

K-Pop Data Analysis

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Starting in 2024.

Executive Summary

Write something here

Disclaimer

This manuscript is written solely by the author, not by ChatGPT or any other generative AI. We emphasize this due to the widespread presence of AI-created articles.¹ Moreover, the opinions and views expressed in this manuscript are those of the author, and do not necessarily state or reflect those of any institution or government entity.

1 Introduction

Briefly describe what the K-pop music is, such as songs and elements

K-pop music (Korean popular music) is a genre of entertainment originated from South Korea (Lie, 2015), and K-pop emphasizes more on the dancing component than the singing element.

Therefore, K-pop shows are like an audio-visual treat, appealing to the general public (Pal and Saha, 2022).

Music: K-pop groups often showcase a wide range of musical styles, from pop and hip-hop to rock and R&B (Rhythm and Blues), within a single discography (Liu, 2024). [sentence needs revision]

Lyrics:

Upbeat and catchy - Many tracks are designed with high energy and memorable hooks, making them easy to listen to and popular for dancing.

Dance: Choreography, complex

Fashion: Dress, make-up, hair style, etc.

Stage and video effects: Bright lights, video-editing for focus, etc.

Important: Write about why K-pop music is so popular across the globe.

K-pop has emerged popularity worldwide since the early 2010's (Khiun, 2013; Sun, 2022). K-pop's international popularity stems from its versatile music, eye-catching performances, and the strategic use of social

¹<https://graphite.io/five-percent/more-articles-are-now-created-by-ai-than-humans>

media, fostering a global community of dedicated fans who actively promote the artists and genre (Kim and Kwon, 2022; Chen, 2023). Therefore, K-pop enjoys global fame – not only across East Asian countries like China and Thailand (Malik, 2023), but also in the United States² and Western Europe³ (Miroudot, 2024).

In addition to the K-pop performance itself, survival reality shows have also been an emerging trend in the K-pop industry (Butsoontorn, 2023; Lee, 2020). The main objective of such shows is to select the top contestants to form a new K-pop group. One major feature is the audience involvement – many survival shows allow the audience to vote on contestants’ performance (Kim and Shin, 2025), keeping the audience engaged with the live episodes.

Need a transition sentence here

Mnet is a television music channel famous for hosting idol-making survival shows, such as *Produce 101* and *Produce 48* (Capistrano and Ramirez, 2023).

1.1 Motivation

The author became interested in K-pop music from the debut of Tzuyu (Chou Tzu-Yu, 周子瑜).⁴ Tzuyu is originally from Taiwan, the country in which the author grew up. In 2015, Tzuyu participated in the South Korean reality television show *SIXTEEN*,⁵ and eventually got added to the newly-formed girl group *TWICE*.⁶ In early 2016, Tzuyu was forced to apologize after she raised the Taiwan flag in a Korean entertainment show (Ahn and Lin, 2019).⁷ The flag controversy incident made headline news in Taiwan,⁸ and it was estimated to bring in 500,000 votes for the 2016 Taiwan presidential election.⁹

Then in 2017, another Taiwanese girl, Snowbaby (蔡瑞雪),¹⁰ joined the Korean live reality show *Idol School* (偶像學校).¹¹ At the end, the show would select nine winners to form the girl group *fromis_9*.¹² This also generated much discussion in the Mandarin-speaking community.¹³ Although Snowbaby was eliminated in the middle of the show, she still deserves praise for her courage to participate as an international contestant.¹⁴ Since Snowbaby graduated from the same high school as the author did,¹⁵ Snowbaby’s experience motivated the author to learn more about K-pop.

The author also followed other K-pop reality shows such as *Produce 48* in 2018.

She loved the visual aesthetics and the artistic performances of K-pop.

To combine with statistical analysis ?!

Explain why and what we are doing in this analysis

Important: Write about the K-pop scandal revealed in 2019 and later.

Although the author enjoyed watching the K-pop survival reality shows, ...

In 2019, the author stopped following the shows produced by Mnet due to the ethical scandals revealed (Miao, 2020), especially the manipulation of voting outcomes on survival shows (Leinonen, 2024).

Therefore, we focus on the ratings directly given by the vocal and dance instructors, rather than the number of audience votes announced by the show organizers.

²<https://bit.ly/4iIHpor>

³<https://nolae.eu/blogs/news/diese-k-pop-konzerte-werden-2025-in-europa-stattfinden>

⁴<https://en.wikipedia.org/wiki/Tzuyu>

⁵[https://en.wikipedia.org/wiki/Sixteen_\(TV_program\)](https://en.wikipedia.org/wiki/Sixteen_(TV_program))

⁶<https://en.wikipedia.org/wiki/Twice>

⁷<https://bit.ly/3DOcNIP>

⁸<https://bit.ly/4k5j7ps>

⁹<https://bit.ly/3CUQWsK>

¹⁰Snowbaby’s YouTube channel: <https://www.youtube.com/@snowbaby>

¹¹[https://en.wikipedia.org/wiki/Idol_School_\(2017_TV_series\)](https://en.wikipedia.org/wiki/Idol_School_(2017_TV_series))

¹²https://en.wikipedia.org/wiki/Fromis_9

¹³<https://www.epochtimes.com/b5/17/7/2/n9346573.htm>

¹⁴<https://bit.ly/41p3pym>

¹⁵<https://bit.ly/424u3gv>

https://en.wikipedia.org/wiki/Mnet_vote_manipulation_investigation

1.2 K-Pop Controversies

Unfinished below

Behind the beautiful K-pop music and dance videos, ...

Blood and sweat ?! Also money and political capital involved. [citation needed]

A lot more content here, probably need a transition paragraph

Survivorship bias is prevalent in the entertainment industry, and the K-pop genre is no exception (Lockwood, 2021). To become a K-pop idol in Korea, aspiring kids usually start as a trainee at an entertainment company in their early teens (Lee and Jin, 2019). The trainees take vocal and dance lessons, and the training process is intense and extremely competitive (Kang, 2017; Lee, 2024). That's why most K-pop artist performances are polished and well-rehearsed (Kim et al., 2021). Nevertheless, very few trainees can eventually get selected to debut and perform on stage as the company's official group (Han and Pothong, 2021), and even fewer K-pop performers can achieve iconic status (Min, 2024). While a performing group enjoys the spotlight and fame, the group typically lasts only a few years before the contract ends (Cho et al., 2023).

K-pop overcrowded market (Liu, 2025).

Strict body weight and dietary requirements, especially for girl trainees (Venters and Rothenberg, 2023; Zysik, 2024).¹⁶

Need another transition paragraph

A K-pop vote manipulation scandal was surprisingly revealed in 2019, starting with the *Produce X 101*¹⁷ and the mysterious 29,978 number.¹⁸ After the producer Mnet¹⁹ published the number of votes each contestant received, people calculated the difference between rankings and noticed a strange pattern of the numbers. The difference was exactly 29,978 votes for five intervals among the rankings from 1st to 10th. The pattern seemed to be generated by some mathematical function, and it was nearly impossible to be a coincidence. Hence people suspected that the voting results were manipulated by Mnet,²⁰ resulting in a lawsuit against Mnet and other companies involved (Choi, 2023).

Finally, Mnet admitted to manipulating the votes in the *Produce 101* series²¹ and the subsequent reality shows, including *Idol School*.²² The show producers rigged the votes in return for financial favors, resulting in not only unfair competition but also employment fraud (Lee and Zhang, 2021). The court demanded that Mnet must provide monetary compensation to the affected trainees, who should have been selected for the debut but lost the opportunity.²³ These entertainment agency representatives were charged with bribery, fraud, and sabotage (Yoshimitsu, 2020).

Idol School: Vote Manipulation Investigation (2019)

<https://www.ptt.cc/bbs/KoreaStar/M.1624467107.A.D7F.html>

What was the penalty of these entertainment agency representatives?

<https://www.ptt.cc/bbs/KoreaStar/M.1680484737.A.28A.html>

Need academic citations, not just news links.

¹⁶<https://www.chinatimes.com/realtimenews/20200928003058-260404?chdtv>

¹⁷https://en.wikipedia.org/wiki/Produce_X_101

¹⁸<https://www.koreaboo.com/news/produce-x-101-rigged-votes-final-members/>

¹⁹[https://en.wikipedia.org/wiki/Mnet_\(TV_channel\)](https://en.wikipedia.org/wiki/Mnet_(TV_channel))

²⁰<https://bit.ly/4iWtPh0>

²¹<https://bit.ly/4oaMEzV>

²²<https://www.popdaily.com.tw/korea/846603>

²³<https://bit.ly/44gkSKG>

Also need to mention other scandals with citations

e.g. sexual harassment (Luu, 2022; Varianna and Kusumawardani, 2024)

e.g. exploitative contracts that mainly benefit the company, not the artists (An, 2025)

Negative impact on the K-pop industry, such as the cancel culture from K-pop fans (Putri and Kusuma, 2025; Febrianti et al., 2023).

Impact on the trainees who lost the chance to debut:

They received monetary compensation, but the debut opportunity could not be recovered. (citation needed)

After the 2019 scandal, Mnet has been under controversy but is still actively producing K-pop dance survival shows.²⁴ Recent works of Mnet include *Kingdom: Legendary War* (2021)²⁵ and *Stage Fighter* (2024).²⁶

As of 2025: the Deepfake and Generative AI videos pertinent to K-pop. (citation needed)

Deepfake videos of K-pop idols are negatively perceived by the fans (Wang and Kim, 2022a,b), and such malicious use of AI damages not only the idols' reputation but also the whole K-pop industry (Alexandri, 2024).

K-pop performance videos published in 2021 or earlier are mostly real, because they were created before the widespread use of generative AI (Cho and Lee, 2025).

1.3 Technical Narrative

Datasets from K-pop reality shows in South Korea

In this project, we explore a few datasets from K-pop reality shows that have at least two sets of contestant ratings. We would like to evaluate the correlation and consistency between the ratings of the same K-pop trainees, so at least two sets of ratings are necessary. Note that contestant ratings differ from audience votes – the former are given by professional K-pop coaches, while the latter come from the general public.²⁷

Unfinished below

Datasets Considered: Need to have at least two sets of contestant ratings to evaluate for correlation and/or consistency.

- Idol School (2017)
 - Female contestants
 - Basic Strength Ratings: Vocal, Dance, Physical, Overall
 - [https://en.wikipedia.org/wiki/Idol_School_\(2017_TV_series\)](https://en.wikipedia.org/wiki/Idol_School_(2017_TV_series))
 - https://en.wikipedia.org/wiki/List_of_Idol_School_contestants
- Produce 101 (2016)
 - Female contestants
 - Judges' Evaluation 1: A, B, C, D, F
 - Judges' Evaluation 2: A, B, C, D, F
 - https://en.wikipedia.org/wiki/Produce_101
 - https://en.wikipedia.org/wiki/Produce_101_season_1
 - https://en.wikipedia.org/wiki/List_of_Produce_101_contestants
- Produce 101 Season 2 (2017)

²⁴<https://www.ptt.cc/bbs/KoreaStar/M.1618588754.A.7C9.html>

²⁵https://en.wikipedia.org/wiki/Kingdom:_Legendary_War

²⁶https://en.wikipedia.org/wiki/Stage_Fighter

²⁷For Mnet-hosted shows, voting requires an account on the Mnet Plus app. <https://www.mnetplus.world/en/>

- Male contestants
- Judges’ Evaluation 1: A, B, C, D, F
- Judges’ Evaluation 2: A, B, C, D, F
- https://en.wikipedia.org/wiki/Produce_101_season_2
- [https://en.wikipedia.org/wiki/List_of_Produce_101_contestants_\(season_2\)](https://en.wikipedia.org/wiki/List_of_Produce_101_contestants_(season_2))
- Produce 48 (2018)
 - Female contestants (50% from South Korea and 50% from Japan)
 - Judges’ Evaluation 1: A, B, C, D, F
 - Judges’ Evaluation 2: A, B, C, D, F
 - https://en.wikipedia.org/wiki/Produce_48
 - https://en.wikipedia.org/wiki/List_of_Produce_48_contestants
- Produce X 101 (2019)
 - Male contestants
 - Judges’ Evaluation 1: A, B, C, D, X
 - Judges’ Evaluation 2: A, B, C, D, F, X
 - https://en.wikipedia.org/wiki/Produce_X_101
 - https://en.wikipedia.org/wiki/List_of_Produce_X_101_contestants

Datasets NOT Considered: These datasets do not have enough sets of contestant ratings for our analysis.

- Mix Nine (2017-2018)
 - Selected 9 females and 9 males for the final team
 - Only one set of contestant ratings was available.
 - https://en.wikipedia.org/wiki/Mix_Nine
 - https://en.wikipedia.org/wiki/List_of_Mix_Nine_contestants
- Sixteen (2015)
 - Female contestants within JYP Entertainment
 - No ratings available for any contestant.
 - [https://en.wikipedia.org/wiki/Sixteen_\(TV_program\)](https://en.wikipedia.org/wiki/Sixteen_(TV_program))

This manuscript is created using R Markdown (Allaire et al., 2024)²⁸ for reproducible data analysis, just like our earlier technical report about the education in Taiwan (Chai, 2024). We have posted our code and data on GitHub,²⁹ so readers can download the GitHub repository and play with the script themselves.

The rest of this manuscript is organized as follows.

e.g. Chapter 23 does something.

2 *Idol School* Dataset (2017)

Idol School (偶像學校) is a 2017 Korean reality television show produced by Mnet. Unlike the 2016 *Produce 101* that mostly featured K-pop trainees,³⁰ *Idol School* did not require any vocal or dance experience and was willing to train the participants from scratch. Despite the low barrier to entry, many participants in the reality show had previously trained under various entertainment companies.³¹ For example, NATTY was

²⁸<https://rmarkdown.rstudio.com/>

²⁹<https://github.com/star1327p/K-Pop-Dataset>

³⁰https://en.wikipedia.org/wiki/Produce_101

³¹https://kpop.fandom.com/wiki/Idol_School

trained under JYP Entertainment³² and made it to the finals of the *SIXTEEN* reality show³³ in 2015. Lee Yoo Jeong (李悠汀) previously debuted in the girl group *myB*, but the group disbanded in 2016.³⁴

For *Idol School*, we need to add some academic citations.

Shall we also mention some beginners who quickly learned to perform K-pop? Showing that it's possible to succeed with little-to-no initial experience.

e.g. Lee Si An (李詩安) and Yoo Ji Na (柳知娜) started out as complete beginners in the show, but they picked up the K-pop dance very fast and survived until the final episode.

e.g. Baek Ji Heon (白知憲) and Lee Na Gyung (李娜景) also scored low in the initial performance test, but both of them eventually made it to the top nine for the debut.

In the live reality show *Idol School*, nine winners were selected to form the new girl group *fromis_9*.³⁵ This girl group debuted in 2018 and remained active until the contract with Pledis Entertainment ended in 2024. In January 2025, five members of the group signed a new contract with ASND.³⁶

What was the announced selection process for the nine winners?

Audience voting

What was the actual selection process instead?

Need to write the data description

Wikipedia data: https://en.wikipedia.org/wiki/List_of_Idol_School_contestants

2.1 Read in the *Idol School* Dataset

We manually copy-pasted the contestant data from Wikipedia into a Microsoft Excel workbook (.xlsx), and used the R package `readxl` (Wickham and Bryan, 2023) to load the dataset. A main advantage of .xlsx over .csv is that we can have multiple data sheets in the same Excel file for consolidation. Moreover, Excel supports Chinese characters, so we can also include the Chinese names of each contestant. Since the English translation of Korean names look similar to each other (Kim, 2020), we also include the date of birth (DOB) to make it easier to uniquely identify each contestant. For those who are able to read Chinese, we put each contestant's name in Chinese characters as well.

Need to briefly describe the data and the initial test in the show

Specify the column names we included, also the column names we printed here.

For each contestant, we focus on these columns below:

- **Name_Chn**: Chinese name of the contestant.
- **Name_Eng**: English name of the contestant.
- **DOB**: Date of birth (yyyy-mm-dd) of the contestant.³⁷
- **Vocal**: Vocal score in the initial test, ranging from 0 to 10 in 0.1 point increments.
- **Dance**: Dance score in the initial test, ranging from 0 to 10 in 0.1 point increments.
- **Physical**: Physical score in the initial test, ranging from 0 to 10 in 0.1 point increments.
- **Overall**: Average of the vocal, dance, and physical scores.

Additional variables:

- **Ability_Rank**: Rank of the contestant by the initial test score average.

³²https://en.wikipedia.org/wiki/JYP_Entertainment

³³[https://en.wikipedia.org/wiki/Sixteen_\(TV_program\)](https://en.wikipedia.org/wiki/Sixteen_(TV_program))

³⁴<https://zh.wikipedia.org/wiki/MyB>

³⁵https://en.wikipedia.org/wiki/Fromis_9

³⁶<https://kpop.fandom.com/wiki/ASND>

³⁷In the Excel file, the date of birth is shown in m/d/yyyy format.

- **Final_Rank:** Final rank of the contestant published by the show.
- **Round_Eliminated:**
 - R1: Eliminated in the first round.
 - R2: Eliminated in the second round.
 - R3: Eliminated in the third and penultimate round.
 - R4: Eliminated in the fourth and final round.
 - Survived: Selected for the debut and joined the newly-formed K-pop group.
 - X: Left the show before the first round of elimination started.
- **Special_Notes:** Notes that are worth mentioning but do not belong to any other column, such as nationality (outside South Korea) and score error correction.

Add the metadata in the Excel file or the Appendix ?!

Currently I prefer adding the metadata in the Excel file for proximity to the data itself.

Show the first 10 records as a snapshot of the dataset.

```
library(readxl)
idol_school = read_excel("UNFINISHED_Idol_School_Dataset.xlsx",
                        sheet="Idol_School_Dataset")

# Date of birth (DOB) should be date only, not a full timestamp.
idol_school$DOB = as.Date(idol_school$DOB)

columns_to_show = c("Name_Chn", "Name_Eng", "DOB",
                    "Vocal", "Dance", "Physical", "Overall")

idol_school[1:10, columns_to_show]
```

```
## # A tibble: 10 x 7
##   Name_Chn Name_Eng      DOB      Vocal Dance Physical Overall
##   <chr>    <chr>    <date>    <dbl> <dbl>    <dbl>    <dbl>
## 1 NATTY    NATTY    2002-05-30  9.8   8        8.1     8.63
## 2 劉怡伶    Tasha    1993-10-11   8     9.5       8     8.5
## 3 李采映    Lee Chae Young 2000-05-14  8.5   8.5       7.5    8.17
## 4 宋河英    Song Ha Young 1997-09-29  8.6   5.9       9.8     8.1
## 5 金恩書    Kim Eun Suh   2000-11-14  6.3   6.9      10     7.73
## 6 金明智    Kim Myong Ji  1997-10-09  5.5   7.9       8.2     7.2
## 7 張圭悧    Jang Gyuri    1997-12-27  7.2   7.1       7     7.1
## 8 朴宣      Park Sun      2004-05-25  9.5   6.1       5.5    7.03
## 9 李悠汀    Lee Yoo Jeong 1997-02-26  5.8   6.2       9       7
## 10 金娜妍    Kim Na Yeon   1996-05-15  8.3   6         6.4    6.9
```

A total of 41 contestants entered the *Idol School* reality show. But the 41st contestant, Som Hye In (慎惠仁), left the show early due to health reasons. She was unable to complete the basic test, so her score was zero in all three categories (vocal, dance, and physical). Hence we remove the last row (all zeros) and keep only the remaining 40 contestants' scores in the dataset.

```
# We MUST remove the 41st contestant's scores (all zeros).
idol_school = idol_school[1:40,]
```

2.2 *Idol School*: Exploratory Data Analysis

Context: Write about how the vocal, dance, and physical scores were evaluated.

Physical testing contains a group exercise and an individual exercise.

Also mention the top performers in overall scores and in each category.

Most of the top performers had experience as a trainee under an entertainment company, and some even had debuted before.

Then why did they join the *Idol School* reality show?

Unfortunately, Snowbaby (蔡瑞雪) did not do well.

Snowbaby had not received any vocal or dance training in K-pop, so she was a complete beginner in the show.

2.2.1 Error Correction in Data

Still need to write the description

To observe the patterns of the *Idol School* data published on Wikipedia,³⁸ we first sorted the scores of each category (vocal, dance, and physical) in descending order.

What did we notice?

What changes did we make from the Wikipedia data?

Our presumption is that in each category, no two contestants should have the same score. However, after sorting the *Idol School* data, we found two 3.5's and two 1.2's in the physical scores. Especially that the two 3.5's belong to top-ranked contestants Bae Eun Yeong (裴恩英) and Park Ji Won (朴池原), this issue quickly caught our attention to make corrections to the data.

Add a few transition sentences

Idol School (2017): Videos with subtitles in Simplified Chinese are available on the Bilibili platform.³⁹

Screenshots saved:

https://github.com/star1327p/K-Pop-Dataset/tree/main/Idol_School_Rating_Screenshots

Then continue the discussion.

In the video clip, Park Ji Won (朴池原) and her partner were the first runner-up in the group physical exercise.⁴⁰ We are surprised that Ji Won's physical score was only 3.5. According to the video's score table for contestants ranked 11th to 20th,⁴¹ Ji Won's physical score should be 6.2. The Wikipedia table shows an inconsistency in Ji Won's overall score, i.e., the average across the three categories. Ji Won's vocal score was 7.9, and her dance score was 5. These numbers seem to be reasonable for Ji Won, because she is known for excellent singing and good dancing as a performer.⁴² Therefore, we assume both scores to be correct. If the physical score had really been 3.5, then Ji Won's overall score would be 5.47, dropping her from 13th place to the 18th. If the overall score of 6.37 had been correct, then Ji Won's physical score should be 6.2. The second scenario is more likely to be true, given the evidence we found in the video clip. Hence we corrected Ji Won's physical score to 6.2.

The two 1.2 physical scores are more difficult to check for the underlying values, probably because they occurred in two contestants of lower ranking.⁴³ The two contestants, Jessica Lee (李瑟) and Michelle White

³⁸https://en.wikipedia.org/wiki/List_of_Idol_School_contestants#Elimination_chart

³⁹<https://www.bilibili.com/video/BV1554y1C7wj/>

⁴⁰Screenshot of the group physical exercise: <https://bit.ly/4a7QT9m>

⁴¹<https://bit.ly/400KUuH>

⁴²Park Ji Won was the main vocalist in *fromis_9*. <https://bit.ly/402yCFI>

⁴³Physical scores of all contestants in *Idol School*: <https://bit.ly/3DRNK0Z>

(懷特·米雪兒), ranked in the lower half of all 41 contestants in terms of the overall ability test. Both of them got eliminated in the first round, so they did not receive much attention in the show. With the help of Google Translate,⁴⁴ we were able to translate the image of Korean text to (readable) English. Finally, we discovered that Michelle White's physical score should be 1.3, not 1.2.

2.2.2 Summary Statistics

Check for the mean and median of each category score

The five-number summary refers to the five most important percentiles in the data sample – minimum, 1st quartile, median, 3rd quartile, and maximum.⁴⁵ The `summary` function in R outputs the five-number summary along with the arithmetic mean for the data.

```
# Combine all three summary tables
vocal_summary = summary(idol_school$Vocal)
dance_summary = summary(idol_school$Dance)
physical_summary = summary(idol_school$Physical)

score_summary = rbind(vocal_summary, dance_summary, physical_summary)
row.names(score_summary) = c("Vocal", "Dance", "Physical")
print(score_summary)
```

```
##           Min. 1st Qu. Median   Mean 3rd Qu. Max.
## Vocal      1.0   2.875   4.95 4.8850   6.425  9.8
## Dance      1.0   3.825   5.55 5.4850   7.025  9.5
## Physical   0.4   1.675   3.25 4.1925   6.425 10.0
```

Observation:

Vocal and dance scores have 1 as the minimum score (who participated but made a blunder while performing), and the maximum score is below 10 (full mark). Physical scores have a wider range because the first place is automatically given a 10, and the other contestants' scores are calculated using the best performer as the baseline. Hence it is possible to receive a physical score below 1.

Vocal:

NATTY received 9.8 as the highest vocal score, and the instructor said her singing performance was perfect (considering that NATTY is originally from Thailand and hence not a native speaker in Korean).⁴⁶

On the other hand, Lee Hae In (李海印) received a score of 1 in vocal, because she unfortunately lost her voice and could barely sing at that time.

The median score of vocal is 4.95 (rounding to 5), which indicates decent performance.

Dance:

Although the best score was only 9.5 (given to Tasha (劉怡伶)), the median score of dance is the highest (5.55) among the three categories.

In K-pop, dance is an essential element for performers (Lee, 2018; Auh, 2025). In the live band, everyone must dance!

K-pop trainees: More talent in dance than in vocal (singing). (citation needed)

⁴⁴<https://translate.google.com/>

⁴⁵http://en.wikipedia.org/wiki/Five-number_summary

⁴⁶NATTY's birth name is Anatchaya Suputhipong. [https://en.wikipedia.org/wiki/Natty_\(Thai_singer\)](https://en.wikipedia.org/wiki/Natty_(Thai_singer))

The video clip showed that Lee Si An (李詩安) and Yoo Ji Na (柳知娜) struggled in the dance exercise, but it was Jung So Mi (鄭昭彌) who got the lowest score of 1.

c.f. Vocal roles are divided into main vocal, lead vocal, and sub-vocal (i.e., everyone else, or simply “vocal”).⁴⁷

Generally the most challenging lines are assigned to the main vocal and the lead vocal, while the other vocals receive easier parts. (citation needed)

Physical:

Kim Eun Suh (金恩書) came in first and received the full mark of 10, while Song Ha Young (宋河英) got 9.8 as the second place.

The physical scores are harsher than the vocal and dance scores. In the vocal and dance activities, the lowest score is 1 to account for the contestant’s participation. However, the lowest physical score observed is 0.4, and a total of five students received a score below 1. Physical also has the lowest median score (3.25) among all three categories.

The show did not reveal how the physical scores were calculated from the raw time sustained by each participant in each exercise.

Physical: group physical exercise vs individual exercise

But after watching the video clip on the physical tests, we suspect that the individual exercise accounted for a larger proportion of the physical score. We saw in the video that Lee Da Hee (李多熙) and Kim Na Yeon (金娜妍) came in first in the group physical exercise. However, Da Hee’s physical score was only 4.9, and Na Yeon got 6.4 (which is good but not one of the best).⁴⁸

Remark: That’s why it is important to remove the record with all zeros, otherwise the minimum score would be zero in every single category. Then we would not have noticed that the vocal and dance scores start from 1 with mere participation, but the physical scores have a different scale.

Comparison:

The median in physical score (3.25) is lower than the median in vocal (4.95) or dance (5.55), indicating that many contestants did not do well in the physical test. In fact, some contestants had a remarkably high score in dance but a low score in physical. One example is Bae Eun Yeong (裴恩英), who scored 9.3 in dance (second place) and 3.5 in physical (slightly above the median of 3.25). Another example is Lee Hae In (李海印), who got 8.4 in dance but only 1.8 in physical.

With a few exceptions:

e.g. Jo Yuri (曹柔理) received only 2.2 in dance but 5.9 in physical. Jo Yuri had not received any K-pop training prior to the show in 2017, but she was a long jump athlete during her school years.⁴⁹

e.g. Song Ha Young (宋河英) got 5.9 in dance and 9.8 in physical. Song Ha Young was a certified aerial yoga instructor before she first appeared in the *Idol School* reality show.

Figure 1 is the **box plot** of the vocal, dance, and physical scores in the *Idol School* show. We visualized the data using **ggplot2** (Wickham, 2016) to compare the three sets of scores.

<https://www.sthda.com/english/wiki/ggplot2-box-plot-quick-start-guide-r-software-and-data-visualization>

```
# UNFINISHED HERE

library(tidyr)

# Convert wide data to long format
long_data <- pivot_longer(
```

⁴⁷<https://bit.ly/3RFAHDL>

⁴⁸Screenshot of the first place team in the group physical exercise: <https://bit.ly/3EDBhz5>

⁴⁹<https://bit.ly/431HHR5>

```

idol_school,
cols = c("Vocal", "Dance", "Physical"), # Specify columns to pivot
names_to = "Category",                 # Name of the new column for the group labels
values_to = "Score"                     # Name of the new column for the values
)

# Category should be 1. Vocal, 2. Dance, and 3. Physical.
# Hence we reorder the levels in the data frame.
long_data$Category <- factor(long_data$Category,
                             levels = c("Vocal", "Dance", "Physical"))

# UNFINISHED HERE

# To-Do:
# [done] 1. Change the group order!!!
# 2. Add ggtitle for plot title (optional)
# [done] 3. Add Figure caption and reference it in the narrative.
# https://r-charts.com/distribution/box-plot-group-ggplot2/
# 4. Make the font size of axis labels larger and easier to read!!

library(ggplot2)
ggplot(long_data, aes(x=Category, y=Score)) +
  stat_boxplot(geom = "errorbar", width=0.25) +
  geom_boxplot()

```

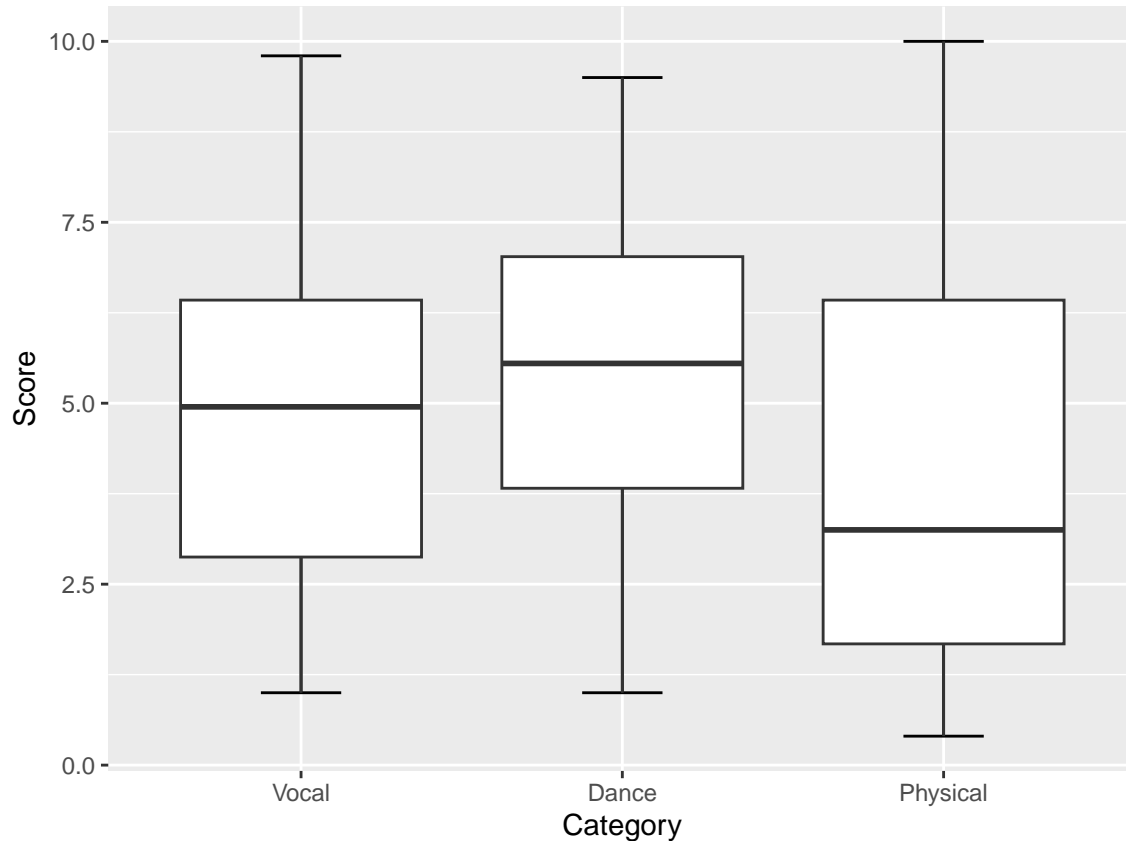


Figure 1: Box plot of the vocal, dance, and physical scores in the *Idol School* show

2.2.3 Correlation between Vocal, Dance, and Physical Scores

We can obtain the pairwise correlation coefficients of each category. There is a positive association between the vocal, dance, and physical scores. We round each number to three decimal places.

```
vocal_vs_dance = round(cor(idol_school$Vocal, idol_school$Dance), 3)
dance_vs_physical = round(cor(idol_school$Dance, idol_school$Physical), 3)
vocal_vs_physical = round(cor(idol_school$Vocal, idol_school$Physical), 3)
```

```
# Use the cat function to output multiple lines at a time
cat(paste0("Correlation of vocal and dance:   ", vocal_vs_dance, "\n",
          "Correlation of dance and physical: ", dance_vs_physical, "\n",
          "Correlation of vocal and physical: ", vocal_vs_physical))
```

```
## Correlation of vocal and dance:    0.645
## Correlation of dance and physical: 0.509
## Correlation of vocal and physical: 0.664
```

Alternatively, we can also compute the correlation matrix for the three score categories (variables). The diagonal elements are always exactly 1 – because they represent the correlation of a variable with itself, which is a perfect positive correlation. The off-diagonal elements indicate the correlation coefficient between different categories.

```
round(cor(idol_school[,c("Vocal", "Dance", "Physical")]), 3)
```

```
##           Vocal Dance Physical
## Vocal    1.000 0.645   0.664
## Dance    0.645 1.000   0.509
## Physical 0.664 0.509   1.000
```

Create the scatterplots and/or correlation plots!

Use `ggplot` or not ?!

Need to explain the correlation coefficients and the K-pop context.

The training at a K-pop entertainment company in Korea usually includes vocal and dance lessons (Padget, 2017), so it is reasonable to see a high correlation between vocal and dance scores. Theoretically dance and physical should be highly correlated (Ngo et al., 2024), but in the Idol School dataset, we observed a slightly lower correlation in dance vs physical than in dance vs vocal. Physical strength is essential to dancing, but dance also includes other critical elements such as technique and aesthetic expression (Geukes et al., 2023).

Do more analysis to the Idol School data!

2.3 Idol School: Additional Resources

Students who were eliminated from the show:

https://www.ptt.cc/bbs/fromis_9/M.1555819461.A.C73.html

In 2017, a Taiwanese blogger followed the whole *Idol School* series, and used algorithms to predict the final ranking.⁵⁰ Both random forests and SVM⁵¹ predicted Lee Hae In (李海印) to be in the top 9 for the debut, but Hae In ended up in an unexpected 11th place.

K-pop fans crowdsourced to count the votes for Hae In, and the number of confirmed votes was already higher than the number of votes published by Mnet. (Note that the number of confirmed votes is a subset of all actual votes.) This raised suspicion that the *Idol School* results may have been rigged.⁵²

Then in 2019, the court's investigation revealed widespread manipulation of the participant rankings. (citation needed)

A lot more evidence revealed that the rankings were manipulated by the organizers.

In the final episode of *Idol School*, Lee Hae In (李海印) actually came in first place. However, Mnet adjusted her ranking to 11th, resulting in Hae In being unfairly eliminated.

Elaborate more on the vote manipulation

Idol School: Vote Manipulation Investigation (2019)

<https://www.ptt.cc/bbs/KoreaStar/M.1624467107.A.D7F.html>

Consider creating a table to document the number of votes manipulated

Columns:

- Episodes 1, 2, ..., 11
- Number of participants
- Number of rankings that were fabricated

⁵⁰<https://shavid.pixnet.net/blog/post/331691281>

⁵¹SVM stands for Support Vector Machine. https://en.wikipedia.org/wiki/Support_vector_machine

⁵²<https://star.ettoday.net/news/1022482>

Therefore, it is meaningless to predict the final rankings in a K-pop survival show. That’s why we decided to analyze only the contestant scores given by the professional instructors. These scores are a relatively good benchmark of raw performance, especially that they were not artificially changed to favor any particular contestant.

3 *Produce 48* Dataset (2018)

Produce 48 dataset (2018)

Wikipedia data: https://en.wikipedia.org/wiki/Produce_48

Need to write the background information of the reality show

Produce 48 featured 96 contestants primarily from South Korea and Japan. The show was a collaboration between the Mnet’s *Produce 101* series⁵³ and the Japanese *AKB48* idol group (López Del Valle, 2021).⁵⁴

Write a sentence about the prevalence of multicultural K-pop reality shows (citation needed)

Some former contestants in *Idol School* tried again in the *Produce 48* reality show in 2018.

A total of 12 contestants were eventually selected from *Produce 48* to create the time-limited girl group *IZ*ONE*,⁵⁵ which was active during 2018-2021 in both Korea and Japan.

3.1 Read in the *Produce 48* Dataset

Produce 48 dataset (2018)

Wikipedia data: https://en.wikipedia.org/wiki/Produce_48

Need to write the data description

Similar data format to the *Idol School* dataset described in Section 2.1.

Same definition as in the *Idol School* dataset:

Name__Chn, **Name__Eng**, **DOB**, **Final__Rank**, **Round__Eliminated**, and **Special__Notes**.

Since there are only 96 participants, contestants who voluntarily left the show early (not due to elimination) are assigned to a 100 in **Final__Rank**.

List the newly-introduced variables here:

- **Unfinished here.**
- **First__Eval**: Rating of the first evaluation (A, B, C, D, F).
- **Second__Eval**: Rating of the second evaluation (A, B, C, D, F).
 - X: Left the show before completing the second evaluation.
- **Country**: Nationality, most contestants are from Korea or Japan.

Snapshot of the *Produce 48* dataset:

⁵³https://en.wikipedia.org/wiki/Produce_101

⁵⁴<https://en.wikipedia.org/wiki/AKB48>

⁵⁵https://en.wikipedia.org/wiki/Iz*One

```
library(readxl)
produce_48_data = read_excel("UNFINISHED_Idol_School_Dataset.xlsx",
                           sheet="Produce_48_Dataset")

# Date of birth (DOB) should be date only, not a full timestamp.
produce_48_data$DOB = as.Date(produce_48_data$DOB)

columns_to_show = c("Name_Chn", "Name_Eng", "DOB",
                    "First_Eval", "Second_Eval", "Final_Rank")

produce_48_data[1:20, columns_to_show]
```

```
## # A tibble: 20 x 6
##   Name_Chn Name_Eng      DOB      First_Eval Second_Eval Final_Rank
##   <chr>    <chr>      <date>      <chr>      <chr>      <dbl>
## 1 張員瑛    Jang Won Young 2004-08-31 B          B          1
## 2 宮脇咲良    Miyawaki Sakura 1998-03-19 A          A          2
## 3 曹柔理      Jo Yuri        2001-10-22 A          F          3
## 4 崔叡娜      Choi Ye Na     1999-09-29 A          B          4
## 5 安俞真      An Yu Jin      2003-09-01 B          A          5
## 6 矢吹奈子    Yabuki Nako    2001-06-18 F          A          6
## 7 權恩妃      Kwon Eun Bi    1995-09-27 A          C          7
## 8 姜惠元      Kang Hye Won   1999-07-05 F          F          8
## 9 本田仁美    Honda Hitomi   2001-10-06 C          A          9
## 10 金采源      Kim Chae Won   2000-08-01 B          B          10
## 11 金玟周      Kim Min Ju     2001-02-05 D          C          11
## 12 李彩演      Lee Chae Yeon  2000-01-11 A          A          12
## 13 韓霄瑗      Han Cho Won    2002-09-16 D          B          13
## 14 李佳恩      Lee Ka Eun     1994-08-20 A          A          14
## 15 宮崎美穗    Miyazaki Miho  1993-07-30 D          D          15
## 16 高橋朱里    Takahashi Juri 1997-10-03 B          A          16
## 17 竹內美宥    Takeuchi Miyu  1996-01-12 A          B          17
## 18 下尾美羽    Shitao Miu     2001-04-03 D          D          18
## 19 朴海允      Park Hae Yoon  1996-01-10 A          D          19
## 20 白間美瑠    Shiroma Miru   1997-10-14 B          D          20
```

Data entry complete for all contestants in *Produce 48*, including those who left in the middle of the show.

Create a matrix for the two sets of ratings.

For each rating, also check how many contestants are from Korea and how many are from Japan.

```
# UNFINISHED HERE
produce_48_data[81:96, columns_to_show]
```

```
## # A tibble: 16 x 6
##   Name_Chn Name_Eng      DOB      First_Eval Second_Eval Final_Rank
##   <chr>    <chr>      <date>      <chr>      <chr>      <dbl>
## 1 克利絲汀    Alex Christine 1996-12-09 B          C          82
## 2 栗原紗英    Kurihara Sae   1996-06-20 F          D          83
## 3 趙英燕      Cho Yeong In   2001-10-31 B          C          84
## 4 淺井裕華    Asai Yuuka     2003-11-10 F          D          85
## 5 安藝媛      Ahn Ye Won     2001-02-10 F          F          86
```

##	6	内木志	Naiki Kokoro	1997-04-06	D	C	87
##	7	金有彬	Kim Yu Bin	2003-02-27	B	D	88
##	8	趙思朗	Cho Sa Rang	2003-09-05	B	F	89
##	9	崔韶恩	Choi So Eun	2001-09-19	B	C	90
##	10	篠崎彩奈	Shinozaki Ayana	1996-01-08	F	F	91
##	11	元書妍	Won Seo Yeon	2000-05-23	C	F	92
##	12	月足天音	Tsukiashi Amane	1999-10-26	F	F	100
##	13	田中美久	Tanaka Miku	2001-09-12	F	C	100
##	14	梅山戀和	Umeyama Kokona	2003-08-07	F	X	100
##	15	植村梓	Uemura Azusa	1999-02-04	F	X	100
##	16	松井珠理奈	Matsui Jurina	1997-03-08	B	B	100

Let's look at the nationality breakdown of *Produce 48* contestants. Although *Produce 48* advertised a collaboration between Korean and Japanese entertainment groups, the Korea-Japan split is not 1-1 among participants. The majority (56%) of contestants are domestic within South Korea, while a lower but remarkable (40%) proportion is from Japan. Also, two contestants are from China and another one is from the United States.

```
table(produce_48_data$Country)
```

```
##
## China Japan Korea   USA
##      2    39    54     1
```

3.2 *Produce 48*: Two Evaluations of Contestant Performance

Write some narrative about *Produce 48*

At the beginning of the show, there were two evaluations to the 96 contestants' talents. Each evaluation involved a sing-and-dance performance and resulted in a letter grade (A-F). Both letter grades were recorded for each contestant.

In the first evaluation, the contestants were required to perform a popular K-pop song as their initial practice. Then the mentors gave each individual a grade based on their performance, and assigned them to temporary training classes at their level.

```
table(produce_48_data$First_Eval, dnn="First_Eval")
```

```
## First_Eval
##  A  B  C  D  F
## 15 25 22 15 19
```

The second evaluation was to have each contestant perform the *Produce 48*'s theme song "Nekkoya (Pick Me)".⁵⁶ After the song was announced, the contestants were given three days to prepare for the choreography and memorize the lyrics. The song has a Korean version and a Japanese version, so each student may choose to perform in their preferred language. Then the students were given their new grades, and reassigned to their new practice classes.

Need to explain the "X" ratings

⁵⁶[https://en.wikipedia.org/wiki/Nekkoya_\(Pick_Me\)](https://en.wikipedia.org/wiki/Nekkoya_(Pick_Me))


```
table(produce_48_data$Second_Eval, dnn="Second_Eval")
```

```
## Second_Eval
##  A  B  C  D  F  X
## 14 20 22 16 22  2
```

Cross-table: **First_Eval** as row, and **Country** as column

Let's examine how Korean and Japanese participants scored in the first evaluation. We noticed that the majority of contestants from Japan were placed in D or F (lowest grades), while very few contestants from Korea did. Although the Korean K-pop coaches criticized the Japanese contestants for their performance, we would like to emphasize that the Idol training process differs greatly in Korea and Japan.⁵⁷ In Korea, the primary focus is on vocal and dance techniques, while in Japan, the Idol training values artistic interpretation and individual expressiveness (Lee, 2023).

In the show, many Japanese contestants bursted into tears due to the harsh feedback given by the Korean K-pop instructors.⁵⁸ The Japanese contestants enjoyed highly positive responses in their own country, so they thought they would receive an A in the evaluation during *Produce 48*. Instead, most of them received an F (failure). After the first evaluation, some Japanese contestants even withdrew from the show for various reasons.⁵⁹

```
table(produce_48_data$First_Eval, produce_48_data$Country,
      dnn=c("First_Eval", "Country"))
```

```
##           Country
## First_Eval China Japan Korea USA
##           A      0      2     13   0
##           B      2      4     18   1
##           C      0      5     17   0
##           D      0     11      4   0
##           F      0     17      2   0
```

Cross-table: **Second_Eval** as row, and **Country** as column

What about the second evaluation?

Observation: Contestants from Japan faced a little better in the second evaluation – approximately half of them received a satisfactory grade (A, B, or C).

The scoring of domestic contestants in Korea became harsher this time – one third of them were rated unsatisfactory (D or F).

Need to specify the (inferred) reason

```
table(produce_48_data$Second_Eval, produce_48_data$Country,
      dnn=c("Second_Eval", "Country"))
```

```
##           Country
## Second_Eval China Japan Korea USA
##           A      0      4     10   0
##           B      0      6     14   0
```

⁵⁷<https://www.adaymag.com/2020/10/22/japanese-vs-korean-idol.html>

⁵⁸<https://star.ettoday.net/news/1192170>

⁵⁹<https://star.ettoday.net/news/1181576>

```
##           C      1      8     12     1
##           D      1      9      6      0
##           F      0     10     12      0
##           X      0      2      0      0
```

Cross-table: **First_Eval** as row, and **Second_Eval** as column

```
table(produce_48_data$First_Eval, produce_48_data$Second_Eval,
      dnn=c("First_Eval", "Second_Eval"))
```

```
##           Second_Eval
## First_Eval A B C D F X
##           A 6 3 4 1 1 0
##           B 4 8 5 5 3 0
##           C 3 6 4 3 6 0
##           D 0 3 5 3 4 0
##           F 1 0 4 4 8 2
```

List the names of the six contestants who got $A \rightarrow A$.

There are six contestants who got A's in both evaluations.

Miyawaki Sakura (宮脇咲良) is the only Japanese participant, and she was ranked 2nd in the final debut. The other five contestants are all from Korea.

Lee Chae Yeon (李彩演)

Known for her excellent dancing skills (citation needed)

Also made it to the final debut.

Lee Ka Eun (李佳恩)

Explain her actual ranking (5th) and the published ranking (14th) (citation needed)

<https://www.ptt.cc/bbs/KoreaStar/M.1605669895.A.97D.html>

The remaining three did not do so well in the audience votes ?!

Note that possessing a high talent does not guarantee being selected to debut in the new girl group; having a low starting point does not result in first-round elimination, either.

```
inds_A_to_A = which(produce_48_data$First_Eval=="A" & produce_48_data$Second_Eval=="A")
produce_48_data[inds_A_to_A, columns_to_show]
```

```
## # A tibble: 6 x 6
##   Name_Chn Name_Eng      DOB      First_Eval Second_Eval Final_Rank
##   <chr>    <chr>    <date>    <chr>      <chr>      <dbl>
## 1 宮脇咲良 Miyawaki Sakura 1998-03-19 A          A           2
## 2 李彩演   Lee Chae Yeon 2000-01-11 A          A          12
## 3 李佳恩   Lee Ka Eun    1994-08-20 A          A          14
## 4 羅高恩   Na Go Eun     1999-09-03 A          A          29
## 5 李河恩   Lee Ha Eun    2004-10-30 A          A          48
## 6 黃召硯   Hwang So Yeon 2000-08-21 A          A          60
```

Jo Yuri (曹柔理): $A \rightarrow F$

Yabuki Nako (矢吹奈子): $F \rightarrow A$

What about other participants?

Kang Hye Won (姜惠元): $F \rightarrow F$

Nevertheless, Hye Won made it to the debut of the *IZ*ONE* girl group, and she was ranked 8th out of all 12 finalists.

Next step: Breakdown the 1st-cross-2nd table by country (Korea and Japan)

1st-cross-2nd table: Korea

```
produce_48_korea = produce_48_data[which(produce_48_data$Country=="Korea"),]
table(produce_48_korea$First_Eval, produce_48_korea$Second_Eval,
      dnn=c("First_Eval", "Second_Eval"))
```

```
##           Second_Eval
## First_Eval A B C D F
##           A 5 2 4 1 1
##           B 3 7 3 2 3
##           C 2 4 4 3 4
##           D 0 1 1 0 2
##           F 0 0 0 0 2
```

1st-cross-2nd table: Japan

```
produce_48_japan = produce_48_data[which(produce_48_data$Country=="Japan"),]
table(produce_48_japan$First_Eval, produce_48_japan$Second_Eval,
      dnn=c("First_Eval", "Second_Eval"))
```

```
##           Second_Eval
## First_Eval A B C D F X
##           A 1 1 0 0 0 0
##           B 1 1 0 2 0 0
##           C 1 2 0 0 2 0
##           D 0 2 4 3 2 0
##           F 1 0 4 4 6 2
```

3.3 *Produce 48*: Additional Resources

What happened next?

The final rankings were arbitrarily changed by the show organizers, because they received under-the-table monetary transactions from some entertainment companies, such as Starship and Woollim (Gu, 2020).⁶⁰

What were the political dynamics at play?

The show organizers received gifts from Starship and Woollim.

Evidence: Three contestants were unfairly eliminated from the debut in the final round of the show. (citation needed)

The media announced two of them:

Lee Ka Eun (李佳恩): Actual ranking 5th, published ranking 14th.

<https://disp.cc/ptt/KoreaStar/1brmSfeA>

Han Cho Won (韓霄瑗): Actual ranking 6th, published ranking 13th.

Cho Won's Wiki: <http://bit.ly/45HLq8j>

⁶⁰<https://www.koreastardaily.com/tc/news/122447>

K-pop fans suspected that the third contestant artificially removed was Japanese, who was replaced by another Korean contestant for the *IZ*ONE* debut.⁶¹

Additional suspects by the K-pop fans.

Many K-pop fans wondered why Jang Won Young (張員瑛) was ranked 1st place in the finals, while the well-known Japanese contestant Miyawaki Sakura (宮脇咲良) came in 2nd. Traditionally the first place (a.k.a. the center position) for the group debut is given to a Korean participant rather than an international one, despite the emerging popularity of K-pop survival shows featuring multicultural performers (Ahn, 2022). Therefore, K-pop fans suspected that Won Young was artificially moved to first place, and that Won Young's actual ranking was between 2nd and 5th.⁶² Sakura's official ranking was second place, but she was most likely to be the original first place, i.e., received the most votes in the final round.⁶³

The importance of being selected in 1st place for the group debut:
C-position or center position in K-pop (citation needed)

For example, what were the privileges of the first place artists in *Idol School* and *PRODUCE 48*?

Usually the 1st place in the debut get the center position in the newly-formed K-pop group. (citation needed)

The girl group *fromis_9*: Roh Ji Sun (盧知宣) won first place in the finals of *Idol School* reality show, so she got the center position for the *fromis_9*'s debut single song. Ji Sun was also uniquely featured on the debut album cover as a special issue, giving her excellent recognition and visibility.⁶⁴

However, the *IZ*ONE* assigned the center position to Miyawaki Sakura (宮脇咲良), not to the *PRODUCE 48* champion Jang Won Young (張員瑛).⁶⁵

Idea: We can assume that the vote manipulation happened only in the final round of the show.
News citation needed.

Comparison: the 20 participants in the final round vs the rest

Or compare in other rounds: survived vs eliminated ?!

Combine the ratings in the two evaluations:

Average method or take the best score only ?!

4 Tentative Placeholders

Write something here

4.1 Test for Non-English Characters

CJK = Chinese, Japanese, Korean

Chinese example

RStudio 有辦法打中文嗎？

```
print(" 大家好，很高興能認識你們！")
```

```
## [1] "大家好，很高興能認識你們！"
```

⁶¹<https://www.ptt.cc/bbs/KoreaStar/M.1605679750.A.B79.html>

⁶²<https://www.kagit.kr/posts/123744>

⁶³<https://bit.ly/4n0QuKG>

⁶⁴<https://bit.ly/473Dcae>

⁶⁵<https://star.ettoday.net/news/1870619>

Japanese example

思い出にするにはまだ早すぎる

```
print(" みやわき さくら")
```

```
## [1] "みやわき さくら"
```

```
print(" 宮脇 咲良")
```

```
## [1] "宮脇 咲良"
```

This template does not support Korean characters yet.

4.2 R Markdown Narrative

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.

When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
summary(cars)
```

```
##      speed      dist
##  Min.   : 4.0    Min.   :  2.00
##  1st Qu.:12.0    1st Qu.: 26.00
##  Median :15.0    Median : 36.00
##  Mean   :15.4    Mean   : 42.98
##  3rd Qu.:19.0    3rd Qu.: 56.00
##  Max.   :25.0    Max.   :120.00
```

4.3 Including Plots

You can also embed plots, for example in Figure 2:

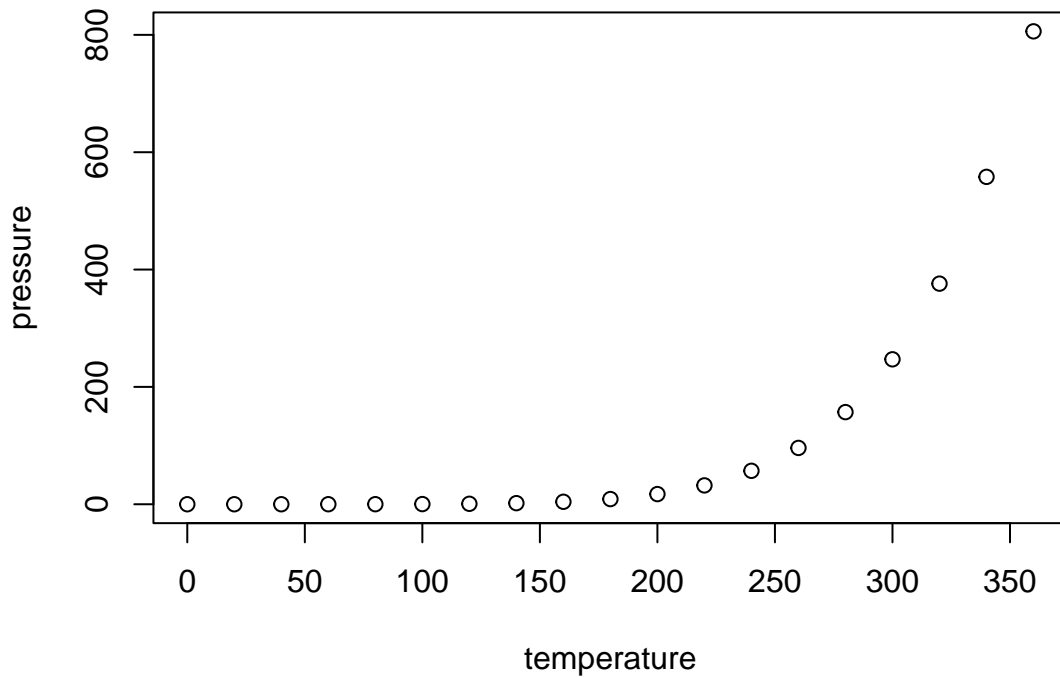


Figure 2: Test Plot

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

Acknowledgments

The author is immensely grateful to her significant other, Hugh Hendrickson, for providing his support in the author’s professional development.

Technical discussions: Cheng-Shun Liu (劉承順) and Chih-Kuang Lee (李治廣, Kevin).

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