance or even replace the current

practice of the model method for solving word problems. The software is built by combining the best parts of the model method and algebra. Students using this approach should be able to connect well with the pictorial representations and the algebraic expressions making the transition from Primary Math to Secondary Math more naturally and smoothly.

3. **Project management and execution**

- (a) *Provide a detailed write-up of work performed. Describe the individual and collaborative work done by the various organizations involved in the project, if the project involves more than one school/ organisation.*

The project team completed all necessary required work in running the software and implementing the intervention at the school sites. The work involved the designing of special word problems for online (through using the software) homework assignments and offline (paper and pencil) homework assignments. The other main task was to design, code and test the web based software that allowed students to solve word problems in a structural approach and to receive hints, helps and reminders along the way. The intervention required students to complete online homework assignments through using the software and to complete and submit written offline homework assignments. The online and offline homework assignments had overlapping questions for comparison study. Students were informed that these homework assignments were extra work to help them become better in solving word problems. Five set of assignments were given out in each term. Students work were collected and analyzed.

- (b) *Highlight any problems encountered (e.g. technical or personnel problems, material/ equipment sourcing problems) and how these were resolved. Include reasons for any delay if the programme took longer than the proposed time frame.*

The major problem encountered was the hiring of the software developer. It took almost a year to get one at the end through an external agency. This also resulted in higher cost. The delay significantly reduced the performance of the project.

The other problems encountered were technical challenges and recruiting students to participate in the intervention. Most of the technical challenges were overcome by re-thinking and re-designing our approach through re-coding and testing. The failure to obtain consent and accent for students to participate was unexpected. As time was running out, all efforts to get more students did not prevail. The project team had to settle with only a small sample to work with.

4. **Milestones**

Provide the timeline and milestones, as well as numbers of man-hour required, for the project, and where an activity is not carried out as projected, provide reasons in this space.

Activity	Start Date	End Date	Duration	Remarks
Design primary math word problems	1 Jan 2016	31 Dec 2017	24 months	A total of 100+ word problems for various topics were created for various levels with various difficulties. Each problem was designed based on the 4+1 approach. As the software evolved through development challenges, the problems were also had to be modified along the way.
Design, develop and test software	1 Nov 2016	31 May 2018	19 months	Software development started late because of the delay in hiring the software developer. There were a few technical challenges encountered along the way which required re-thinking, re-designing and re-coding. A complete working version was created in Oct 2017.
Pilot test	1 Nov 2017	31 Dec 2017	2 months	2 Trial runs were carried out in Nov 2017 at Westwood Primary and Jing Shan Primary. Further improvements were done based on the feedback collected. The final version was completed and was ready for implementation in Jan 2018.
Implementation and data collection	1 Jan 2018	31 May 2018	5 months	1 class of 24 P4 students at Endeavour Primary consented to participate. Five homework assignments were given in Term 1 and another 4 homework assignments were given in Term 2. 1 class of 5 P4 students at Jing Shan Primary consented to participate. Another class of 11 P6

				<p>students also consented to participate around half way through Term 1. Not all homework assignments were given out. Most students did not wish to continue in Term 2.</p> <p>No student participated at Westwood Primary because the teacher involved was not assigned to teach math (only science) in 2018. Other teachers were invited to participate but none agreed due to lack of knowledge of the project and the uncertainties involved.</p>
Data Analysis & Report	1 Mar 2018	31 Jun 2018	4 months	<p>Pre and post tests together with perceptions surveys were administrated with students at Endeavour Primary. Due to the small number of samples at Jing Shan Primary, data collected were not used for analysis.</p> <p>As the final sample size is small overall, a simple descriptive method was use to analyze the data.</p> <p>In summary, there is no significant findings to show that the intervention and the use of the software demonstrated any positive improvement or impact.</p>

5. **Key Performance Indicators (KPIs) Updates**

Provide the following for the entire project, where applicable, in Annex A:

- *The number of schools benefited from the project*

- *The number of teacher researchers involved in the project*
- *The number of IDM-based lesson packages created for the project*
- *No. of workshops held to share knowledge and outcome*
- *List of paper publications in APA format*
- *List of presentations at international conferences in APA format*
- *List of products and applications developed*
- *List of industry involvement*

6. **Fund Utilization Rate**

Provide a breakdown of budget and expenditure in Annex B. Please provide an explanation if fund utilisation rate (with reference to the latest budget projection) is below 90%.

Due to the delay of hiring the software developer, the software was not completed as scheduled which prevented the project team to move beyond the web based platform. Equipment needed for mobile development had to be cancelled and having the fund transferred to manpower. As the project timeline was cut short due to the delay, some planned activities were also cancelled.

Total utilization rate as at 30 June 2018 is 89.9%. There are still some outstanding payments to be processed. Once settled, the final utilization rate should be above 90%.

7. **Future Plans**

Briefly describe any new research areas or product development arising from this project. If there is potential to scale the tools or interventions arising from this project, briefly share how they can be scaled to similar and different contexts, and what resources would be required for scaling the tool or intervention.

The developed software needs to be further tested, fine-tuned and improved. It is also found that the software used solely for homework based may not be sufficient to help students developing their competency as students may lack self motivation and self discipline to proceed on their own. A follow up study in using the software for in-class used together with practice at home may produce better results. Another possible way, is to use the software right from P1 or P2 to establish a strong foundation and routines for solving word problems

8. Final Statement of Account

Please enclose a statement of account of the above project from your Finance Department. The statement should reflect the approved budget and the expenditure in the year reported in terms of manpower, equipment, consumables and others, as well as the balance at the end of the project.

9. Equipment Purchased

Please provide an inventory list of equipment purchased under the grant in Annex C.

10. Additional Comments (optional)

In no more than 250 words, comment on how this project could have been improved, scaled up and sustained, and what could be the best mode of practice and propagation.

The project could have been improved if there were no delay in the hiring of the software developer which would allowed the project team to have more time for implementing the intervention using the software.

At this stage, the project is not ready for scaling because insufficient number of interventions were being carried out due to short of time. However, with these limited implementations, the small data collected has indicated somewhat that the approach and the software are feasible, practical and useful.

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