CAT 4
RESOURCE DEVELOPMENT

Group 4-006
Fewest Moves Challenge

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Abstract

The Rubik's cube is a 3D combination puzzle invented in 1974 by Hungarian sculptor and architecture professor, Erno Rubik. Held by the World Cube Association (WCA), the Fewest Moves Challenge (FMC) is an event organized in Rubik's cube competitions, where competitors attempt to solve a cube in the fewest moves possible, from a given scramble. This project aims to create an easy-to-understand, offline learning package for experienced cubers to gain insights and skills related to FMC, to encourage them to engage in FMC in cubing competitions.

Introduction

Competition over cubing began, leading to the formation of the WCA in 2004. Although speedcubing remains an interesting sport among cubers, experienced cubers tend to lack awareness regarding the Fewest Moves Challenge (FMC) competition, one of the 17 official events the WCA holds at cubing championships.

Contestants are given a pen, 3 Rubik's Cubes, and a stopwatch. A sheet of paper with a scramble in standard Rubik's cube puzzle notation and a net of a cube with that scramble performed, some information about more difficult notations (e.g.: rotations), and a space to write the finished solution are given. Contestants have 60 minutes to find the solution which requires the fewest moves possible.

Given the lack of knowledge about FMC amongst cubers, our project attempts to promote more attention and interest in FMC.

Objectives

1. Create a learning resource for cubers to learn FMC
2. Encourage cubers to engage in FMC in cubing competitions
3. Allow cubers to utilise skills learnt from FMC and apply it to other cubing events

Target Audience

Our target audience are experienced cubers, as they possess sufficient prior exposure to handle FMC which is harder than regular speedcubing events. Our definition of experienced cubers refers to those who have at least participated in an official competition before, but the inclusion of other cubers may vary as we wish to expand our outreach to be flexible. Experienced cubers are apt for FMC as they may discover interest in FMC but have not challenged themselves before, and thus we want to provide them an opportunity to gain knowledge in this cubing area.

Literature Review

Learning and recognising patterns and training how to apply the appropriate algorithms are required to solve the Rubik's cube. According to McClelland, K. & Grata, L. (2018), the essence of computational thinking involves breaking down complex problems into more manageable subproblems (problem decomposition), using a sequence of steps (algorithms) to solve problems, reviewing how solutions transfer to similar problems (abstraction), and finally determining if it can more efficiently solve those problems (automation). This is useful for students who face difficulty in their ability to think critically to solve problems in their daily school lives, allowing them to retain knowledge more quickly and effectively through iterated cubing training, honing their problem-solving abilities.

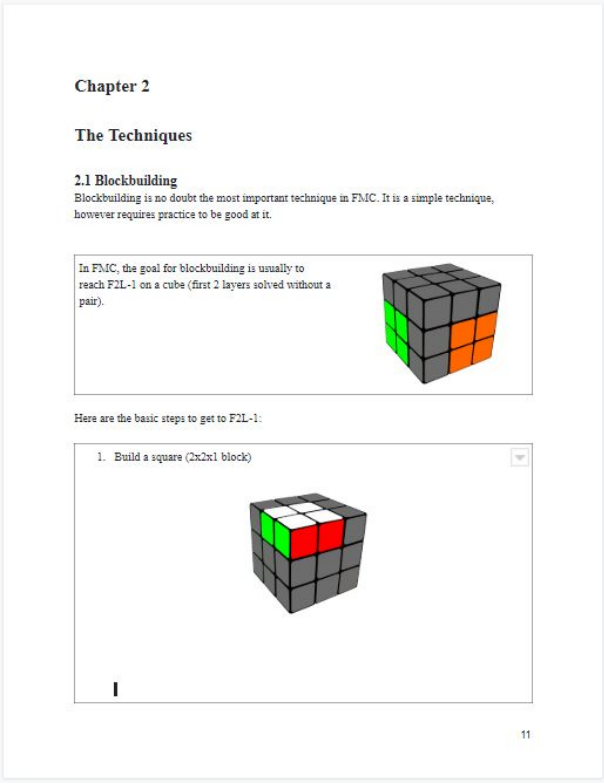
Furthermore, the type of problem-solving methodologies that cube solving trains is a problem-solving process specifically geared towards a single context. This and other problem-solving methods based on a specific knowledge geared towards particular situations outperform widely applicable methods (Tiensuu, 2012, p. 29). Hence, cubing can produce a greater impact on students who pick up this problem-solving skill.

In addition, research shows that the humans' attention span is shortening. Researchers from Microsoft surveyed 2,000 participants in Canada in 2015 and studied the brain

activity of 112 others using electroencephalograms (Microsoft, 2015). The results showed the average human attention span has fallen from 12 seconds in 2000, to 8 seconds in 2015. It is significant that students remain focused and attentive in this technological era, where youths tend to become distracted by their smart devices. Learning and solving the cube is able to help students retain this longer attention span, affirming a need for our product.

Learning Package

The resource created for this package was an offline tutorial with visual aids which would be useful, especially for users who dislike long texts or for users who learn better through visual explanations. The tutorial incorporates the latest and more effective teaching styles in the hope of educating the users more productively.



Chapter 2

The Techniques

2.1 Blockbuilding

Blockbuilding is no doubt the most important technique in FMC. It is a simple technique, however requires practice to be good at it.

In FMC, the goal for blockbuilding is usually to reach F2L-1 on a cube (first 2 layers solved without a pair).

Here are the basic steps to get to F2L-1:

1. Build a square (2x2x1 block)

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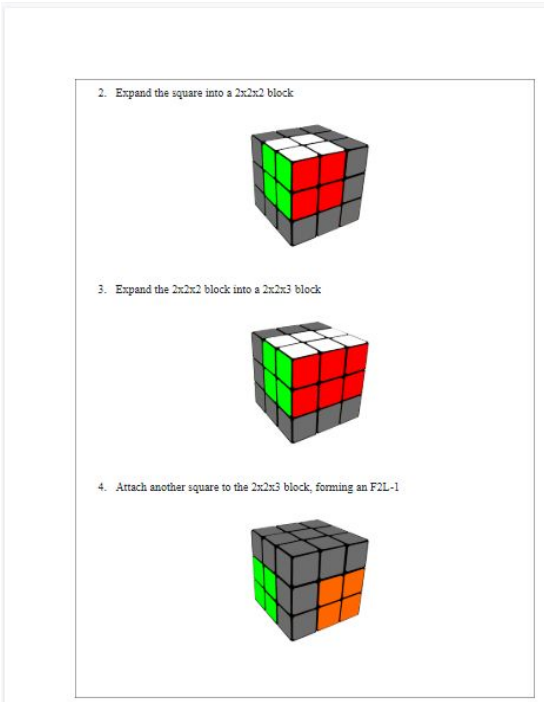

2. Expand the square into a 2x2x2 block

3. Expand the 2x2x2 block into a 2x2x3 block

4. Attach another square to the 2x2x3 block, forming an F2L-1

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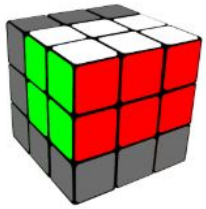
Example 2
R D R' D2 R D L R' D' B L' D

// 2x2x2
L D' L // white-blue-red square
B' // 2x2x3 block

EXTRA: an extra L2 move forms an F2L-1!



From then on, to create an F2L-1, you build another square then attach it to the block, same concept, just remember you have more possibilities to build your square now.

Example 1

Scramble: **L2 F' B U2 R2 D' B' R D2 R2 U F2 B2 U D2 F2 D' L2**

Can you find a pair (match up a corner and an edge) in 2 moves?
hint: yellow-green-red corner and green-red edge

Solution: **U** // align
R2 // join

We produced our own diagrams and included examples for illustration, to allow readers to understand the concepts we wish to convey. To allow readers to better retain these techniques, we created multiple scrambles for them to practice themselves.

Practice 1 (white-green-red 2x2x2)

1. **R2 B' D L U' L D L F' D2 B2 U** (1 move)
2. **U2 R B' L B' L D' F U2 F' L D'** (2 moves)
3. **U2 L U2 B' U' D F' R D' B L' F** (3 moves)
4. **R2 B' L B2 U' D L U2 R2 L2 B2 U** (4 moves)
5. **U R' F2 R2 B' L2 U2 L D2 F2 R D** (5 moves)
6. **F R' F' B' U L' D2 R2 D2 R2 B U2** (6 moves, can you find all 4 solutions?)
7. **R U' B R D L2 U2 F' B' D2 F' B'** (7 moves, there are 9 solutions)

Solutions

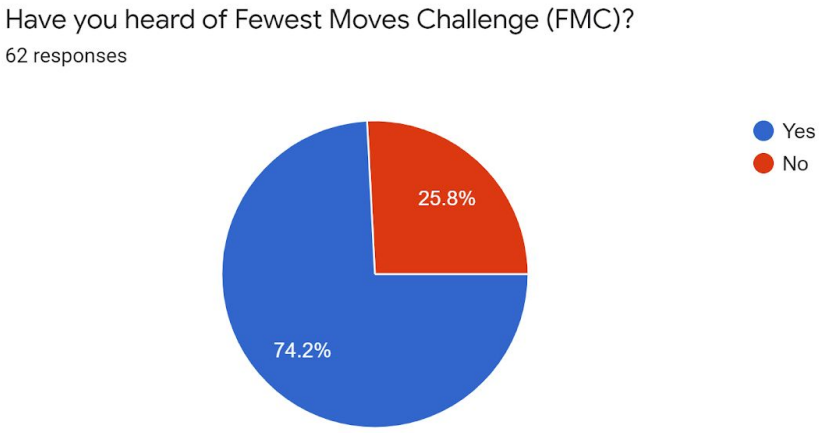
1. R'
2. R2 F2
3. B L U'
4. B' D L' F2
5. D' B2 D' R' U
6. R2 F' L F D' R2
   R2 F' L D' F R2
   F' L F R2 D' R2
   F' L F U' B2 U
   (4 solutions)
7. B D' L U2 B' R U
   D2 R B' D2 U B2 R'
   F L' D B2 R U2 F'
   L2 R U' F' D U2 R
   L2 U' R F' D U R
   R D' B2 D' B U R'
   L' D U R U2 F U'
   L' F' R2 U' R' D F'

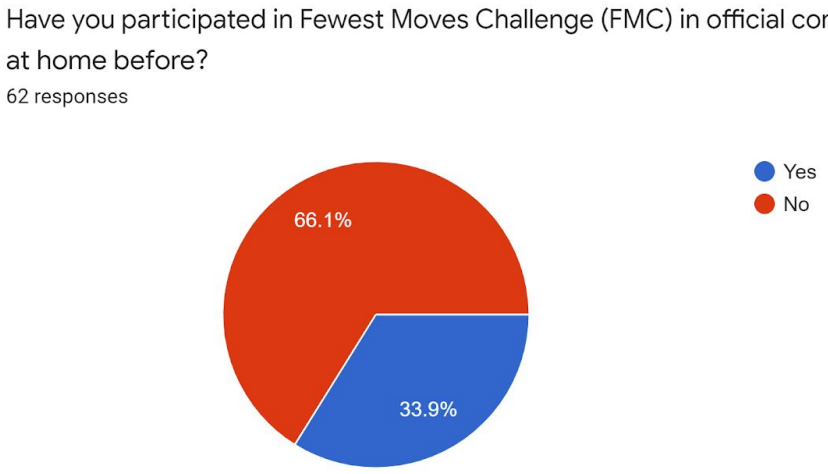
A table of contents and reader guide are also provided for learners to refer to specific parts easily. All these ensure that readers can learn effectively and independently.

Methodology

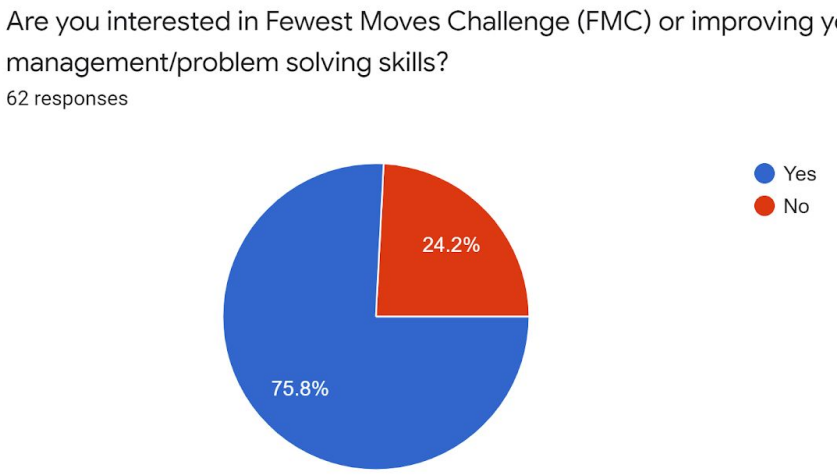
Needs analysis

FMC involves more challenging concepts than grasping the basics on solving a Rubik's cube. Thus, we conducted our survey on experienced cubers who are more suited given their ability level and standard.





Our data shows that the majority of cubers, despite having heard of the FMC challenge, still have not participated in any official competitions or attempted FMC during their time at all. Thus, we can infer that cubers who are aware of FMC have not challenged themselves to do it, which highlights the need for us to assist cubers in learning FMC.



As many people have expressed great demand for learning FMC, our resource can equip them sufficiently to take up the challenge.

Construction of resource

From our needs analysis and research about the latest FMC techniques, we realized that existing online resources lack examples and visual aids, leading to confusion in readers. Existing tutorial videos also failed to include step-by-step or detailed explanations. Thus, we added detailed and clear explanations in our resource, as well as relevant visual aids. Finally, we gathered recommendations from the cubing community to improve our package.

Perceived Impacts

Our FMC package would help improve the problem-solving abilities of participants, engaging their creativity as they attempt to reduce moves with the guidance of our resource. The solving methods in the resource boosts one's efficiency when dealing with daily tasks. It improves hand-eye coordination as participants switch between perception and physical cubing actions, simultaneously enhancing their fingers' dexterity.

FMC also helps participants to change their perspective as they explore possible solutions to the cube, broadening their viewpoint when they face a problem, as well as teaching participants the importance of patience and perseverance.

FMC involves computational thinking skills: decomposition, pattern recognition, focusing on parts of the cube, and applying the algorithms to solve the cube, encouraging a part-by-part approach to solving problems.

Most importantly, more people may gain interest in FMC, compete in FMC in official competitions, and learn to appreciate the different cubing experience.

Feedback from top solvers

In light of the pandemic, our project's outreach was limited, and we decided to share our learning package to the online speedcubing community, and obtained advice for improvement from top speedcubers globally, before making improvements to our resource. These cubers' vast experience and knowledge makes their insights more reliable, valuable and useful for seeking improvement.

Wong Chong Wen

2 Asian Records

18 FMC National Records

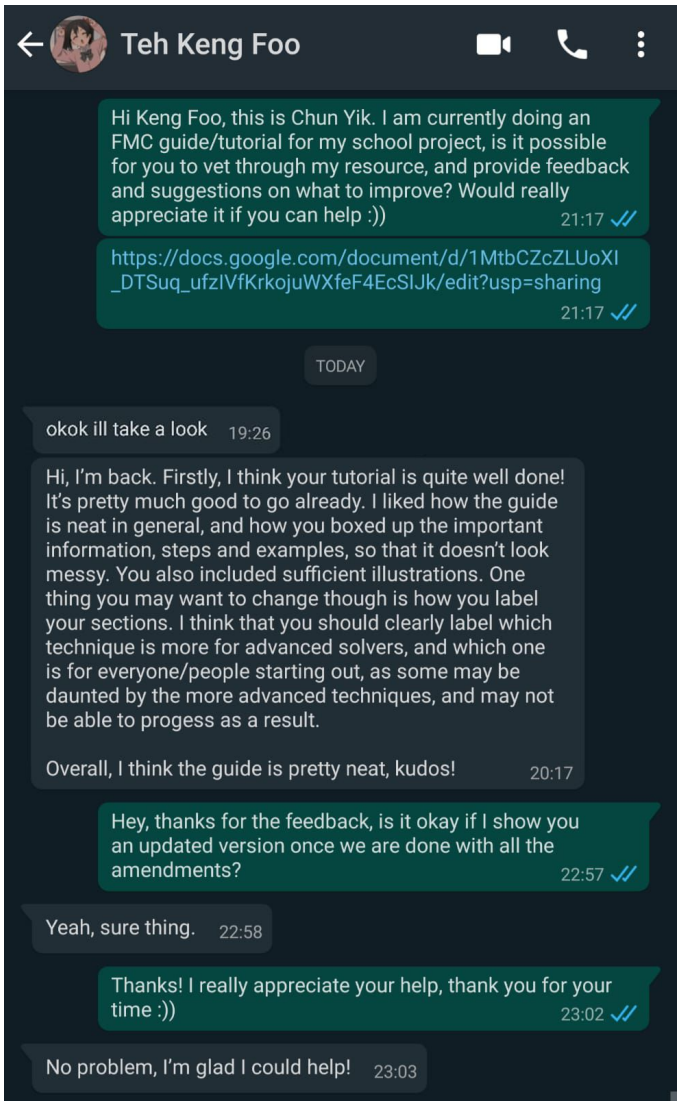
currently 1st in Singapore,
2nd in Asia, 9th in the world

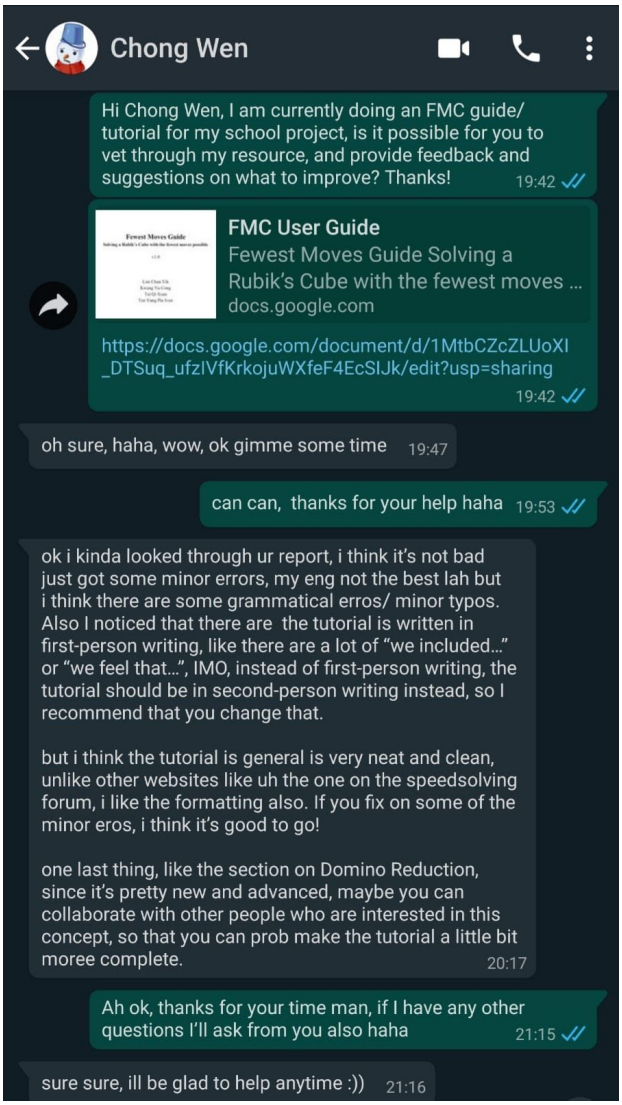
Teh Keng Foo

2 FMC National Records

Former Asian Record Holder

currently 1st in Malaysia,
5th in Asia, 18th in the world





The general response of our resource was a mix of positive and negative reviews. Some positive feedback included the neatness and cleanness in terms of presentation, which is said to be better compared to available resources. The guide was overall appeasing and presentable, and well-targeted at developing FMC learners. Conversely, negative comments included minor errors in language, styling and labelling and other areas which we had amended. Furthermore, some suggestions raised were providing video tutorials and collaborating with other top cubers, to make the guide more holistic and comprehensive.

Limitations

While some of our project's objectives were to improve the attention span and problem-solving skills of users, it is difficult to determine the extent of such impacts. In addition, FMC is time-intensive as it is not a simple concept to grasp.

Due to the COVID-19 situation, we were unable to conduct pilot tests, thus we have less direct feedback from resource users. Concrete feedback given during pilot testing was still preferable to ascertain the effectiveness of our product.

Further extensions

Taking the suggestions for our resource into account, basic errors in language, styling etc have been largely resolved and amended in our resource. However, enhancements such as the addition of visual tutorials and collaborations with cubers are possible continuations to our project for future work on our package.

Conclusion

Throughout this project, we developed our collaborative, time management and problem-solving skills as we worked to overcome physical restrictions in light of COVID-19. It was important that we communicated efficiently in order to complete our resource punctually while not compromising on quality. Relooking at our objectives, we believe we have successfully made a convenient and effective FMC learning package, and our aims, overall, have been mostly achieved online. Ultimately, we hope that more people will pursue FMC, and appreciate the beauty in this unique cubing event.

Acknowledgements

We would like to express our gratitude to the international speedcubing community for sharing new and updated techniques and methods, allowing us to successfully provide updated information for all users.

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