Attempt to Develop a Real-time Analysis and Scouting Analysis Program for Water Polo Matches:

Research and Development of the Analysis Program for Water Polo Completed

Rintaro SONODA

Toho Junior High School, Third year (Ninth grade)

*This research papers and all raw data have already sent by FedEx in December directly to Undergraduate Admission Office

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Abstract

This research paper is about how I have developed the real-time and scouting analysis program and have finally completed it. As my water polo team is in a unique situation, where we do not have any coaches or supervisors, I as a captain took on much of those responsibilities for the team, and I was always in charge of facilitating the meetings without supervisors. It was difficult for me and my teammates to be able to find our weaknesses and strengths without supervisors, so objective analysis and evaluation were always necessary for all of us to so that we could have objective perspectives of our team.

By using this "Real-time and Scouting Analysis Program," we can quickly learn not just what each player's weakness is, but also see how much each of them have contributed in the games. In water polo games, especially, it is usually difficult to remark all the contributions during the games as most of time, players cannot capture everyone's movement, however, with my program, I was able to make it easier to keep track of the players. This program provides positive and negative feedbacks to the team members after each game. We can then make appropriate practice menus for each player. And with my program, we can also record opponent team's plays. Therefore, we can see how our opponents play, and we can be better prepared for the future games.

From the year 2017, taking over a year to complete it, I wrote as many as 15,000 codes. Through such "trial and error," I have developed and improved my skills using Progate so that the program can analyze each player's offence, defense, pass style, number of pass cuts, and shooting style. Every player can access the data if they have the URL, with their smartphones or iPad. I hope that this program will help my team to become better with consistent open discussion with objective data. And in the future, I would like to develop this program into an application for smartphones so every player can use it more easily.

After three years of research on water polo, I have finally developed this program which I believe is extremely helpful for my team to improve. Throughout this process, I was able to beat the odds and make this program a possibility while broadening relationships and opportunities along the way. I would like to express my appreciation to Mr. Teramoto, Mr. Shimizu, Mr. Enomoto, and all my teammates. Lastly, I am grateful to Toho Junior High School for giving me the opportunity.

*This research paper was first written in Japanese as an individual summer project in the ninth grade at Toho Junior School, with which I won the first prize. I then translated into English when I was in the 11th grade and proofread and modify in the 12th grade.

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I. Introduction

At the beginning of this year, a generational change took place, and I was given the heavy responsibility of captain of the Toho Junior High School swim team (water polo team) right after we lost in the Spring Junior Olympics qualifying round in January 2018.

As an experienced player who started

playing water polo in the fourth grade, I was lucky enough to be allowed to play on the team with my seniors in tournaments from the time I entered the school, so I was able to experience many big games right from the start of junior high school. My desire to become better grew stronger each game. Unfortunately, when I was in the first year of junior high school, I lost in the spring Junior Olympics qualifier in January. That's when I began to wonder if there was anything I could do to contribute to making the team even stronger, other than improving my skills. Just when I was in my first year of junior high school, there was the Rio de Janeiro Olympics, and the Japanese men's national water polo team made it to the Games. It occurred to me that if I could more easily analyze the games of the Japanese team and provide the results of the data analysis to my own team, I could offer a new perspective. I was a beginner in programming, but I started developing a real-time analysis program that you can input data during a match and get real-time analysis results in January 2017.

Since then, I've been continuing my analysis program research and development, trying to go beyond the framework of summer vacation free research and complete it before the end of my last summer vacation in middle school in 2018, so that my team could actually utilize it.

Toho's swim team is not in a "blessed" environment compared to other teams that are always at the top.

First of all, Toho Junior High School's swimming pool is located outdoors, so we can only practice at our school from the end of April to the end of September. (In Japan even if it is seasonal sports, it is common that all sports club members practice all seasons through year) In reality, however, there is a always big tournament called the Kanagawa Championship at the end of October, so until the end of October, we practice in the outdoor freezing pool, wearing only swimsuit, under the cold weather, consequently challenging the limits of our bodies. And before I entered the Toho Water Polo Club Team, from November to March was considered to be the off-season, and they practiced on land and swam once a week in municipal pool. Then they would have to compete in the Junior Olympics qualifiers in January when they were in worst shape and when their water polo skill had declined due to the off-season. So, after I joined the water polo club, the club built a relationship with another team and we were able to practice at their heated pool for a limited time on the weekends. On weekdays, I went to a swimming school that had a water polo team only during the winter, or took personal lessons in private sport gym club, and sometimes went to faraway places to find a heated pool. As a result, depending on the day of the week, I would return home after 10:00 pm. Although I had to work harder than others in order to achieve both academic and athletic success. Time management became very important. I drew

one month schedule every end of month for next month and check every day to see if there were anything I have forgotten. I became stricter to myself. Fortunately trying new way, that is to go to swim lessons even during winter, I began to feel that the Toho Junior High School team was actually getting stronger in a tangible way.

Second reason why Toho seems inferior to other Top water polo team, Toho Junior High School values the independence of its students, the swimming team has a tradition of not having a coach nor supervisor at practice. As a result, students have to study, think, practice, and learn on their own. And Captain takes all the responsibilities for team and practice menus and coordination for expedition lessons. Naturally, pre-game meetings and post-game review sessions are also held by the students alone. Needless to say, the Top water teams have indoor heated pools and always have coach and supervisors.

Objectively, I am not complaining about this less “blessed" environment. When I first entered the school, I was surprised at the current situation of Toho's swim team, but I have come to believe that there is a wide range of areas where I can learn and develop my skills because of this environment.

Mr. Ono, a former coach of the Japanese national soccer team says, "If the players are doing things because they are told to do them rather than because they want to do them, there is a mistake somewhere" (Ono 2010). Now that I have taken on the role of captain, I have come to realize that there are many things that we are able to do on our own because of this environment. Without a coach at all times, we have to think hard about how to become stronger on our own, and we keep running into problems, but since there is no other way but to solve them on our own, I am actively improving the problem-solving skills, regardless of the difficulties we might face. I also feel that I have learned a lot from being a part of other club teams, as I have had to build relationships with other team members and coaches from different environments.

This challenging environment at Toho Junior High School was one of the reasons why I decided to develop a real-time analysis program, to think about it myself, to investigate it myself, and to work towards its practical application in order to provide objective information if coach or supervisors were there.

Since I was a beginner in programming, I had to face countless obstacles to complete the Water Polo real-time analysis program. After many twists and turns, I became the captain of the team in January of this year, managing the review meetings and pointing out ways to improve the team. As a result, I began to see the problems we had been facing.

Fundamentally, there was almost no

data analysis of the games. The desire to solve this problem was the main driving force behind the development of this real-time analysis. In the past, the members of the team would often talk about the most memorable plays, such as shots or passing errors that led to the opponent's score. However actual flow of the game and the detailed contributions of each member of the team were not often discussed. Almost no one remembered the negative actions that led to the opponent's score on a minor play. In a review session with just the players in the absence of a leader, no matter how much they reflected while playing back the video, they often viewed the video based on the information they had already memorized. I felt that there were various limitations in the fact that the review session proceeded without any room for new perspectives when watching the video.

According to Enomoto, a leading expert on real-time analysis of water polo, "Franks et al." investigated the observation and memory skills of soccer coaches during games and reported that even skilled coaches could accurately remember only about 40% of the shots that appeared during a game, and the memory rate was about only 16.8% when events other than shots were included. (Enomoto et al. 2000). If the memory rate is about 16% even for the coach who objectively observes the game, the memory rate of the players involved must be less than half of that. In our team, where the coach is not always present, it would be ineffective if we do not have review meetings and meetings that allow us to look at our own play objectively, based on factual and objective analysis.

I also strongly felt that objective data is indispensable, especially for a team without a coach like ours, in order to think about strategies for the next game, to properly recognize our issues and work on them during practice, and to eliminate our own biased assumptions.

That's why this year I wanted reach a level where I could effectively contribute to the project, so from January 2018 I started devoting three to five hours a week to learning and developing programming skills. Continuing from last year, I asked Mr. Daiki Teramoto* to make time for a conference call for 30 minutes to an hour almost every week, giving me guidance as needed. During the summer vacation, when I was not except practicing or playing water polo, doing my homework or having lessons, I spent most of my time on the development of this analysis program. It was a great summer vacation, but my friends in the same grade who attended public junior high schools all spent their summer vacation studying for exams. As a student at an integrated junior and senior high school, I decided to change the positioning of the summer vacation in my mind, thinking that it would be a period of summer vacation where I could study whatever I wanted without studying for exams.

Of course, I can't create an environment where there is a heated swimming pool or where the coach is always present. However, I can create an environment where I can bring objective data to the current team, and where each team member, including myself, can develop the ability to analyze the data objectively. If I can do that, we can become a stronger team as we spend our days working on our skills. With this in mind, we aimed to complete the program by the end of this summer vacation. As a result, we wrote more than 15,000 lines of source code every day, including the source code we had to rewrite.

Last year, we spent six months to complete the basic part of the real-time analysis program, but it took us longer than expected to learn the programing language called “Javascript”. As a result, we were not able to complete the calculation function on the output screen, and we did not get a chance to hear the opinions of others.

This year, we further deepened our learning by referring to our past reflections and the various suggestions from the professors who responded to our research paper. In the process of completing the real-time analysis program for water polo games, we thought that the real-time analysis program alone would not be sufficient for game review meetings and strategy meetings.

As a result, apart from the real-time analysis program, we decided to also work on the development of a "scouting data analysis program" to plan strategies for future games. In the development process, I also wrote about the process of developing a trial version of the real-time analysis to make the program more practical, rather than creating the final version all at once. In addition, I included the process of identifying the issues that came to light through the use of the trial version, and ultimately getting to the final version.

Therefore, while last year's research paper described the basic research process of this program, this research paper is a summary of the entire second half of the development process, including practical verification. Ultimately, this project took one and a half years to complete the water polo match analysis program.

II. Outline of this study

1.Purpose of the Study and Research Procedures

In the game of water polo, it is often impossible to observe what is happening under the water. Even the parts of the game that are above the surface are mostly blocked by water, making it very difficult to capture the game and individual performances objectively.

However, water polo, as described in "Laiki's Water Polo," a book written by Laiki in 1923, is said to be the most scientific of all ball sports. Data analysis of performance in many other ball sports such as soccer, rugby, and volleyball are now commonplace, and many analysis tools exist for these sports. In particular, real-time analysis is practiced as a game performance analysis to quantify various things that happen during a game to be used for training, technical practice, and strategy, and its effectiveness has been proven in many research papers (Okuda et al. 2005). These were introduced in the previous papers I wrote.

However, as a result of my research in my first year of junior high school when I tried to analyze the game of Japanese men's water polo when it participated in the Rio Olympics for the first time in 32 years, it turns out that there are no tools for water polo analysis that are made in Japan or that we can use. I've been researching for the past three years and still haven't found anything.

The introduction of real-time analysis in water polo was attempted by Frank Paterson in 1986 (Takagi et al. 1986), and since 2003, in order to promote and develop water polo, FINA (International Swimming Federation) has been improving both tactics and strategies through the development of video equipment, personal computers, and other analysis equipment. The results of data analysis are now published on the competition website (Suh 2013). In Japan, there is a real-time analysis system implemented by the Scientific Research of the Technical Department of the Water Polo Committee of the Japan Swimming Federation, with two versions: one to support the Japanese team and the other to support the competition. In 2004, however, the analysis items were so complicated that they required a skilled person to input the data, and the final analysis had to be done in Excel (Suh 2004). Although Enomoto et al. have been developing analysis software since 1997, there is currently no tool that can be used for analysis with a tablet, unlike the case with other ball games.

Therefore, this year, 2018, our goal was to develop the foundation of real data analysis programming that we completed

last year, and complete it to the point of implementation, making it practical and effective. We attempted to complete a real-time analysis program and to study its effectiveness.

1) Research and Development Procedures

The development process of this real-time analysis program was divided into seven phases as follows

Phase 1: Pre-surveys, previous research surveys, and interviews

In order to learn more about the game of water polo from the perspective of data analysis, we watched the Junior Olympics finals and also had a hearing to get opinions from the people involved, including the members of the club, on the program that we were able to develop until last year.

Phase 2: Acquiring programming skills

Regarding learning programming, last year I learned the most important basics of programming. This year, we needed to acquire full-fledged programming skills, so from January 2018, we set aside three to five hours every week to learn the necessary skills, with Mr. Teramoto's advice as needed.

Phase 3: Completion of the real-time analysis trial version

Mr. Teramoto advised us that if we were greedy and tried to cover everything in the program, it would not be practical, so we decided to complete the trial version first and actually analyze the data in preparation for the summer Junior Olympics qualifiers in July.

Phase 4: Practice and analysis of the real-time analysis trial version

We finished writing the source code for the trial version and made it ready for practice by adding calculation formulas so that the instructions would be output from the input screen to the output screen. We analyzed all three games of the Junior Olympics qualifying round using the trial version and discussed the effectiveness of the program based on the result data.

Phase 5: Identifying issues after implementing the trial version

Using the trial version, we analyzed the data and tried to see how much we could learn from the data so that we could verify its effectiveness. We also identified issues with the trial version to make it more practical. At this time, we also set aside time to get opinions from water polo data analysis experts again to make the program more effective.

Phase 6: Program review and program completion

Based on the above considerations and issues, the program was reviewed so that the final version of the data analysis program could be completed, and the stage was set to complete a more practical and effective program for the 2018 version.

Phase 7: Upload and complete.

After setting up the environment, such as setting up passwords, the water polo real-time analysis site was uploaded, and the practical version, which allows users to enter the site with a password, was in the completion stage.

2) The main purpose of this research>

In order for our team to become stronger, we will be able to provide fact-based objective data, and we will be able to give feedback to each player and the results of the analysis of the entire team's game structure to the entire team, so that they can reflect on themselves and get hints for improving their skills. In addition, the same program can be used to analyze the opposing team, so that the team can use the results of the analysis of the factual database to plan their menu and game strategy in preparation for the match against the opposing team. The following are the main objectives of the development of this program.

(1)During each game in the tournament, enter your team's game details (assisted passes, successful passes, missed passes, pass cuts, counterattacks, shoot blockings, fouls, ejections, floats, driving, back cuts*, etc.) and shooting patterns. The data can be quantified and fed back to each team member immediately after the game.

(2)Data from (1) above should first be made available to each player, coach, and other related personnel after the game so that they can view the data on their own smartphones.

(3)To overcome the weaknesses of each player on the Toho team and apply them to the practice menu.

(4)By the time of the review meeting after the game, analyze the data of each player of the opposing team while playing the video of the opposing team in all the games, and at the review meeting, analyze the game objectively by combining the data of 1) and the data of the opposing team, so that you can plan the strategy for the next game.

(5)This program will input data that shows not only the movements and shooting tendencies of each player, but also the overall structure of the game, so that the accumulation of such data will enable individuals to analyze their own strengths and weaknesses in the game.

(6)To be able to identify match-by-match

trends that show changes in the overall team's game.

(7)Learn the characteristics of the opponent's defensive attacks and develop counterattack measures.

(8)By also accumulating data on opposing teams, we can study them more objectively.

(9)Even after completion, the program can be improved on a case-by-case basis by listening to the team's requests.

(10)Make this program available to Toho swimming club members and other related parties by logging in.

3) A brief explanation of the rules of water polo>

The game of water polo is played by a team of seven players, one goalkeeper and six field players, in a pool 30 meters long by 20 meters wide and at least two meters deep. In this game, players from both team swim in a basic front crawl, or face-up crawl, while dribbling and passing the ball with one hand, aiming at the opponent's goal, which is 90cm high by 3m wide. A player may tackle the player in possession of the ball, but it is also a foul to hold the ball in the water to keep it from being taken away when tackled. This tackle is different from rugby in that it is a tackle without physical contact, so it is an action to put pressure on the ball carrier so that he cannot pass. Therefore, it is also a foul to use your hands or feet to push an opponent. These are simple fouls and can be committed many times. The more serious offenses are called "exclusion fouls," where the player is ordered to stay in the ejected area for 20 seconds or until a point is scored or a defensive or offensive return is made. If repeated three times, the player is ejected for the remainder of the game, which is called "permanent ejection". If the defending team interferes with an obvious scoring play within its own 5-meter line, it will be called a "5-point" penalty foul.

The game is played in four periods of four minutes per period for junior high school students, and the attack time is set at 30 seconds each, with the side that takes the center ball being the first to attack (Sonoda 2016).

The detailed rules of water polo are described in detail in my 2016 paper, "An Attempt to Analyze the Game of Water Polo" so please refer to that.

4) Explanation of terms

・Assisted pass: a pass that leads to a goal

・ Pass cut: The act of cutting off an opponent's pass.

・Counterattack: To attack the opponent goal before the opponent team is ready for defending. The advantage of this attack is

that we can have outnumber the opponents. We sometimes call it “Transition”.

・Press cut: The act of pressing an opponent and steal the ball away from the opponent player.

・Shoot blocking: The act of blocking an opponent's shot by raising one hand (raising both hands is prohibited).

・Pass Success: Successful ball pass.

・Passing error: Ball passing fail

・Fouls: Minor infractions (In water polo, minor infractions do not result in ejection, no matter how many times they are committed).

・Ejection: A serious fouls, limited to two ejections per game, with the third resulting in a permanent ejection.

・Hole set: The action of shooting from a “set” position in front of the goal.

・Driving: move to drive inside

・Floater-back steal: The act of blocking or stealing the ball from floater who takes the zone in front of the goal.

■Phase One■

Phase one: Preliminary survey and previous research survey and interviews and their results

<.Outline of Preliminary Survey>

1)Survey of the latest relevant research papers and previous studies on real-time analysis

For two years in a row in 2016 and 2017, I conducted prior research on analytical methods and real-time analysis to some extent. This year, I borrowed my parent's ID to search for papers from the NDL (National Diet Library) and obtained them by remote viewing method and printed the papers published on the Internet at home. The following resources helped to broaden the scope of possible reference for my own research as well as to investigate the latest research.

(1) A paper on recent trends in real-time data analysis in water polo and other ball sports

(2) A paper on the latest technological improvements in water polo

(3) A paper on scouting and data analysis in ball games

(4) Articles and books on improving team skills

As for (3), since it is also a program to improve the capability of the thesis team that serves as a reference for data analysis items, we also surveyed papers on improving team capability and technology for reference, even though they are not directly related to real-time analysis.

2) An "objective" survey of water polo matches

As a final confirmation of the items required for analysis, we observed the Junior Olympics' main competition matches from the perspective of data analysis and obtained materials used by referees, and began to develop a trial version of the program.

3) Interviews with stakeholders and feedback survey on the trial version of the program, which was created based on the program completed up to last year.

Before starting the development of the final version, we took the opportunity to ask the water polo team members, seniors, and coaches for their opinions on the program at last year's stage, which we were unable to do last year due to time constraints, to help us develop the completed version.

4) Research on the latest technological achievements of the program

In the course of further development since last summer, there were many times when I could not expand my ideas because I was a beginner programmer, and my ideas were confined to a narrow range that I could understand. At Mr. Teramoto's suggestion, I decided to attend a presentation by the award winners of the "unexplored project" sponsored by the Ministry of Economy, Trade and Industry. I was able to listen to the developers talk about how far the latest programs can actually go and to see the actual products, which gave me an opportunity to expand my ideas.

Fig. Pamphlet for the presentation of the winners of the unexplored project

<. Preliminary Survey Results>

1) Findings from previous studies

In recent years, I have heard that many papers are published on the Internet, so I personally searched for papers by entering keywords and printed the ones I found. I also used the NDL search system to search for papers using my parent's number and password and used them as reference for this

research and development. I also referred to papers that I had already referred to in the past, but which I thought would be useful to refer to again this time, thinking that I might learn something from a new perspective.
The following is a paper that gave us a great deal of insight into this research and development. The outline of the paper and what we learned from it are summarized below.

(2) ***"Game Analysis of Water Polo Games Focusing on Offense: A Comparison of the High School Athletic Meet and the World Championships " :*** **(Enomoto, Shibata Bulletin of Tokyo Gakugei University, Vol. 50, 1998)**

＜The purpose of this paper's research＞

In water polo, various game analyses have been conducted so far, examining the differences in offense and defense between the Japanese team and other foreign teams, and pursuing issues for the Japanese team. In particular, the factors that determine victory or defeat in games against the rest of the world have been examined, and it has been determined that plays resulting from major fouls are the key to victory or defeat.

The world's top teams tend to score a higher percentage of their goals during major fouls. Enomoto et al. have developed a real-time analysis system focusing on shooting-related information, and by creating a computerized database, it is now possible to immediately examine game and team trends from various perspectives. This time, they further improved this system and analyzed personal fouls, which determine whether a team wins or loses a water polo game, by comparing the top high school teams and the top-level teams in the world.

<What I learned from this paper>

Shot Information (IS), Personal-Foul Information (IP), and Personal-Foul Information on the Situation (IPS) are decisive factors in determining whether a game is won or lost, so by analyzing these three items, counterattack measures for the next matchup can be formulated.

IS: Shot variations: Goal, line out violation, corner throw, bar or post, bar or post rebound, keeper save, keeper rebound, defensive save, defensive rebound.

An IP is a serious foul that gives the opponent a chance to score, with an ejection and a penalty.

IP: 3 items as personal fouls; Ejection foul, Penalty fouls, other fouls

On the other hand, the offense opens up scoring opportunities by setting up plays that induce personal fouls against the defense. This is called IPS. (Personal-foul Information on Situation) Many teams aim to induce personal fouls as one of their

offensive tactics, and it is an important factor of many teams' offensive strategies.
IPS: 4 items as the situation of the opponent's offense that provoked the fouls: Drive play, Floater play, Turnover, and other movements.

(1) Cut-Ins were the main offensive option for Japanese high school level teams, international professionals' shoot was mainly composed of floaters.

(2) One thing that both high-school and professional levels have in common is that the goal scoring rate per counterattack is much higher than the average goal scoring rate of the total shots taken, which shows its importance.

(3) The play that induces water withdrawal is often a turnover in high school, while at the world level it is often a floater.

***(3)"Game Analysis on Team Contribution of Water Polo Athletes"*: (Enomoto, Minami, M. Takahashi, J. Takahashi, S. Suh, and K. Komori, Journal of Sports Methodology, Vol. 14, No. 1)**

< purpose of this paper's research.>

In ball games, individual evaluation is essential, but most of the practice is spent on evaluation of team behavior. Sakai et al. used basketball scores to evaluate individual achievement in a game by classifying the plays in the final phase that determine the outcome of the attack into "positive contribution" and "negative contribution" plays to the victory or defeat of the game, and assigning positive and negative points to each play. This study quantifies the relationship between the result of each attack and the score in the next attack in water polo games, clarifies the contribution of the players involved in the attack, and helps to develop a team contribution system for water polo players.

<What I learned from this paper>

This study aims to contribute to the development of a team contribution system for players in water polo games by examining the differences in the scoring contribution index for each play in the final phase of different attacking plays. Here are the results.

In the analyzed games, the offensive contribution index for each result entry was: overtime and personal fouls, overtime and re-attacking after a shot, resume after a goal and a personal foul and resume after a goal, re-attack after a shot, turnovers and personal fouls that do not involve shooting, other and personal fouls, personal fouls and re-attacking after a shot,

Personal fouls and turnovers after shooting.
Significant differences were observed in the above eight items.

(4) *"Analysis of the game of Basket Ball on the Scouting Sheet"*:(Mitsuo Sasaki, Journal of the Institute of Physical Education, Keio University, 18 1978. p.63 - p.79)

<The purpose of this paper's research.>

Create scouting sheets for individual play scouting and team play scouting. Use the sheets to explore the main factors that influence the game.

Items on the scouting sheet:

A: General characteristics of the team

(1) Positions and heights of starting members

(2) Substitution strategy

(3) Characteristics of the offense: Patterns of strength and core players

(4) Defensive characteristics: types and patterns they are good at

(5) Player characteristics that stand out in particular

(6) Changes after timeout

B: Formation and play

(1) Jump Ball: Record floor balance and points for that play

(2) Set Offense & Half Throw-in: In the set offense, record the entire movement and the point of the play, as well as which player to start with.

(3) Full Court Defense & Throw-ins: In full court defense, record floor balance and movement patterns and points. For throw-ins, record the floor balance and movement patterns on the play against the press defense.

C: Shoot Position

Write the player number in the position where the shot was made. Type of shot: layup shot, rebounding shot, free shot, other.

D: Good play and bad play

—Examples of good play—

(1) Assist pass

(2) Get Loose Balls

(3) Interception

(4) Held Ball: Opponent ball and loose ball are turned into held ball.

(5) Good Help: When a score is not allowed due to help defense.

(6) Good defense: When you induce an offensive foul.

(7) Shot check: When a shot block results in the ball going to your team.

(8) Offensive rebound: When you get the ball from a rebound on offense.

(9) Defensive rebounding

—Bad play entry—

(1) Easy shot: Missing shots with no defense.

(2) Missed pass: When a mistake is made due to inaccuracy from the passer.

(3) Catching errors: Failure to catch the ball on the receiver's end.

(4) Dribbling error: Losing the ball on a failed dribble.

(5) Foul

(6) Held Ball: When two opposing players have firm possession of the ball, resulting in a Jump-Ball

(7) Violation: When you commit a violation

that results in the opposing team getting the ball.

How to use the sheet:Record the above on sheets and give the corresponding playing instructions.

(1) On the team general characteristics sheet, determine the marksman and give instructions on key points for team offense and team defense.
(2) In formation play, determine the marksman and give instructions to the corresponding defenseman and key points of the team defense.
(3) In the shooting position sheet, the marksman is determined, and instructions are given on key points for individual and team defense against the shot, as well as instructions on rebounding measures.
(4) On the good play and bad play sheets, identify the characteristics of each player and team, and provide instructions on key points for offense and defense as individuals and as a team.

<What I learned from this paper>

By fully analyzing the opposing team through data analysis, you can reduce the number of games lost due to operational failures. Especially in balanced games, the use of data analysis is the key to strategy-making or favorable development.

The factors that determined the winner from this study were (1) proper strategy planning, (2) reduction of misplays, (3) improvement of rebounding, and (4) the ability to play fast.

(5) ***"Feedback on scouting information during basketball games"*** **(Kasai, Katsuta, Saito, Sendai University Graduate School of Sports Science Master's Thesis Collection, Vol. 7. 2006.3)**

<The purpose of this paper's research>

Research on "how to feed back" gathered data and strategies during basketball, which may be effective for the University of Sendai.

(1) Proposing of a "feedback method" that we believe can provide appropriate feedback of in-game scouting information to players at University of Sendai.
(2) Verify that the proposed training method is effective for the player.

-Feedback model
(1) Top model: Scouting information is communicated to the players by the head coach (H-coach) and several assistant coaches (A-coaches).
(2) Sendai University model: Model for communicating scouting information to players from Coach H, Coach A, Primary and Secondary.
(3) Improved model: Scouting information is shared among H-coaches, A-coaches, primary and secondary duties, and then

narrowed down to H-coaches and A-coaches to convey to players.

What I learned from this paper;
(1) Set up a discussion with the team staff.
(2) Identify the person giving the feedback, mainly the H coach. (Identify the presenter)
(3) Present the information to be fed back visually and concretely, using figures and numbers.

As for how to give feedback.
(1) The results suggest that players' subjective evaluation of the improved model is high.
(2) From the Sendai University model, it is suggested that the improved model is an effective way of feedback for the University of Sendai.

6) Results of a survey on the "objective view" of water polo matches.

In order to complete an effective and practical program this time, I felt the need to objectively watch the games of the teams that had made it through the qualifying rounds, and I watched the games of the Spring Junior Olympics Finals held for two days at Chiba International pool in March.
As a result, I thought that the goal difference of the teams would also be useful for my research, so I took a picture of it as shown in Figure 2.

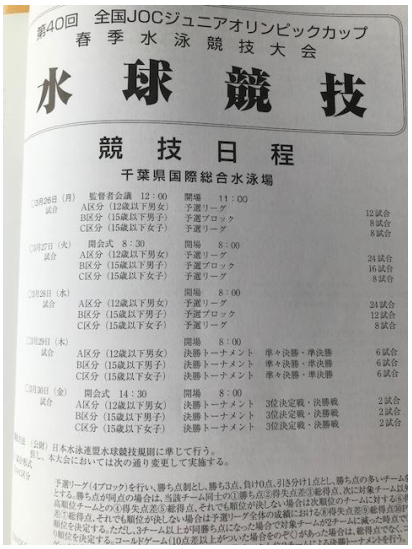

第40回 全国JOCジュニアオリンピックカップ
春季水泳競技大会
水球競技
競技日程
千葉県国際総合水泳場

Fig.2 Spring 2018 Junior Olympics Brochure

I also watched the Kanto Tournament in which the Toho High School water polo team competed. At that time, I saw that the high school students were using an official water polo record sheet to keep track of their games. As shown in Figure 2, this form allows each player to enter the name of the player on both teams, personal fouls, and the number of points scored. The time spent shooting is also recorded. We obtained this information because we thought it would be helpful in developing the program. (From Water Polo Rules, 2015)

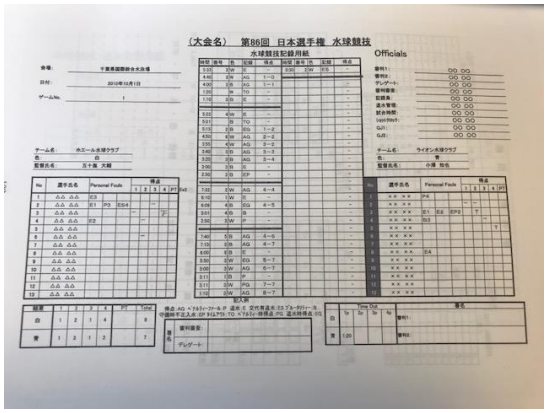


Fig.3 Water Polo Record Form

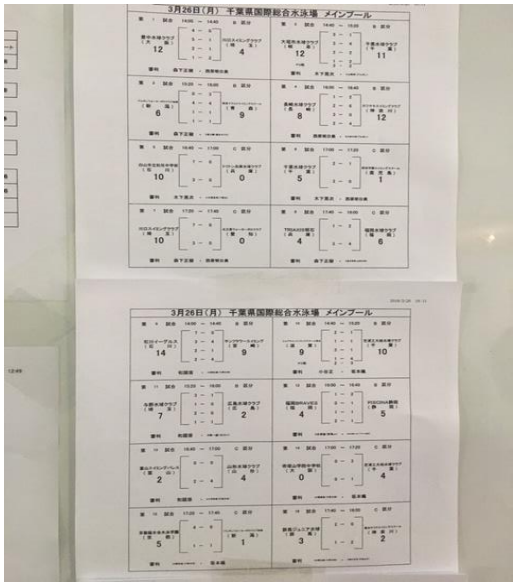


Fig.4-1 Spring Junior Olympics Finals Score List (Day 1)

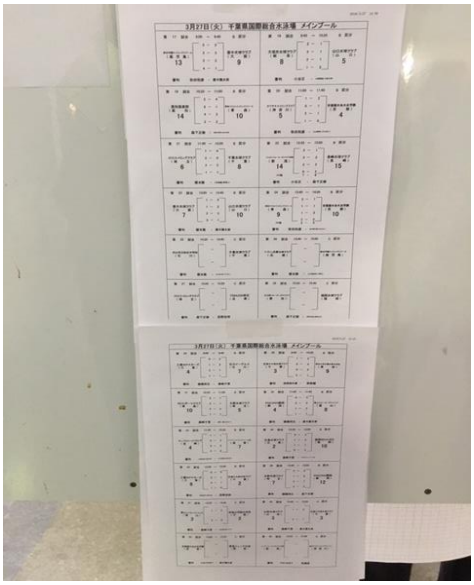


Fig.4-2 Spring Junior Olympics Finals Score List (Day 2)

5) Results of interviews with related parties

In addition to the contents completed by last year, I went to the Junior Olympics and the Spring Kanto Tournament, and added items that I had noticed, and prepared a trial version for the hearing, and then conducted the hearing in the following order.

1) Interviews with Toho Water Polo Club alumni club an team members

I took the time to ask my peers and senior members for their opinions on the current program content. The points were as follows.

{Good point}

-High usability

-I want to use it as soon as it's completed.

-I want it to use in high schools.
{Areas for improvement}
-It's better to have a shooting form.

We were encouraged by the generally positive response of most of the club members we interviewed, many of whom wanted to use it as soon as it was completed.

2) Interviews with managers

The managers gave me some time to give my opinion on the program content with the improvements mentioned above. In addition to the items that the team as a whole needed, the managers also gave me some guidance on the perspective needed by my position, especially since I am a floater back*, which helped me to see what I needed to do better. The points are as follows

{Areas for improvement}

It's better to have a shooting form.
It's better to add the floater-back perspective to the defense types, because it's missing.

The floater-back is the key to the defense, blocking the floater from attacking the goal.

３）Interviews with family members

{Good point}
-It is designed so that the individual's contribution to the team can be objectively understood.
-In particular, it is easy to input the shot positioning in the style of a select box so that the head number can be easily input for real-time analysis.
-It is designed to be used by anyone.
-The data is easy to read.

{Area for improvement}
-There are some screens that seem difficult to use when inputting data, and this should be improved in the future. Also, the trial version does not allow you to save the data, so the previous data is overwritten every time you play a game, which is an inconvenient.
-It would be better if the data of individual could be accumulated and used as material for annual review.
-In addition, it would be more efficient to look back at the previous data of each game.

7). Survey results of the latest technological achievements in programming

At the end of last year, as I was learning and continuing to learn to program, I kept running into my limitations as a beginner in IT. Perhaps it was because I was so focused on the immediate task of learning the technology one by one that I didn't really understand IT itself, and my ideas ended up being at the level of Excel data analysis.

Mr. Teramoto told me that there

would be an "unexplored project results briefing" over two days in early February 2018 at the Fujisoft Akiba Plaza Akiba Hall in Akihabara, and I thought it would be a good opportunity to learn about the whole picture of IT, so I decided to attend it.

This debriefing session mainly consisted of reports on the results of the 20 prize winners and was also streamed live on Nico Nico Douga. All the people gathered at the venue were adults. I felt like I was the only junior high school student, which made me feel very out of place, and I hesitated to enter the venue. However, some of the titles were of interest to me, so I mustered up the courage to enter the hall. The prizewinners' research is as follows.

{Details of research by the winners of the unexplored project}

(1) Cyber Security Human Resource
(2) Development Platform
(3) Development of a typographic system with high static verification capability by type
(4) Developing firmware for free PCs
(5) Development of a high-performance communication infrastructure that automatically optimizes for the environment
(6) GUI-based custom microcontroller design platform
(7) Development of a high-speed gram processing engine for various data sources
(8) Development of an inexpensive and lightweight data glove for bill state recognition
(9) Development of a real-time voice conversion system that can mimic any human voice
(10) Ruby-based development environment for CPU + FPGA platforms
(11) Graph Genome Browser
(12) Home AI that works spontaneously using video as input
(13) Multi-wave ultrashort time imaging by computational photography
(14) Presentation Mechanism Using Hanger Reflex for HMK with Built-in Tactile Force Presentation
(15) Development of an automated system for creating personalized summaries using biometric data
(16) Presentation Support System Using Companion Robot
(17) Development of an insole-type device that transmits information with the foot
(18) Rhythm learning aid with electrical stimulation
(19) Software for Improving Sports with Music and Fun
(20) Maze Creation Kit for Learning Logical
(21) Thinking through Prototyping
(22) Development of an MR system that uses your own body as a controller

The presentation that particularly interested me and impressed me was "Rhythm learning assistance by electric stimulation" (Dr. Hiruko). It is a system that assists in learning rhythm by applying EMS (Electrical Muscle Stimulation), which

uses electrical stimulation to drive muscles, and by providing muscles with rhythm converted into electrical stimulation by the program.

Participating in this presentation was a great opportunity to experience a part of the ever-evolving IT world, and helped me broaden my horizons, which had been limited to writing source code on a PC.

At this time, many of the latest popular programs on the market are open source before they are completed. This means that anyone can access the source code and program experts from all over the world can give their opinions and suggestions. I found out that the overall performance of the program has been improved worldwide by open source. The program developed by Mr. Teramoto, "Hack for Play," which allows users to learn programming while playing games, is also based on an opensource* system. He said that he continues to improve the program as he receives various suggestions and opinions. Of course, they are only making suggestions, and it is up to the programmer to decide whether to accept them or not, but sometimes they receive unexpected suggestions that completely change the way they develop.

As for how elementary and junior high school students these days learn the latest programs, they usually learn and develop their own techniques by getting various opinions from their peers. I felt that it is very important for those who develop programs to have a system where they can get opinions on problems they would not see on their own.

*Open source: Open source is a system in which the source code (text written in a programming language) of software is released to the public free of charge, and feedback can be freely obtained. If you want to get opinions from all over the world, you need to write the source code in English. You can receive countless valuable advice and feedback, but only the developer can actually improve the software. Some software is free to improve these days. Normal software requires a usage fee.

■Phase Two■

～Mastering of Programming Techniques～

From the time I started learning programming until this summer, my goal was to get to a level where I could program from scratch by myself. This is what Mr. Teramoto taught me when I met him. It is not that there are no easy ways to learn programming. One way to learn is to use existing software to develop certain programs. On the other hand, if you can't use the software, you can't develop anything. I wanted to develop a program from scratch as I envisioned it, so I felt like I took a long detour. However, thanks to this, this year I have reached a level where I can develop a program from scratch at the level I have in mind.

The following is a list of typical items used to acquire the skills necessary to complete the development of this program.

1. Use the “Progate” to learn

First of all, we learned about “HTML*”, “JavaScript*”, “jQuery*”, and other programming languages by using the “Progate”, a website that allows you to learn them practically while having fun with a game-like atmosphere (https://prog-8.comhttps://prog-8.com/). Progate is a popular website that is currently available in 12 countries and has 460,000 users.

To be more specific, there is a character named "Ninja Wanko", and as I complete various programs, the character's level increases. For example, the "completed actual program" appears on the right side of the screen, and the incomplete "current program" appears next to it at the same time, so I have to keep writing source code for the "current program" until it completely matches the "completed actual program”. If you write the wrong code, it will keep responding as "incorrect". There is also an "Answers" page, so if you don't get the correct answer, you can look at that page, but if you look at it, your character's level will not increase because your "experience" will be reduced by half. Therefore, it is a learning program designed in such a way that you will not be able to move forward unless you find the correct answer yourself.

For each language of one program, there are four to five units, and there are 14 programing languages in total. Therefore, if you complete about 60 or more programs in total, you will have completed the course (15 total classes, 68 lessons). This kind of software was easy to understand and keep up with for a programming beginner like me. During the process, I learned to use e-typing, a free typing software to improve my typing skills in order to increase the speed of my source code input.

*What is HTML; stands for Hyper Text Markup Language and is one of the most basic markup languages used to create web pages. Most of the web pages you see in your

browser are made with HTML.

*What is Java Script; It can be used to calculate numbers and create graphs, which cannot be done with HTML alone. It is also capable of creating passwords, which is essential for creating a website.

*What is j Query; It is the same as JavaScript's calculation and graphing functions. There is no particular problem even if you don't use it. However, it can be written with considerably less code than JavaScript.

*What is E-typing: It is a free website for typing practice.

2. Learning as I develop

It is said that once you have mastered JavaScript and jQuery, you are ready to create your ideal program, and you can actually create your ideal program by applying the basics I have learned since last year. In reality, when you write the source code* based on the basic technology, it often does not turn out to be a complete program. When this happens, first suspect a typing error, and write "Debugger" at the end of the JavaScript source code to see if the program's typing error is displayed in the console*. If it shows up as a typo, rewrite the source code again. If it doesn't show up as a typo, I'll spend the next 20 minutes as I did last year trying to figure it out so that I can rectify the source code for the complete program.

There are countless ways to search for this information in programming, and in the beginning, you may find yourself unable to find anything no matter how much you search. However, as your programming skills improve, your research skills will also improve, and you will be able to find out what keywords to enter into the search engine, and you will be able to get the information you need quickly.

Like last year, when I couldn't get an answer after 20 minutes, I asked Teramoto through Discord*. As soon as I get a hint from Teramoto, I rewrite the source code by myself. The 20-minute rule is the one I learned from Teramoto last year. The 20 minutes is the time when a beginner gets sick of programming. The main reason why they get tired of programming is because they can't create the ideal program no matter how many time they write the source code. 20 minutes is a learning method where people desperately look for answers. So if I still don't understand after 20 minutes, I can ask questions to Mr. Teramoto, the same way as last year. I had fundamental questions or encountered too many obstacles, I can have a conference call with Mr. Teramoto by using discord.

In order to keep track of the progress of the program development, I also used Trello software to keep a compact summary of the program development process.

*What is source code: The computer reads the source code from above and executes it faithfully. The following is a part of the source code I actually wrote;

```
<!DOCTYPE>

<head>
    <meta charset="UTF-8">
    <title>桐朋水泳部</title>
        <link      rel="stylesheet"
type="text/css" href="home.css">
        <link      rel="stylesheet"
href="https://maxcdn.bootstrapcdn.
com/bootstrap/3.3.7/css/bootstrap.
min.css"          integrity="sha384-
BVYiiSIFeK1dGmJRAkycuHAHRg32OmUcww
7on3RYdg4Va+PmSTsz/K68vbdEjh4u"
        crossorigin="anonymous">
    <style>
        body {
            background: skyblue
        }
    </style>
                              <script
src="https://ajax.googleapis.com/a
jax/libs/jquery/1.12.4/jquery.min.
js"></script>
    <style>
        body {
            background: skyblue
        }
```

The above is the part of the actual source code of this program

*What is the console; it is a mechanism that appears when you right-click on a completed program and select "Verify".

*What is the Discord; It is a free communication tool like Line, but it differs from Line in that it allows you to post source code, making it a popular communication tool among programmers and gamers. It also allows for conference calls and screen sharing. To set up this conference call, I checked Mr. Teramoto's schedule on Google Calendar and requested a time when he was available and I wanted to meet him.

*What is the Trello; It is a signboard-style tool that allows you to manage your tasks visually by moving cards around, and I used it to manage the programs I wanted to create on a daily basis, dividing them into "completed", "in progress", and "incomplete". This is not a tool for programming people, but a tool that many people use to manage their work. In the beginning, I shared the screen with Mr. Teramoto to check the progress, but from the middle of the project, I used it daily to manage my own schedule.

Actual image of Trello is shown below;

*What is the Google Calendar; it is a free scheduling tool provided by Google that syncs with your iPhone and can be used worldwide as long as you have a Gmail account and internet access.

＊Google Calendar example

＊What is CSS?

Abbreviation for cascading style sheets, which are used to adjust the size, color, and thickness of buttons, pictures, tables, and other objects written in HTML.

＊What Components are?

This site contains about 100 or so designs that can be used as a reference for the look and design of sites created with HTML.

＊What is Git Hub?

It means to hub (gather) Git (a system for storing and tracking changes to program source code). In other words, it is a web service that allows people all over the world to save and publish their own programs and so on, by using the Git system. It can be used free of charge, and can be made private for a fee.

The repositories created by GitHub are basically all open to the web.

■Phase Three■

～Completion of the Real-time Analysis Trial Version～

1. Real-time game analysis program trial version development procedure

The preliminary research provided us with a variety of perspectives, but it also raised the question of whether it is really a good idea to develop an entire program that reflects all of the opinions, and whether it is practical considering the enormous amount of time it would take. Therefore, instead of developing a program that reflects all the opinions before the Junior Olympic Qualifying round, I decided to set a level of development that is realistic time wise, and to complete it as a trial version in mid-July 2018. By actually using it to analyze the trial version at the Summer Junior Olympics Qualifying Tournament to be held in July, we decided to confirm its effectiveness, identify issues, and attempt to complete a more effective and practical analysis program.

The purpose of developing the trial version was to provide objective data to each individual player first, rather than overall data, so that they could look at their own game objectively and use it as a material for looking back.

2. Examination of trial version items and creation of output screen images

Based on the foundation planned and promoted last year, the following points were focused on for improvement

(1) Review of data items required for match analysis

(2) Data item extraction for real-time analysis

(3) Examining the output image of the trial version of the real-time analysis program

3. Actual trial version development

(For details of the R&D process up to last summer, please refer to "Kiri no Tomo" No.54. We discussed the main points that need to be improved on the contents completed last year.) The contents are as follows.

(1) Shoot positioning will be developed based on the input screen developed last year, so that the results of shot positioning (from where on the field the shot was taken, and whether it was

successful or missed) will be output in a table for each player.

(2) Analyze offensive and defensive styles, including all 12 items required as a floater back (assisted pass, successful pass, missed pass, pass cut, counterattack, shoot blocking, foul, ejection, taking position in the hole, driving, back cut, etc.) and enter and analyze shooting style tendencies. The results can be displayed as graphs and can be used to provide real-time feedback to each team member immediately after each game. I will also make an analysis program that includes shooting form. The types of shooting forms are as shown below;

(1) Middle shot: A shot from 7 to 8 meters or more.
(2) 5-meter shot: Free throw shot over 5 meters (has been changed to 6 meters in 2020 after an official rule modification)
(3) Floating shot: The act of taking a shot inside the “Hole”, the area in front of the goal.
(4) Floating back shot: The act of shooting backwards when floating.
(5) Water retreat shoot: The act of shooting while the opponent player was ejected following a foul
(6) Hand-to-hand: The act of shooting the ball from one player's hand to the other player's hand frequently.
(7)1on1: When a counterattack is set and the only defender is the keeper, and the player takes the ball to the goal by himself and shoots by himself.
(8) Cut Shoot: The act of driving in the middle lane before shooting.
(9) Goal to goal: The act of shooting from the keeper into the opponent's goal.
(10) Last-minute shot: The act of taking a last-second shot in the last five seconds or so.
The above shooting form is now developed to be displayed as a bar graph for each player.

4. Measuring total swim distance

As for the measurement of total swimming distance, it is difficult at this time without using large-scale software, and it was not clear from the interview how meaningful total swimming distance is for real-time analysis of games for junior and senior high school students. Therefore, it was decided not to develop a program to measure total swimming ability.

5. Using “athletic ability index”

Rather than using a program that outputs the overall trend of offense and defense in a bar graph, which I considered last year, I decided to consider a method to calculate the "index" because we judged that it would present more useful information if we could see the "athletic ability index,"

which is a measure of the contribution to the team that has been proven effective in previous studies. However, I judged that it would be difficult to create the formula before the trial version, so I decided to first transfer the data from the offense and defense analysis of the trial version to Excel as it was, calculate it, analyze the results, and only if the results showed valid values, develop a complete version of this analysis program.

6. Records two kinds of shooting forms

I thought it was important to develop two analyses methods, one for shooting form and the other for offense and defense, so that I could understand the whole structure of the game. I developed a program for both methods including offensive and defensive analysis and shooting form analysis. The input screen for shooting form analysis is shown in Table 2, on the next page. Tables 3 and 4 are printed versions of the respective input screens.

Table 1：Input screen for shoot positioning

<Real Screen>

<Translated into English>

Name of your team

Name of opponent team

	5		4		3GOAL		2		1	
A	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼
B	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼
C	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼
D	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼
E	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼
F	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼	Score ▼	Miss ▼

Press to go OUTPUT SCREEN

Table　2 ：Shoot Form Style Analysis Input

<Real Screen>

シュートフォーム

番号	ミドルシュート	6mシュート	フローティングシュート	5mペナルティ	退水シュート	ハンドツーハンド	バックシュート	1対1	カットインシュート	ゴールトゥーゴール
1番	0	0	0	0	0	0	0	0	0	0
2番	0	0	0	0	0	0	0	0	0	0
3番	0	0	0	0	0	0	0	0	0	0
4番	0	0	0	0	0	0	0	0	0	0
5番	0	0	0	0	0	0	0	0	0	0
6番	0	0	0	0	0	0	0	0	0	0
7番	0	0	0	0	0	0	0	0	0	0
8番	0	0	0	0	0	0	0	0	0	0
9番	0	0	0	0	0	0	0	0	0	0
10番	0	0	0	0	0	0	0	0	0	0
11番	0	0	0	0	0	0	0	0	0	0
12番	0	0	0	0	0	0	0	0	0	0
13番	0	0	0	0	0	0	0	0	0	0
000番	0000000	0000000	000000	000000	0000000	000000	0000000	0000000	000000	000000

<Translated into English>

# of players	Middle shoot	5m	Floating shoot	Floating back Shoot	Exclusion Shoot	Hand To Hand	Back Shoot	1 by 1	Cut In	Goal to Goal	Middle Shoot Re-start
#1											
#2											
#3											
#4											
#5											
#6											
#7											
#8											
#9											
#10											
#11											
#12											
#13											

Table 3 ：Offense and Defense Style

Input Screen

<Real Screen>

試合のオフェンスとディフェンス

番号	パスカット	退水誘発	プレスカット	ハンドアップ	パス成功	パスミス	ファール	退水	フローティング	フローティングミス	カットイン	バックカット	シュートミス	シュート成功
１番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
２番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
３番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
４番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
５番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
６番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
７番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
８番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
９番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
１０番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
１１番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
１２番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
１３番	0	0	0	0	0	0	0	0	0	0	0	0	0	0
000番	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000

<Translated into English>

# of players	Pass Cut (Pass Steal)	Counter	Press cut (Press Steal)	Hand Up	Pass Success	Pass Miss	Foul	Exclusion	Floating	Floating miss	Cut In (Drive)	Back Cut (Back Steal)	Shoot miss	Trigger Exclusion foul
#1														
#2														
#3														
#4														
#5														
#6														
#7														
#8														
#9														
#10														
#11														
#12														
#13														

■Phase Four■

～Real-time Analysis Program Trial Version Practice and Analysis Results～

1．Practice the Trial Version

In the Junior Olympics qualifying games held in July this year, all three games were played in an official four-period (four 4-minute periods) round-robin format. Unfortunately, my team lost in the preliminary round, but I decided to analyze the data of all the games using the trial version, because all the games were very instructive and each game had very different characteristics.

{Match Summary}

The first match against the Makuhari Water polo club was very close and saw a change in lead in the last few seconds, while the second match against the Chuo University Junior High School water polo club was a huge victory for Toho, against a team we had never won against before. At that point however, it became difficult for the team to qualify for the finals due to the other teams' wins and losses as well as the goal difference.

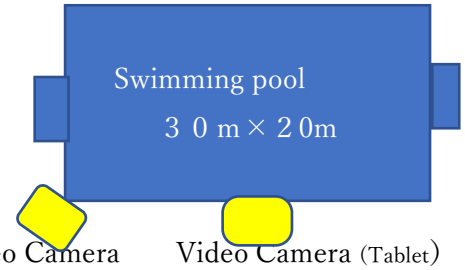
The last qualifying match of the second day was against the Meiji Nakano Water Polo Club, which is very famous for being a champion for several times and a very strong water polo school. Toho Junior and Senior High School had never defeated the Meiji University Nakano Water Polo Team before. Even in this preliminary round, the Meiji University Nakano water polo team had been winning cold or overwhelmingly against their opponents. Our high school seniors had strong feelings for the Meiji University Nakano water polo team, and most of them came all the way to Gunma Prefecture to support us, so although it was impossible for us to make it through the qualifying round at that point, we did not want to lose by a large margin. As a result, we lost 1:4, but the other team had their starting lineup for all four periods, so it was a real battle. In the end, we were able to keep the game to four goals, which earned us praises from everyone there.

{How to analyze with the trial version}

By analyzing these three games using the trial version of the data analysis, I tried to verify its effectiveness. The trial version at this stage had three input screens: 1) defensive and offensive style analysis, 2) shooting form analysis, and 3) shooting positioning, as shown in Figure 4-1, Figure 4-2, and Figure 7-1.

Since this was a trial version, data analysis could only be done on my PC, where I did all the programming and development. Therefore, I did not analyze the data in real time, but input each player's movements into the PC after each game while playing back the video. For this purpose, I used a video camera and a tablet to record the game,

and asked my parents to record the game at two other locations shown in the following image, so that I could see the entire game and each player's movements.



The reason why both the camera and the tablet were used for recording is that when right after the game players want to look back at it, they have to do so on the tablet if there is no place to project the game. Also, I thought it would be useful to compare all angles of the footage before and after the analysis. For this reason, I recorded the game with both the camera and the tablet.
After the game, I returned home and entered the data for my team and then the opposing team. Since the data from all of these output screens would be quite large, this paper includes the data for myself, referred to as number 2, and the data from the opposing team's number 2 in the output data of 1) and 2) for reference.

For detailed results of each data analysis, please refer to the complementary files "TOHO TEAM DATA Trial Version" and "OPPONENT TEAM DATA Trial Version".

When the trial version was completed, the saving function was not yet programmed, so the output screen was photographed and recorded with a smartphone.

2. Results of offensive and defensive analysis

"Frank states that coaches who spend most of their practice time giving advice on team behavior are not adopting the best approach for developing individual players' abilities. He also added that, in ball games, team evaluation is necessary, but individual evaluation is essential for improving individual players' abilities (Enomoto, Minami, et al. 2001). When I effectively became captain and took charge of review meetings and gave feedback to each player, I felt that it was very important to be able to accurately point out problems so that improvements could be made from one game to another.

For this reason, I thought that the greatest effect of the data analysis program would be the ability to present objective data to each individual player, so I created this interface where the whole team could easily input information from each player on a single screen, and easily read the output data.

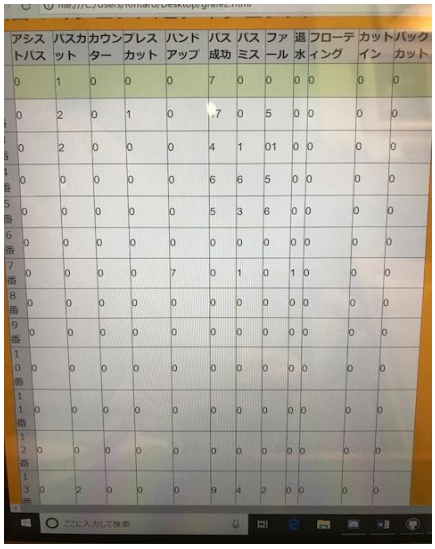
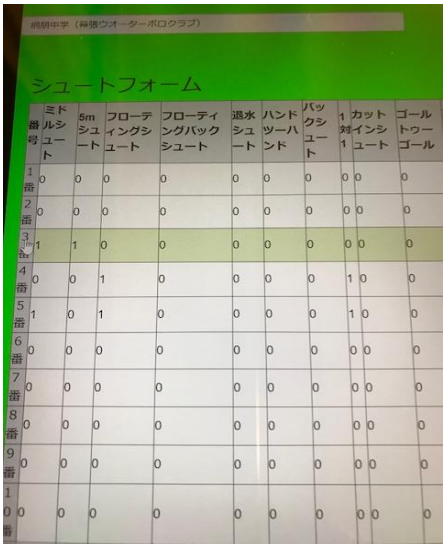


Fig4-1 Offensive and defensive style input screen



Fig,4-2 Shooting form input screen

At this time, based on suggestions by Dr.Enomoto that it is best to have two people input the data, one person was asked to dictate the data (such as "Toho #XX pass successfully" or "Toho #XX), and the other person entered them on the screen. This method greatly reduced the amount of time needed to complete the task compared to working alone.

Once all data entered, clicking on the head number of a player (similar to back number in other sports), will display the corresponding data on the output screen next to the input screen (as shown in Figure 5-1).

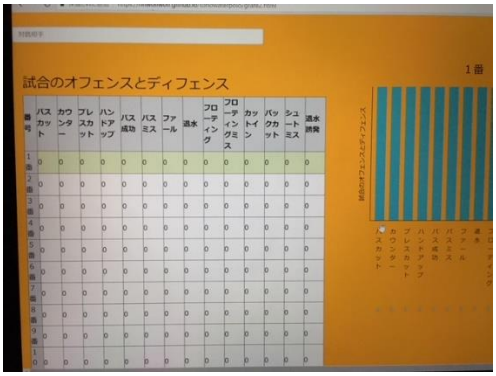


Fig.5-1 Output screen of the shooting form

Fig.5-2 Output screen of shooting form

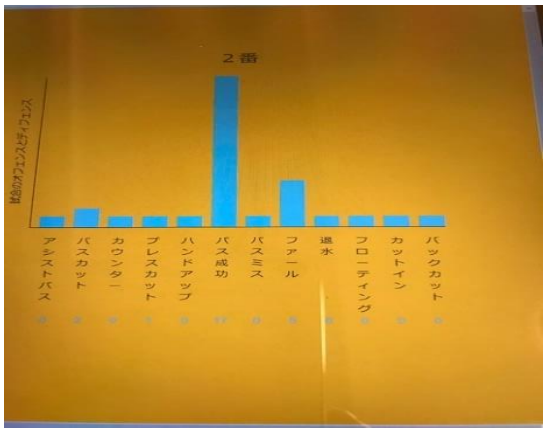


Fig5-3. Shoot analysis result screen of head number 2 in the WPC against Makuhari

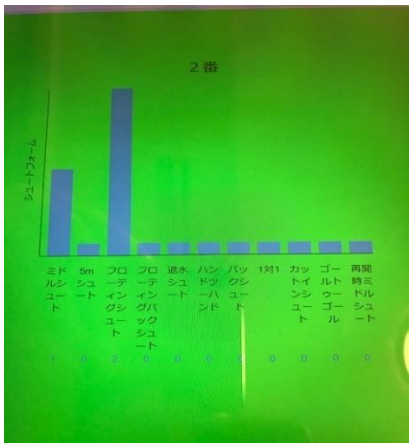


Fig.5-4 Offensive and defensive analysis result screen of head number 2 in the WPC against Makuhari

{Reflections}

This time, in order to examine the validity of the above analyzed data, I compared them to the individual reflection notes that I usually submit to my coach after a game and noted the differences.

As for the results of this comparison, since using each player's data and including here their personal reflection notes could go against their will, I decided to incorporate only my own data. I will also mention information about the rest of my team, taken as a group.

{Water polo notes and analysis data results}

1) Content from Sonoda's (head number 2) note description of Makuhari's performance in the Junior Olympics qualifier:

(1) My counterattacks and press defense were generally sloppy.

(2) When counterattacking, many of us were fast-tracking or committed miscellaneous passing errors, resulting in the reversal of our counterattacks.

2) What the individual data showed:

(1) I made several effective pass-cuts and press-cuts.

(2) Zero missed passes.

(3) 17 successful passes.

(4)I scored three shots.

(5) Five fouls were called.

{Reflection}

Comparing 1) and 2), my impression was that the team's play as a whole was messy and that my play was also messy. However, looking at the data, I saw that I had many successful passes and zero missed passes, indicating that I was making the necessary moves to some extent. In this game, I did not play in a messy manner. The reason for this flawed recollection is that I write on my water polo notebooks not immediately after a game, but after the game

is over, when I am off duty. Some of the members described specific details, but the overall tendency was to write abstract descriptions similar to mine. It is difficult to reflect them in the next play unless they reflect concretely in the factual database and come up with specific strategies and improvement menus. As a result, I was able to verify that feeding back fact-based data to individual players immediately after a match was not only effective in getting hints for improvement for the next match in the same tournament, but also very effective in understanding one's own play objectively again when looking back on the entire tournament.

{Areas for improvement}

The effectiveness of individual data can be fully achieved with the current trial version, but more detailed analysis can be done with data such as pass success rate and shot success rate, which will need to be worked out in the final version.

3. Overall Team Competitiveness Index

We were able to confirm the effectiveness of feedback to individual players. In order to grasp the game as a whole, it is essential to objectively visualize how the movements of individual players affected the actual game. The "competitive ability index", which is obtained by (sum of positive actions - sum of negative actions) / (sum of positive actions + sum of negative actions + sum of effective actions) × 100, which was developed by Steiller as one of the measures to objectify competitive ability, can be calculated by a simple calculation process. (Enomoto, Minami 2001), have tried to calculate it in my own simple way by using the following formula.

Sonoda's formula for calculating the index of athletic ability: (positive action - negative action) x 100

As shown in the table, I divided each action into positive and negative actions, and transferred the data entered in the offensive and defensive data and shooting style analysis programs directly to Excel for calculation. This revealed things that the trial analysis program alone could not. Since the data needed to be accurate for proper consideration, I created the data by re-checking the individual data output from the trial version of the program. I watched the game footage again and made corrections to the values entered in the trial version while inputting them into Excel. Therefore, although there are some discrepancies with the data in the trial data file in the supplementary materials, please note that the final data is the one calculated in Excel.

In the Excel spreadsheet, negative actions are colored yellow to make them easier to see. When the overall and individual indexes are positive, it means that

there were many positive actions in the game. Conversely, when they are negative, it means that there were many negative actions in the game.

Table 5-1, Results of plus/minus action calculation analysis for offense and defense Example

【オフェンスとディフェンス 桐開】

	アシストパス	パスカット	カウンター	プレスカット	ハンドアップ	パス成功	パスミス	ファール	退水	フローティング	カットイン	バックト
1番	0	0	0	0	0	7	0	0	0	0	0	
2番	0	2	0	1	0	17	0	-5	0	0	0	
3番	0	2	0	0	0	3	-1	-1	0	0	0	
4番	0	0	0	0	0	6	-6	-5	0	0	0	
5番	0	0	0	0	0	5	-4	-6	0	0	0	
6番	0	0	0	0	0	0	0	0	0	0	0	
7番	0	0	0	0	0	7	0	-1	-1	0	0	
8番	0	0	0	0	0	0	0	0	0	0	0	
9番	0	0	0	0	0	0	0	0	0	0	0	
10番	0	0	0	0	0	0	0	0	0	0	0	
11番	0	0	0	0	0	0	0	0	0	0	0	
12番	0	0	0	0	0	0	0	0	0	0	0	
13番	0	2	0	0	0	9	-4	-2	0	0	0	
合計	0	6	0	1	0	54	-15	-20	-1	0	0	

Table 5-2 Plus or minus action calculation analysis results for Makuhari WPC shoot form Example

【桐開シュート】

番号	ミドル	5m	フローティング	フローティングバック	退水シュート	ハンドツーハンド	バック	1対1	カットイン	ゴールツーゴール	両開時ミドル	シュートミス	シ合
1番	0	0	0	0	0	0	0	0	0	0	0	0	
2番	1	0	2	0	0	0	0	0	0	0	0	0	
3番	0	1	0	0	0	0	0	0	0	0	0	2	
4番	0	0	0	0	0	0	0	0	0	0	0	2	
5番	0	0	0	0	0	0	0	0	0	0	0	2	
6番	0	0	0	0	0	0	0	0	0	0	0	0	
7番	0	1	0	0	0	0	0	0	0	0	0	2	
8番	0	0	0	0	0	0	0	0	0	0	0	0	
9番	0	0	0	0	0	0	0	0	0	0	0	0	
10番	0	0	0	0	0	0	0	0	0	0	0	0	
11番	0	0	0	0	0	0	0	0	0	0	0	0	
12番	0	0	0	0	0	0	0	0	0	0	0	0	
13番	0	0	1	0	0	0	0	0	0	0	0	-2	
合計	1	2	3	0	0	0	0	0	0	0	0	6	

4.Results and discussion for each game obtained from data analysis

The following is a discussion of each of the three games after calculating the "competition index ability" for all three games. Finally, we have also summarized the points for improvement in the final program development based on the actual analysis. First, the results and discussion of the offense, defense, and shooting analysis are summarized as follows；

1) Toho vs. Makuhari Water Polo Team ～Offense and defense data analysis results

Table 6-1;Toho's offense and defense in the WPC against Makuhari's plus/minus action calculation results

【オフェンスとディフェンス 桐蔭】

	アシストパス	パスカット	カウンター	プレスカット	ハンドアップ	パス成功	パスミス	ファール	退水	フローティング	カットイン	バックカット	プラス行為 (A)	マイナス行為(B)
1Qtr	0	0	0	0	0	7	0	0	0	0	0	0	7	0
2Qtr	0	2	0	1	0	17	0	-3	0	0	0	0	20	-3
3Qtr	0	2	0	0	0	3	-1	-1	0	0	0	0	5	-2
4Qtr	0	0	0	0	0	6	-6	-5	0	0	0	0	6	-11
5Qtr	0	0	0	0	0	5	-4	-6	0	0	0	0	5	-10
6Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7Qtr	0	0	0	0	0	7	0	-1	-1	0	0	0	7	-2
8Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13Qtr	0	2	0	0	0	9	-4	-2	0	0	0	0	11	-6
合計	0	6	0	1	0	54	-15	-20	-1	0	0	0	61	-36

Table 6-2; Results of plus/minus action calculations for offense and defense in the Makuhari WPC for opposing teams.

【オフェンスとディフェンス 幕張WPT】

	アシストパス	パスカット	カウンター	プレスカット	ハンドアップ	パス成功	パスミス	ファール	退水	フローティング	カットイン	バックカット	プラス行為 (A)	マイナス行為(B)	(A-B) *100
1Qtr	0	0	0	0	0	5	-1	0	0	0	0	0	5	-1	400
2Qtr	0	1	0	0	0	7	-2	0	0	0	0	0	8	-2	600
3Qtr	0	0	0	0	0	3	0	-5	0	0	0	0	3	-5	-200
4Qtr	0	0	0	1	0	11	0	-5	0	0	0	0	12	-5	700
5Qtr	0	0	0	0	0	6	0	-1	0	0	0	0	6	-1	500
6Qtr	0	1	0	0	0	7	-1	-3	0	0	0	0	8	-4	400
7Qtr	0	0	0	0	0	2	0	-1	0	0	0	0	2	-1	100
8Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13Qtr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
合計	0	2	0	1	0	41	-4	-15	0	0	0	0	44	-19	2,500

Table 6-3 ； Data comparison results for both teams

■桐蔭と幕張WPCの比較差 (桐蔭−幕張WPC)

	アシストパス	パスカット	カウンター	プレスカット	ハンドアップ	パス成功	パスミス	ファール	退水	フローティング	カットイン	バックカット	プラス行為 (A)	マイナス行為(B)	(A-B) *100
チーム合計	0	4	0	0	0	13	-11	-5	-1	0	0	0	17	-17	0

{Reflection}

From this analysis, both Toho and Makuhari Water Polo Club had an index of 2500 in both offensive and defensive play,

and there was no difference in their overall strength. However, Toho made an overwhelming number of missed passes (Makuhari was successful 91% of the time, while Toho was only successful 78% of the time).

{The results of the shoot data analysis}.

Table 7-1: Plus/minus action calculation results of Toho's shooting form in the WPC against Makuhari

【桐朋シュート】

選手	ミドル	5m	フローティング	フローティングバック	逆水シュート	ハンドツーハンド	バック	1対1	カットイン	ゴールツーゴール	再開ミドル	シュートミス	シュート合計	プラス行為 (A)	マイナス行為(B)
1番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2番	1	0	2	0	0	0	0	0	0	0	0	0	3	3	
3番	0	1	0	0	0	0	0	0	0	0	0	2	1	1	
4番	0	0	0	0	0	0	0	0	0	0	0	2	0	0	
5番	0	0	0	0	0	0	0	0	0	0	0	2	0	0	
6番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7番	0	1	0	0	0	0	0	0	0	0	0	2	1	1	
8番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
9番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13番	0	0	1	0	0	0	0	0	0	0	0	-2	1	1	
合計	1	2	3	0	0	0	0	0	0	0	0	6	6	6	-1

Table 7-2; Plus/minus action calculation result of shooting form in Makuhari WPC of the opposing team.

【幕張WPCシュート】

選手	ミドル	5m	フローティング	フローティングバック	逆水シュート	ハンドツーハンド	バック	1対1	カットイン	ゴールツーゴール	再開ミドル	シュートミス	シュート合計	プラス行為 (A)	マイナス行為(B)	(A-B) *100
1番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2番	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	-2	-200
3番	1	1	0	0	0	0	0	0	0	0	0	0	2	2	0	200
4番	0	0	1	0	0	0	0	1	0	0	0	-1	2	2	-1	100
5番	1	0	1	0	0	0	0	1	0	0	0	-3	3	3	-3	0
6番	0	0	0	0	0	0	0	0	0	0	0	-3	0	0	-3	-300
7番	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	-1	-100
8番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
合計	2	1	2	0	0	0	0	2	0	0	0	-10	7	7	-10	-300

Table 7-3 :Data comparison results for both teams

▌シュート対決 (桐朋-幕張WPC)

選手	ミドル	5m	フローティング	フローティングバック	逆水シュート	ハンドツーハンド	バック	1対1	カットイン	ゴールツーゴール	再開ミドル	シュートミス	シュート合計	プラス行為 (A)	マイナス行為(B)	(A-B) *100
チーム計	-1	1	1	0	0	0	0	-2	0	0	0	16	-1	-1	-2	-300

{Reflection}

Based on the results of this analysis, the difference between Toho and Makuhari Water Polo Club was 300. However, Toho's score of -600 and Makuhari's score of -300 indicate that Toho lost by a narrow margin, as both teams had significantly low field goal percentages.

After all, a missed pass was the difference between victory and defeat in this game.

2）Toho vs. Chuo University Junior High School Water Polo Team

Offensive and defensive data analysis results

Table 8-1: The results of Toho's offensive and defensive plus/minus action calculations against Chuo University Junior High School

【オフェンスとディフェンス 桐朋】

	アシストパス	パスカット	カウンター	プレスカット	ハンドアップ	パス成功	パスミス	ファール	退水	フローティング	カットイン	バックカット	プラス行為 (A)	マイナス行為(B)	(A-B) *100
1番	0	0	0	0	0	4	0	0	0	0	0	0	4	0	400
2番	1	0	0	0	1	10	0	0	0	0	0	0	12	0	1,200
3番	1	2	0	0	0	9	0	0	0	0	0	0	12	0	1,200
4番	0	1	0	0	0	8	0	0	0	0	0	0	9	0	900
5番	0	0	0	0	0	6	-1	0	0	0	0	0	6	-1	500
6番	0	2	0	0	0	5	0	0	0	0	0	0	7	0	700
7番	0	0	0	0	1	4	0	0	0	0	0	0	5	0	500
8番	0	0	0	0	0	2	-1	0	0	0	0	0	2	-1	100
9番	0	0	1	0	0	2	0	-1	0	0	0	0	3	-1	200
10番	0	0	0	0	0	2	-1	0	0	0	0	0	2	-1	100
11番	0	0	0	0	0	1	-1	0	0	0	0	0	1	-1	0
12番	0	0	0	0	0	2	0	0	0	0	0	0	2	0	200
13番	0	0	0	0	0	3	0	-1	0	0	0	0	3	-1	200
合計	2	5	1	0	2	58	-4	-2	0	0	0	0	68	-6	6,200

Table 8-2: Results of offensive and defensive plus/minus action calculations for the opposing team, Chuo University Junior High School

【オフェンスとディフェンス 中大付属】

	アシストパス	パスカット	カウンター	プレスカット	ハンドアップ	パス成功	パスミス	ファール	退水	フローティング	カットイン	バックカット	プラス行為 (A)	マイナス行為(B)	(A-B) *100
1番	0	0	0	0	0	5	-4	0	0	0	0	0	5	-4	100
2番	0	0	0	0	0	2	-1	-2	0	0	0	0	2	-3	-100
3番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4番	0	0	0	0	0	4	1	-1	0	0	0	0	4	0	400
5番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6番	0	0	0	0	0	5	0	0	0	0	0	0	5	0	500
7番	0	0	0	0	0	0	1	-1	0	0	0	0	0	0	0
8番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9番	0	0	0	0	0	3	0	-1	0	0	0	0	3	-1	200
10番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
合計	0	0	0	0	0	19	-3	-5	0	0	0	0	19	-8	1,100

Tabke 8-3 Data comparison results for both teams

■桐朋と中央大付属の回数差（桐朋ー中付）

	アシストパス	パスカット	カウンター	プレスカット	ハンドアップ	パス成功	パスミス	ファール	退水	フローティング	カットイン	バックカット	プラス行為 (A)	マイナス行為(B)	(A-B) *100
チーム合計	2	5	1	0	2	39	-1	3	0	0	0	0	49	2	5,100

{Reflection}

From these figures, Toho had a positive contribution index of 6200 in offensive and defensive plays against Chuo University Junior High School, and the difference between Toho and Chuo

University Junior High School is 5100. This game showed a large difference in overall strength. In addition, none of the individual players showed any negative indicators, indicating that each of them had an overwhelming number of positive actions and were able to play calmly and control the path of the game.

{The results of the shoot data analysis.}

Table 9-1: Toho's plus/minus act calculation results for shooting form vs. Chuo University Junior High School

【前期シュート】

背番号	ミドル	5m	フローティング	フローティングバック	逆水シュート	ハンドツーハンド	バック	1対1	カットイン	ゴールツーゴール	再開時ミドル	シュートミス	合計	プラス行為 (A)	マイナス行為(B)	(A-B) *100
1番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2番	0	1	0	0	0	0	0	1	1	0	0	0	3	3	0	300
3番	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	-1	-100
4番	0	3	0	0	0	0	0	1	0	0	0	-2	4	4	-2	200
5番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6番	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	100
7番	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	100
8番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11番	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	-1	-100
12番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13番	0	2	0	0	0	0	0	0	0	0	0	-4	2	2	-4	-200
合計	0	6	1	0	0	0	0	3	1	0	0	-8	11	11	-8	300

Table 9-2 The results of the plus/minus action calculation of the shooting form of the opposing team, Chuo University Junior High School.

【中大付属シュート】

背番号	ミドル	5m	フローティング	フローティングバック	逆水シュート	ハンドツーハンド	バック	1対1	カットイン	ゴールツーゴール	再開時ミドル	シュートミス	合計	プラス行為 (A)	マイナス行為(B)	(A-B) *100
1番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2番	0	0	1	0	0	0	0	0	0	0	0	-2	1	1	-2	-100
3番	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	-1	-100
4番	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	-2	-200
5番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7番	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	100
8番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
合計	0	1	1	0	0	0	0	0	0	0	0	-5	2	2	-5	-300

Table 9-3 Data comparison results for both teams

■前期と中央大付属の回数差（前期－中付）

背番号	ミドル	5m	フローティング	フローティングバック	逆水シュート	ハンドツーハンド	バック	1対1	カットイン	ゴールツーゴール	再開時ミドル	シュートミス	合計	プラス行為 (A)	マイナス行為(B)	(A-B) *100
チーム差合計	0	5	0	0	0	0	0	3	1	0	0	-3	9	9	-3	600

{Reflection}

Although Toho won the game handily, they missed a lot of shots, as shown by the fact that their overall shooting index was 300, but their individual ratings were mostly negative. However, while the opposing team's shooting percentage was

28%, Toho's was 57%, and that is what led to their victory.

3)Toho vs. Meiji University Junior High School Water Polo Team

Offense and defense data analysis results

Table 10-1: The results of Toho's plus/minus act calculation for shooting form vs. Meiji University Junior High School

【オフェンスとディフェンス 桐朋 対 明中 (桐朋サイド)】

	アシストパス	パスカット	カウンター	ブレスカット	ハンドアップ	パス成功	パスミス	ファール	退水	フローティング	カットイン	バックカット	ボジション	プラス行為 (A)	マイナス行為(B)	(A-B) *100
1番	0	0	0	0	0	8	-2	0	0	0	0	0	0	8	-2	600
2番	0	3	0	0	0	12	-1	-1	-1	0	0	2		17	-1	1600
3番	0	0	0	0	0	5	-2	-5	0	0	0	0		5	-7	-200
4番	0	1	0	0	0	2	-4	-5	0	0	0	0		3	-9	-600
5番	0	0	0	0	0	7	-4	-1	0	0	0	0	-2	7	-7	0
6番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
7番	0	0	0	0	0	1	-2	-6	-1	0	0	0		1	-9	-800
8番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
9番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
10番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
11番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
12番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
13番	0	0	0	0	0	4	-1	-4	-1	0	0	0		4	-6	-200
合計	0	4	0	0	0	39	-16	-22	-3	0	0	2	-2	45	-41	400

Table 10-2: The results of the plus/minus action calculation for the shooting form of the opposing team, Meiji University Junior High School.

【オフェンスとディフェンス 対 明中【明中サイド】

	アシストパス	パスカット	カウンター	ブレスカット	ハンドアップ	パス成功	パスミス	ファール	退水	フローティング	カットイン	バックカット	ボジション	プラス行為 (A)	マイナス行為(B)	(A-B) *100
1番	0	0	0	0	0	12	0	0	0	0	0	0	0	12	0	1200
2番	0	0	0	0	0	4	0	-1	0	0	0	0	0	4	-1	300
3番	0	4	0	0	0	6	0	-3	0	0	0	0	0	10	-3	700
4番	0	0	0	0	0	7	0	-5	0	0	0	0	0	7	-5	200
5番	0	0	0	0	0	4	-2	0	0	0	0	0	0	4	-2	200
6番	0	0	0	0	0	0	-2	-2	0	0	0	0	0	0	-4	-400
7番	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	200
8番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14番	0	0	0	0	0	4	0	-5	0	0	0	0	0	4	-5	-100
合計	0	4	0	0	0	39	-4	-16	0	0	0	0	0	43	-20	2300

Table 10-3 Data comparison results for both teams

■桐朋と明中の回数差 (桐朋ー明中)

	アシストパス	パスカット	カウンター	ブレスカット	ハンドアップ	パス成功	パスミス	ファール	退水	フローティング	カットイン	バックカット	ボジション	プラス行為 (A)	マイナス行為(B)	(A-B) *100
チーム計の差	0	0	0	0	0	8	-12	-6	-3	0	0	2	-2	10	-21	-1100

{Reflection}

As you can see from the figures, Toho's "Competitive Ability Index" in this match was 400, the lowest among the three matches. Therefore, we can see that there were quite a few negative actions. Their opponent's index was 2300, indicating that the opposing team pushed us too hard, resulting in frequent fouls and missed passes.

{The results of the shoot data analysis}

Table11-1: Toho's plus/minus action calculation results for shooting form vs. Meidaigaku Junior High School

番号	ミドル	5m	フローティング	フローティングバック	退水シュート	ハンドツーハンド	バック	1対1	カットイン	ゴールツーゴール	再開時ミドル	シュートミス	シュート防御	合計	プラス行為 (A)	マイナス行為(B)	(A-B) *100
1番	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
2番	0	0	0	0	0	0	0	0	0	0	0	-1		-1	0	-1	-100
3番	0	1	0	0	0	0	0	0	0	0	0	-1		0	0	-1	-100
4番	0	0	0	0	1	0	0	0	0	0	0	0		1	1	0	100
5番	0	0	0	0	0	0	0	0	0	0	0	-1		-1	0	-1	-100
6番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
7番	0	0	0	0	0	0	0	0	0	0	0	-2		-2	0	-2	-200
8番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
9番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
10番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
11番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
12番	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
13番	0	0	0	0	0	0	0	0	0	0	0	-2		-2	0	-2	-200
合計	0	1	0	0	1	0	0	0	0	0	0	-7		-5	1	-7	-600

Table 11-2 : The results of the plus/minus action calculation for the shooting form of the opposing team, Meiji University Junior High School.

【明中シュート 対 桐朋】

番号	ミドル	5m	フローティング	フローティングバック	退水シュート	ハンドツーハンド	バック	1対1	カットイン	ゴールツーゴール	再開時ミドル	シュートミス	合計	プラス行為 (A)	マイナス行為(B)	(A-B) *100
1番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2番	0	1	1	0	0	0	0	0	0	0	0	0	2	2	0	200
3番	1	0	0	0	0	0	0	0	0	0	0	-3	-2	1	-3	-200
4番	0	0	0	0	0	0	0	0	0	0	0	-1	-1	0	-1	-100
5番	0	0	0	0	0	0	0	0	0	0	0	-3	-3	0	-3	-300
6番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7番	0	0	0	0	0	0	0	0	0	0	0	-1	-1	0	-1	-100
8番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13番	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14番	0	0	0	0	0	0	0	1	0	0	0	-4	-3	1	-4	-300
合計	1	1	1	0	0	0	0	1	0	0	0	-12	-8	4	-12	-800

Table 11-3: Comparison results between the two teams

■桐朋と明中の回数差（桐朋ー明中）

番号	ミドル	5m	フローティング	フローティングバック	退水シュート	ハンドツーハンド	バック	1対1	カットイン	ゴールツーゴール	再開時ミドル	シュートミス	シュート合計	プラス行為 (A)	マイナス行為(B)	(A-B) *100
チーム計の差	-1	1	0	0	0	0	0	-2	0	0	0	5	3	-2	5	-300

{Reflection}

As you can see from the figures, both teams are not very decisive, despite the fact that they shoot a lot. However, of all the matches, the -800 for the opposing team is the most negative, which means that of both keepers, their keepers saved the most shots.

5. Shoot Position Analysis

This analysis method was learned when I was researching the analysis of the Japanese men's national water polo team's games at the 2016 Rio de Janeiro Olympics, and since it is a method used by many researchers in previous studies in Japan, we programmed it to allow for real-time analysis.

	5	4	3	2	1
A					
B					
C					
D					
E					
F					

Fig.6-1 Shot positioning chart based on Latuko Rudich's taxonomy

This is the Latko-Rudici classification method used by Takahashi et al.199 in the analysis of water polo match games, here regarding shooting positions. In the vertical direction, lines are drawn parallel to the goal line at 2m, 4m, 7m, 11m, and 15m, and divided into six sections from the top: A, B, C, D, E, and F. F refers to all the field after the half line. In the horizontal direction, two lines are drawn from the goal posts to the sideline and the midpoint of the sideline, and from the right, the classification is divided into five sections: 1, 2, 3, 4, and 5. Since the rules have now been revised and are different from what they were then, this analysis program has been set up in the form of 2m, 5m, 7m, 10m, 12.5m and above from the top. Please assume that the following figure represents half of the pool field. (In the diagram, 3 is where the goal is located)

	5	4	3	2	1
A 2 m					
B 5 m					
C 7 m					
D 1 0 m					
E 12.5m					
F All field beyond Half line					

Fig.6-2　Shoot positioning table using the six-divisions method used in this analysis program

In other words, if you shoot from the 3 of A in this Latko-Rudici taxonomy, it is a floating shot.

[INPUT SCREEN]

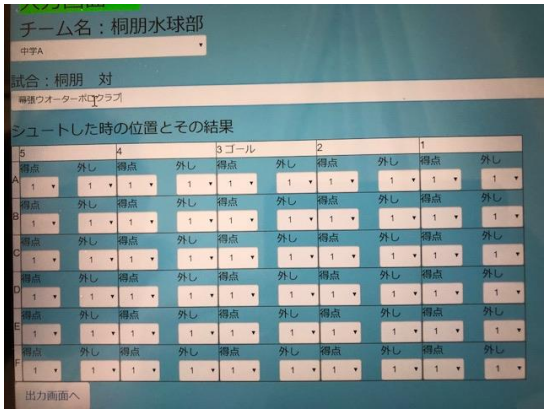


Fig.7-1　Input screen for Shooting positioning input screen

This could be entered by selecting the head number in the "score" select box if the shot was successful where it was taken, or in the "miss" select box if the shot was missed. Since the purpose of this was also to provide individual feedback to each player, the program was designed so that the output would be generated for each player, as shown in the following figure. Based on this, it is possible to analyze one's own shooting tendencies immediately after a game.

Fig.7-2 Shooting positioning output screen

A "○" indicates a successful shot, and an "X" indicates a missed shot or a shot that was saved by the opposing keeper. In the trial version, the results were also sorted by head number (by individual) so that feedback could be given to the individual.

The following is the data for each game of the Junior Olympic Cup qualifiers. As for the method of feedback, since the data is divided into two screens and the head numbers are output as 1 to 6 and 7 to 13, I took a picture of each individual's data, recorded it, and sent it to each player.

5. Results and Reflection of shot positioning data analysis for each match

1) Toho vs Makuhari WPC

■Toho side shot positioning

Fig.8-1 （Head number 1 to 6）

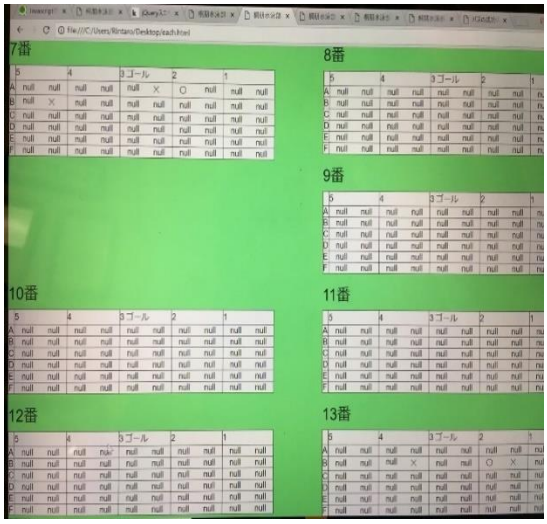


Fig8-2 (head numbers 7 through 13)

■Shot positioning on the opposing side

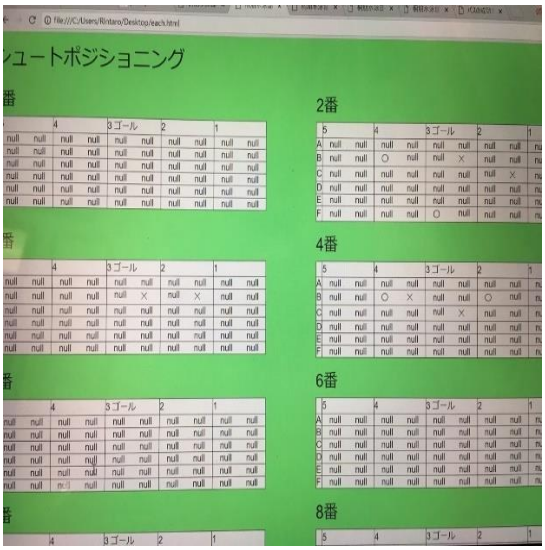


Fig.9- 1 （Head number 1 to 6）

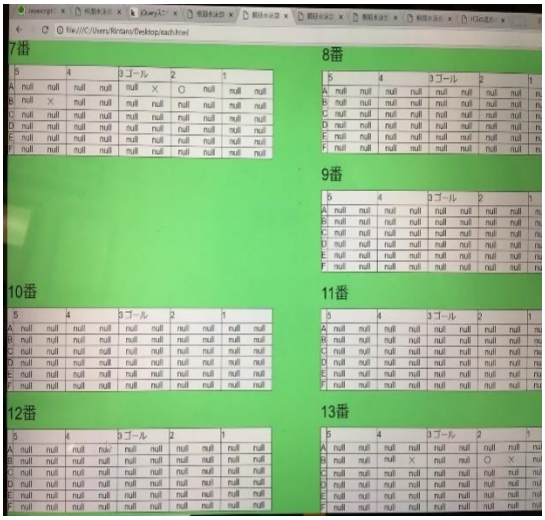


Fig.9-2 （head numbers 7 through 13）

2）Toho vs Chuo Junior High School

■ Toho side shot positioning

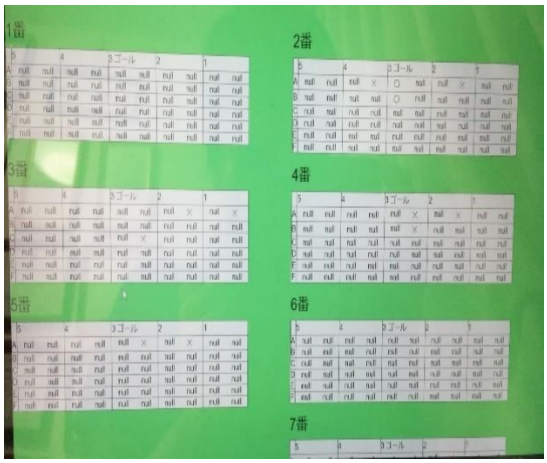


Fig.10-1　(Head number 1 to 6)

Fig.10-2　(Head number 7 to 13)

■Shot positioning on the opposing side

Fig.11-1　(Head number 1 to 6)

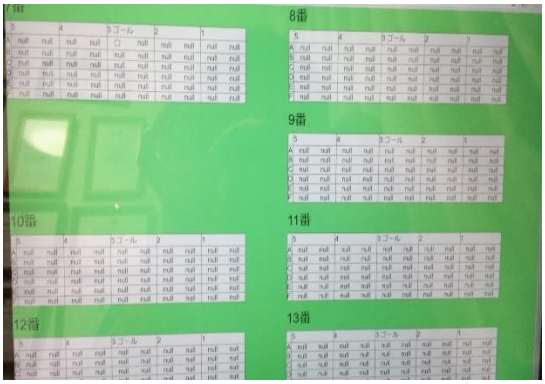


Fig.11-2　(Head number 7 to 13)

3)Toho vs. Meiji University Junior High School

■Toho side shot positioning

Fig. 12-1 (Head number 1 to 6)

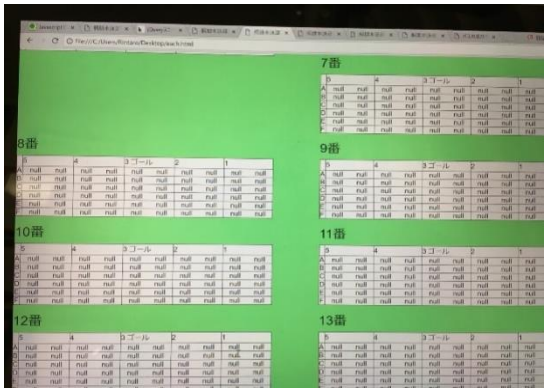


Fig.12-2　(Head number 7 to 13)

■Shot positioning on the opposing side

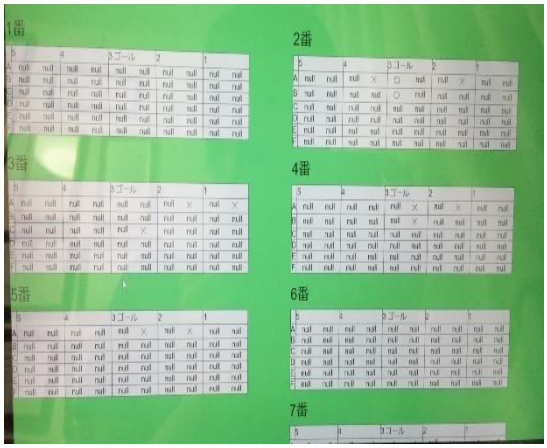


Fig.13-1 (Head number 1 to 6)

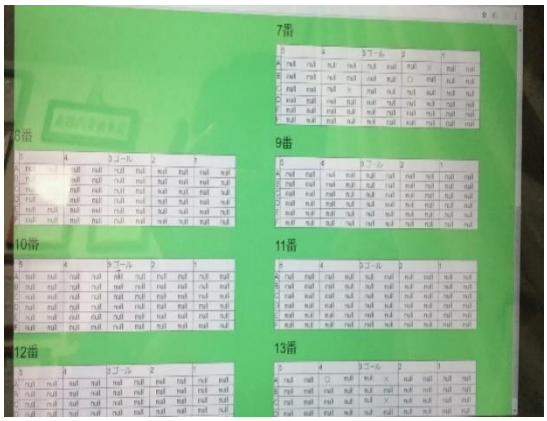


Fig.13-2　(Head number 7 to 13)

{Reflection}

When I looked at the data results, I could see that the places where each member of the team, including my own, scored were consistent with our notes, so I knew I remembered them clearly. In addition, when the data was collected, it was found that there was a consistency in the areas where the shots were missed. In other words, despite the fact that shot misses are an important aspect that needs to be improved, it became clear that the players tend not to remember where they missed in the game. We also found that players were mostly unable to remember the position of the opposing team throughout the game. With both sets of data, we can see not only the trends of successes and mistakes, but also the relationship between the mistakes and successes of our opponents and our defensive tendencies, making it easier to plan new tactics.

However, it would be better to have data on overall shot positioning to get a complete picture of the shooting tendencies of the game, so we decided to add that to the final version.

In addition, due to the limitations of my own technology, "Null" is inevitably still displayed. "Null" is a programming term that refers to the fact that there is no valid value. A similar language is “Undefined”. In other words, where there is null, there is no data, so eventually we need to devise a way to prevent the null from being displayed and only the

successes and mistakes of the shoot from being displayed, as shown in Figure 14.

	5	4	3	2	1
A	×			×○	
B		○○	○		
C					
D					
E		×	×		
F			○		

Fig.14-1 Final image shot positioning analysis results

■Phase Five■

～Identifying Issues After Implementing the Trial Version～

１．Improvements after the trial version and from the analysis and discussion

The trial version of the program was developed with the aim of presenting individual results, but the points listed below are areas for improvement.

１）Addition of a program for calculating competitive ability index.

Provided that individual data alone is effective for considering individual issues, it is easier to see the movements and composition of the entire team if we can get an index like the one calculated in Excel. Since we found that we could provide objective data for the entire team, we decided to add the development of a program that could calculate the index.

２）Add a program that can find the pass success rate.

In analyzing the overall trend of all three games, it was found once again that making sure to pass the ball has a significant impact on winning or losing the game, so it was decided that the completed version would include an analysis of the pass success rate, along with a program to analyze positive and negative actions.

３）Added a program to calculate the shooting success rate.

Since the trial version was intended to present individual shooting tendencies, it was found to be effective in understanding individual tendencies. However, the same can be said for the analysis of offensive and defensive styles, but it was found that more useful information needs to be obtained by being able to analyze the shooting decision rate of the entire team at the same time.

４）Add a program that can display the results of an analysis of the overall trend in shot positioning.

In addition to individual shot positioning, we decided to add an analysis program that shows the overall trend of shot positioning so that we can provide data that shows the overall shooting tendency of your and your opponent's team in order to get a simple overall picture immediately after a game.

2. Meeting with Dr. Itaru Enomoto, a leading expert in real-time analysis of water polo.

Toho Junior/High School Almini, Dr. Endo who visit us one of weekends to give us advice, gave me some time to review my research paper "An Attempt to Develop a Real-Time Analysis Program, 2017" and ask for his opinion. At that time, I found out that Dr. Endo knows Dr. Itaru Enomoto, a leading expert in real-time analysis, which is the main focus of my paper. He said he would be happy to introduce me to him at any time, so I asked Dr. Endo for an introduction.

Dr. Itaru Enomoto's specialty is sports science, and he is currently a professor at Kamakura Women's Junior College. He has been working as an analyst for the Japan National Water Polo Team (both men's and women's) since the Rio de Janeiro Olympics. He is also a recipient of numerous awards from the Japan Amateur Sports Association for his leadership. (For supplementary information, please refer to the Japan Swimming Federation's introduction of Japan's national team members for 2017.)
As soon as I was able to find out what I could do to improve the trial version, I asked Dr. Endo to contact Dr, Itaru Enomoto directly so that I could see him, and he immediately asked me to let him know on the phone when I would be available. I gave him some days when I would be able to finish the analysis of the trial version and not have any practice, and he agreed to meet me after the summer camp of National Team which was held in Tokyo.

During the interview, he gave me some advice on my original real-time analysis program, and also some insights which were not available from just reading his paper. I was also able to talk to him about the analysis program currently used by the Japanese national team. This meeting was very helpful for me in creating an image of the finalized version of my program.

{Summary of the interview with Dr. Itaru Enomoto}

In mid-August, I had a meeting with Dr. Itaru Enomoto. He took the time to meet with me during the training camp of the Japanese men's national water polo team before they went to the Asian Games. He was in charge of analyzing the Japanese men's national water polo team to be held in Jakarta, Indonesia, so he went back to the training camp immediately after our meeting.

Although the time was limited, I first had him look at my paper on the Rio de Janeiro Olympics in my first year in order to understand the outline of my research over the past three years. The professor immediately said that as the person in charge of analysis, he would really like to

know more about it, so I decided to send him a copy later.

Next, he looked at my second-year research paper, "An Attempt to Develop a Real-Time Analysis Program". The professor was particularly interested in the UMA TRACKER*, which tried to give the total swimming distance, and had some questions. He explained the background of using it in the trials, and in particular, I talked about the background behind the decision to give up on the calculation of swimming ability index in the development of this program, as it was difficult to accurately keep track of each player's number in the current program, since in water polo, the player is often submerged in the water. This is why I had to give up on the development of the real-time and counting swim length analysis program. The professor also mentioned that the Japanese national water polo team does not measure the swimming ability index. When I heard that, my hypothesis might be wrong that the total length of swim correlate with winning.

The development of the total length of swim program was very difficult and had to be abandoned like the previous year.

UMA TRACKER is a software developed by Mr. Masato Takeuchi of Tokyo Institute of Technology to measure the trajectory of ants. Last year, we tried to apply this software to measure swimming ability during water polo games, but we could not do it as a result of trials because of the unique movements of water polo, such as stopping and sinking in the water, which are different from those of ants.

For more details, please refer to the "Attempt to develop a real-time analysis program <Research and development of a water polo match analysis program, fiscal year 2017>" in "Kiri no Tomo" No. 54.

After that, he took a look at the program I'm working on and gave me some advice on what I can do to improve my level of IT skills, which I've summarized below.

1） On the athletic ability index for positive and negative actions of offense and defense in the program of scouting:

In his paper, Dr. Enomoto wrote "(sum of positive actions - sum of negative actions) / (sum of positive actions + sum of negative actions + effective actions)". The effective action is a measure of whether the team performed according to its strategy. For example, 1) if a team passes the ball to the ace and leaves it to the ace, passing it to the ace will be counted as an effective action. Or 2) If the team is drive-oriented, then driving is an effective act. On the other hand, floating is a negative action in terms of contribution. Or 3) If the team strategy is mainly floating, passing to a floater is considered an effective act.

In my team, most of the players are still in their second or third year of playing water polo, so the strengths and weaknesses of each member and the overall trend of the

team have not yet been established. Therefore, it was difficult to calculate the degree of contribution. I asked Dr. Enomoto if a simplified version of the formula in his paper (sum of positive actions minus sum of negative actions) would be sufficient for the analysis, and he said that the trend could still be analyzed.

Since I was able to confirm that my simple formula was effective to some extent, I decided to proceed with the development of the offensive and defensive analysis programs of the scouting analysis as planned, including the athletic ability index calculated by my simple version of his formula.

However, when each team member is a bit more skilled and the team is able to formulate a strategy, it would be desirable to be able to include the "effective action" factor in the calculation.

２）About the Offense-Defense section

It is always better to induce penalties. The following is a list of items that induce penalties used by the Japanese team and the situations in which ejection is most likely to occur.

- Floating
- drive
- Turnover (1) When the offensive time of 30 seconds is exceeded, or when the ball suddenly becomes the opponent's ball due to pass cutting, etc.

In addition to this, the analysis of Japan's national team includes an item called "Other", which is used when ejection is triggered in other cases. In those situations when it is unclear, it is entered as "other" so that the analyst's subjective opinion does not come into play.

Once again, I looked through the paper "Report of the Water Polo Committee of the Japan Swimming Federation: Game Analysis Support in the National Junior Olympic Cup Water Polo Ball Games" (Otome, Enomoto, Minami, et al. 2014), which Dr. Enomoto co-authored, and found the average and the number and percentage of those occurrences per game calculated as personal file data. The number and rate of ejection per match was calculated as personal file data. Since this is an important aspect of water polo that can directly lead to scoring, the factor of ejection induction was deemed necessary and was included in the final version of the program.

However, we decided not to include the above detailed analysis in this development due to time constraints. I will consider it in the future as I improve the program.

３）Necessity of consecutive runs (scores) in real-time and data analysis

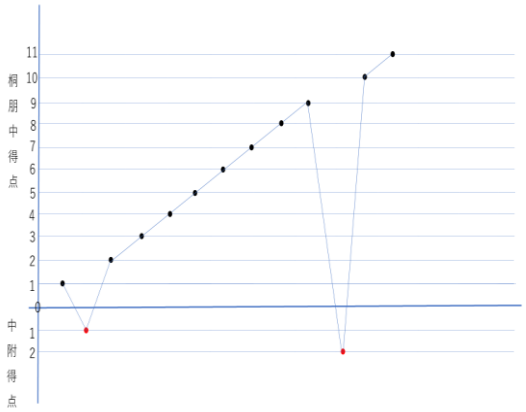


Fig15 Image of the continuous loss graph

If the goals are scored in quick succession, it may be a sign that the opponent has identified a weakness or a trend. In the case of a series of goals, it is necessary to analyze whether the goals were scored due to ejection, personal fouls, etc., or shot positioning, and check and consider where the defense was broken down at an early stage. The figure below is an image I created after listening to Professor Enomoto's talk, and it is similar to the image of the continuous display of goals scored during badminton matches at the Asian Games. If we can understand the tendency of such a sequence of goals scored, it will be useful for later analysis of what was happening there.

4) The need for shooting trajectory items

The current analysis of the Japanese national team's games only analyzes plays such as shooting and retreating water in the end phase, and not defense or successful passing. It can be said that shooting analysis is very important. Therefore, he advised me to include the analysis of the trajectory of the shot (bounce, straight, loop, etc.) in my program as well.

5) Advice as to how to do the analysis.

Against Makuhari Waterpolo Club, we lost by one goal in the Junior Olympic Qualifier, however, in our first game in the Chiba Junior Cup, we won. In the following game, the score was tied, and they lost in a penalty shootout, which is similar to a PK in soccer. He told us that it would be effective to make a hypothesis about why they lost and why they won, and then analyze the results to see if the hypothesis can be verified. I would like to try to analyze the Makuhari game using this method, by carefully hypothesizing three games at a time, when this program is completed, before the next game.

6) Importance of ensuring fairness of results

Since the analyst inputs the data, it is not possible to be sure that there is no subjectivity, so the results are passed on to other analysts to make sure that the results are fair and can be verified

I thought this advice was very important, because the reason I wanted to develop this analysis program in the first place was to provide objective and accurate information.

In the future, the basic captain or

someone who is familiar with the rules will input the analysis, and the results will be distributed at the post-game meeting, where we will review the video and make sure that the data is correct.

As for the real-time analysis and scouting analysis of the Japanese national water polo team, they had been using an Australian company called Sportscode before the Rio Olympics, but they went bankrupt. Currently, they are using software from a US company called Huddle, which costs 600,000 yen a month to analyze. The amazing thing about this software is that it is video-linked, so, for example, if you type in the word "ejection" you can see a video of the 30 seconds prior to the event, allowing you to do a detailed analysis on the spot.

Fig 16 Part of Huddle's analysis program

However, if we can eventually develop such a program and provide it at a reasonable price, it will help improve the skills of the people involved in water polo in Japan, and it will also give more people a chance to learn about the fun of water polo. It would also be a good opportunity to let more people know about the fun of water polo.

After speaking with Dr. Enomoto, I realized that my analysis program is capable of performing sufficient analysis, and I am confident that I will be able to complete it. In the future, it would be ideal if we could include all the advice given by him, but it was difficult to do so considering the technical and time constraints. It was decided that we will review the program as a matter of priority for improvement in order to complete an effective and practical program for junior high school water polo teams.

■Phase Six■

～Real-time analysis and scouting analysis completed development～

1． Final image completed

I was focused on analyzing all the data realistically, but as a result of actual analysis using the trial version, I found that it was better to develop separate programs for real-time analysis, which is the information that is effective immediately after a game, and scouting analysis, which is used to think about the next strategy, so that I can use each of them in different situations and the effectiveness of data analysis will be higher.

Therefore, it was finally decided to create separate real-time analysis and scouting analysis programs.

In addition, in order to make it possible to utilize as long as there is wifi such as with a tablet like an IPad, we developed the following methods:

1）Login screen and menu screen

In order to make the site accessible only to those involved in the Toho Water Polo Club, I set up a login and password. I wanted the first login screen to be simple, so I used the following image. I had already set up the password last year, so I decided to try to find a way to log in using that.

Fig 17-1 Proposed login screen

Fig 17-2 Proposed menu screen

The menu screen was set up so that I could enter the names of my opponents, as well as the players on the bench and their head numbers, referring to the water polo record sheets I had obtained at the Kanto Tournament.

I also wrote the source code for each of them as an image that can jump to the real-time analysis screen or the scouting analysis input screen.

2. Final screen for real-time analysis completed.

Based on the hearing about the analysis results of the trial version, we made the following changes so that the entire shot positioning is output and the overall shot success rate is shown.

1) Shot Success Rate

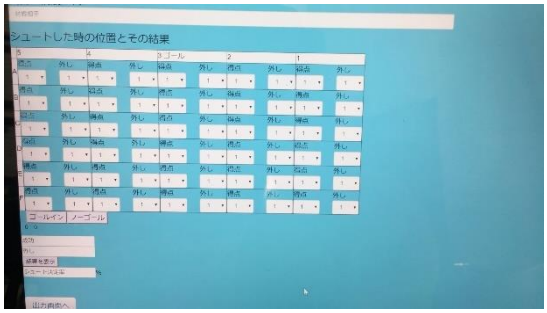


Fig 18-1: Real-time analysis input screen final version

Fig 18-2: Screen for entering the head number in the select box on the real-time analysis input screen

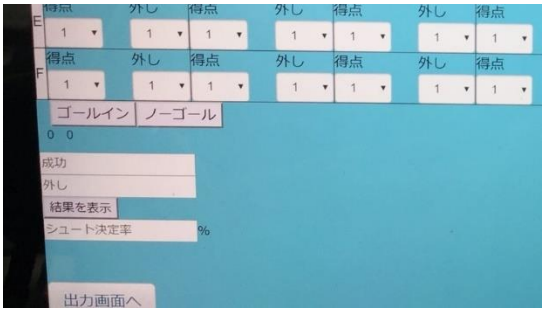


Fig. 18-3: Real-time analysis input screen where the final version of the goal success rate is obtained.

If you press the "Goal in" button on the input screen shown in the figure when you score a goal, the number of goals scored will be entered in the goal in. If you press the "No Goal" button when you miss a goal, the number of missed goals will be output on the screen below. If you enter the total number of goals scored into the "Success" field and the total number of goals not scored into the "Missed" field, you can get the goal scoring percentage of the entire team.

2)Overall shot positioning

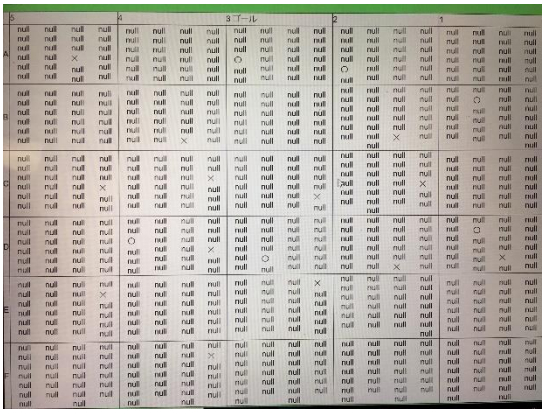


Fig.19： Output screen of the overall trend of shoot positioning

Eventually, it would be good if the real-time analysis screen could also show the opposing team's data at the same time, but even at this stage, if I can prepare two tablets and have two people in charge of analysis, we can measure the shot positioning analysis and shot success rate of not only my own team but also our opponents at the same time. So, for the time being, we will prepare two tablets to complete that process.

3. Scouting input screen completed.

In addition to the offensive and defensive analysis, we also created a screen to produce the competition skill index proposed by Franks. After the development of the trial version, we attempted to make it possible to calculate with data, similar to the offense and defense analysis. Since the offensive and defensive style analysis was designed for individual feedback, a separate table was displayed at the same time as the input. Although the numerical values had to be entered again, the data entered in the analysis of offensive and defensive styles could be entered again so that the positive and negative actions could be calculated instantly, and the overall structure of the game could be grasped. In addition, this screen was completed with the addition of the positive action "Inducing water retreat" and the negative action "Missed shot," which were not included in the offensive and defensive style analysis, reflecting the advice of Professor Enomoto.

After entering the numerical values in the input screen shown in Figure 20-1, the output will be as shown in Figure 20-2. As you can see in the figure, the ability indexes produced, both individually and as a whole, allows you to visualize how each individual contributed to the match, how the team as a whole competed, and the overall composition of the match.

By analyzing the data of the opponents shown in Figs. 21-1 and 21-2, it will be possible to look at the video and objectively analyze the composition and individual movements of the two teams during the review meeting to clarify their strengths and weaknesses. This will provide enough material for each team to think about how to create a training and strategy menu that focuses on the issues that need to be improved before the next game and will also allow everyone to consider strategies that are more in line with actual conditions rather than strategies based on vague information such as impressions or individual memories of the teams involved.

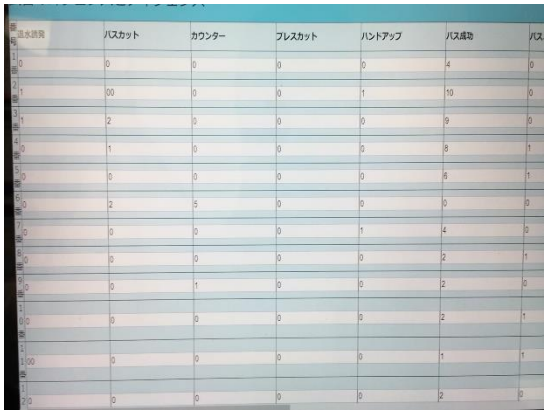


Fig20-1 Input screen of "Competence Index".

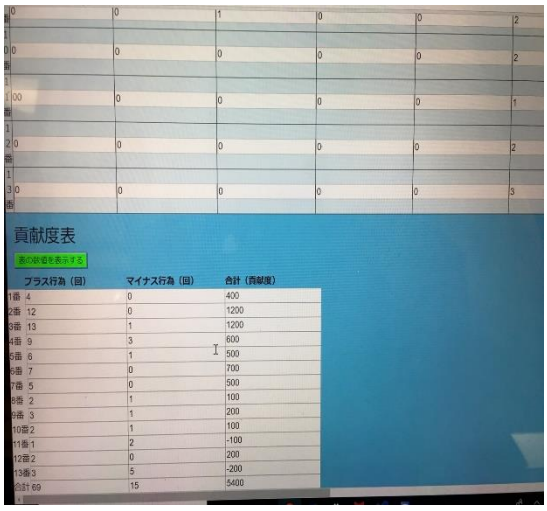
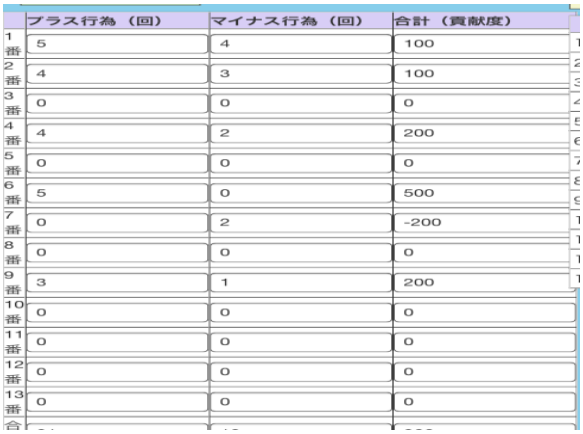


Fig 20-2 : Output screen of "Competitive ability index".

Fig21-1: Toho Side Athletic Performance Index of Chuo University Junior High School vs.

At the time of output, the word used was “contribution index”. However, after reviewing all of the figures, I decided that the "competitive ability index" proposed by Franks would be more appropriate for the content.

:



	プラス行為（回）	マイナス行為（回）	合計（貢献度）
1番	5	4	100
2番	4	3	100
3番	0	0	0
4番	4	2	200
5番	0	0	0
6番	5	0	500
7番	0	2	-200
8番	0	0	0
9番	3	1	200
10番	0	0	0
11番	0	0	0
12番	0	0	0
13番	0	0	0

Fig 21-2: Toho vs. Chuo University Junior High School, Opponent Side Competitive Performance Index

■Phase Seven ■

～Uploading the Program～

1. Completion of both programs

With all the analysis programs completed, I designed the input screen so that entering the password would take you to the menu screen. I also developed separate buttons for real-time analysis and counting analysis. The real-time analysis is limited to shot positioning and shot decision rate, while the counting analysis is divided into a screen for calculating shooting form, offense and defense, and an athletic ability index that includes pass success rate.　hen you click on a button on the screen, you will be linked to the respective screen.　On the input screen, the real analysis button is green and the counting analysis button is orange.

All programs for the 2018 version have been completed and will be named "Water Polo Real Time Analysis and Scouting Analysis SND Formula". SND stands for SONODA.

2. Upload

Now that we were at the final stage of completing the program, i.e., the development of the program had been completed to the level where analysis could be done with a tablet, I had a meeting with Mr. Teramoto to discuss the best way to utilize the site.

I knew that there were ways to use free and paid uploads, but I thought I would check what advantages and disadvantages there were and finalize it.

According to Mr. Teramoto, even if you use a password for a free site, there is a high risk of being let into the screen especially if it is attempted by an IT expert.

However, if the URL is complicated, the risk is reduced even if it is free.　Mr. Teramoto said that unless you know the URL, it is almost impossible to actually get to the screen, "like finding a needle in a desert," and since the site does not currently have a save function, even if you could get to the screen, you would not be able to see what you have entered.

I decided to use the Github* site, which I have used in the past, to upload the data for free. Therefore, the "Water Polo Real-time Analysis and Scouting Analysis SND Formula" website was made available by attaching its URL, rather than searching for it by its name at this stage.

{Uploading procedure}

Put the source code you want to upload into a single folder. (Create a shortcut to make it easy to open.)

Open GitHub and click "new repository" to open a new repository. Put the folder you want to upload into the repository,

write a summary, press commit to master, and then press push (meaning upload).

In settings, go to page and click save to complete the upload.

If you want to change the contents of the source code once uploaded, drag and drop the folder to Visual Studio code set up.

After that, open GitHub, save the changes, and you are done. This analysis program was also completed by repeating this process several times to make it easier to read in the end.

{Completion Screen}

Once the upload was successfully completed and the URL was actually known, the site could be used on tablets such as iPads and smartphones such as iPhones.

The following are the completed screens. These are all screenshots taken from my iPad and sent to my computer for pasting.

1）Menu Screen

Fig.22: Menu Screen

2）Real-time analysis screen

Fig.23- 1 : Real-time analysis input screen 1

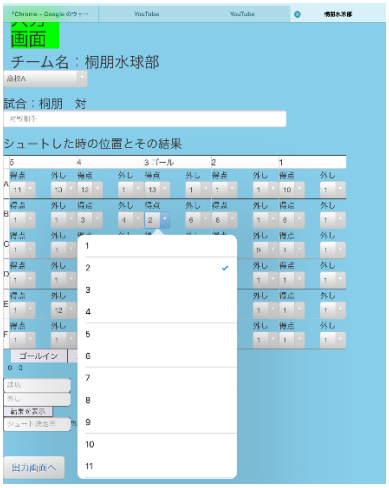


Fig.23- 2 :Real-time analysis input screen 2

Since this analysis input screen is for real time analysis, it is important that the input is easy, so when you click on the ▲ button at the place where the shot was missed or scored, a select box will appear as shown in Figure 23-2, and you can select the “head number” to input.

Fig.23-3:　Input screen for real-time analysis 3

Successful Goal Rate Calculation Screen

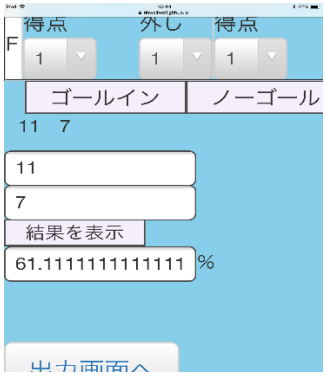


Fig.23-4:　Input screen for real-time analysis 4 -Output screen for Successful Goal rate-

In addition, in the lower left corner of the screen in Figure 23-3 above, there is a button for "Goal in" and "No goal". If you click on it every time you score a goal or don't score a goal, the number of times you have scored a goal will be counted, and the displayed immediately below.

Finally, click on "Go to Output Screen" and you will be able to see the successes, failures, and positioning of each player's shots by their head number, as shown in Figure 23-5.　Therefore, you can zoom in on this screen as shown in Figure 23-6, take a screenshot of each player's table, and send it to your line for immediate review.

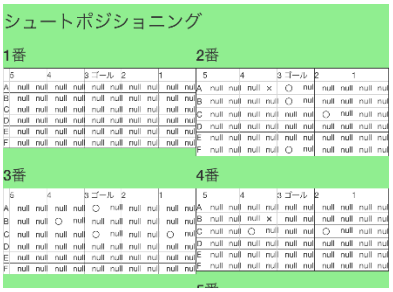


Fig.23-5 : Real-time analysis output screen 1

Results of individual shot positioning analysis

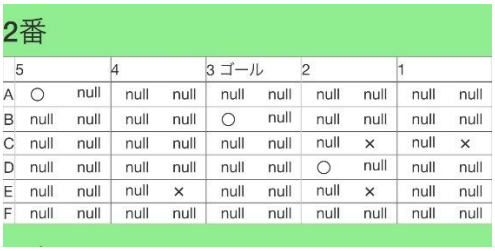


Fig.23-6 Individual shot positioning Data for sending personal results of analysis

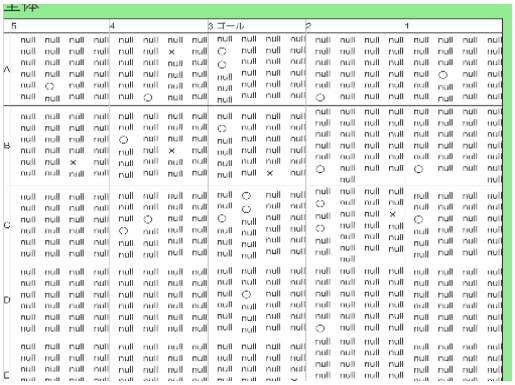


Fig.23-7 Real-time analysis output screen 2 -Overall shoot positioning analysis results-

If a shot from that position is marked with a "〇“, it was a success, while an "X" indicates that the shot was either missed or stopped by the opposing keeper. At the moment, "Null" is inevitably displayed. In the future, it will be necessary to improve the display so that you can see only the "〇" and the"X", or also the head number, such as "1" for success and "❶" for failure.

Fig.23-8 Real-time analysis output screen 3
For data reset

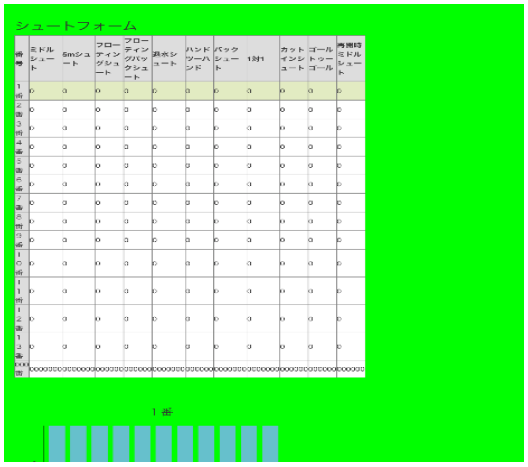


Fig.24-1 Counting input screen 1
Shooting form analysis screen

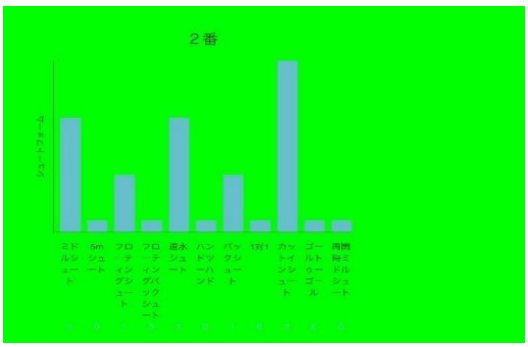


Fig.24-2 Scouting analysis output screen
Shoot Form Analysis

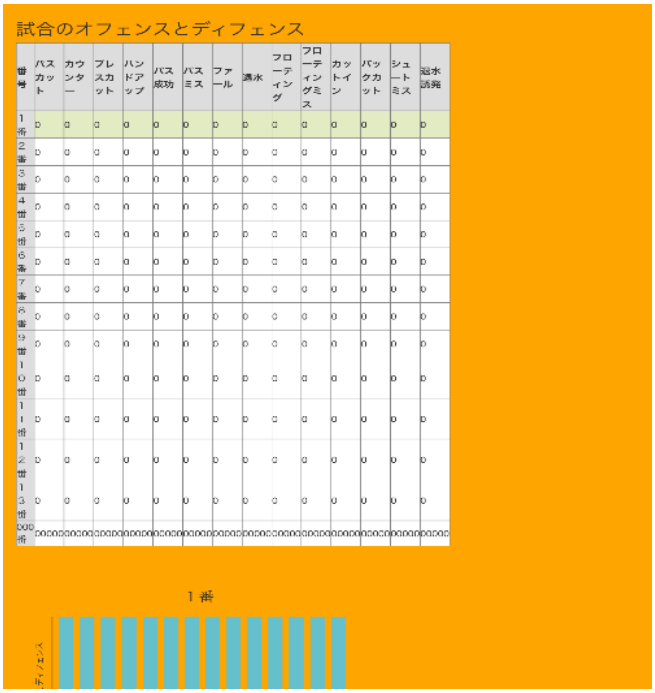


Fig.25-1 Counting Input Screen 2
Offense and Defense Analysis Screen

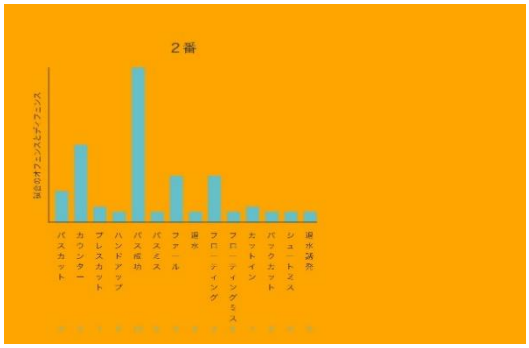


Fig.25-2 Scouting analysis output screen
Analyze offensive and defensive styles

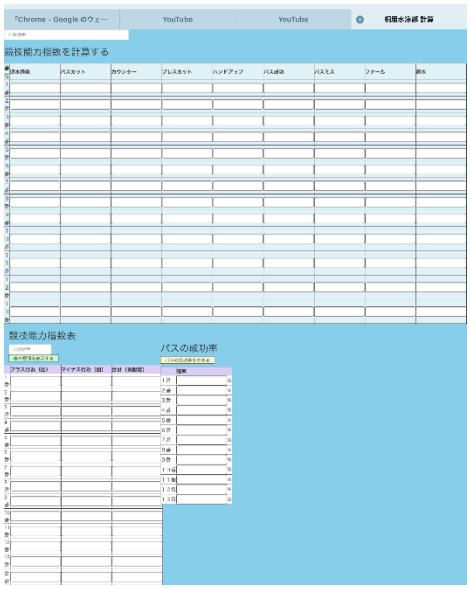


Fig.26-1 Counting input screen
Athletic ability index analysis input screen

Fig.26-2 Competition ability output screen

3.How to provide feedback on the data

According to Kasai (2006), the feedback method of counting information is more effective when it is shared by all the coaches, managers, and assistant managers, and then only one or two people give feedback to the players, rather than the traditional model of each coach, manager, and assistant manager giving feedback to the players. The improved model, in which the feedback is shared with all the coaches, main and assistant, and then given to one or two people, is considered more effective. In fact, during and after a game, when many people are pointing out various things and giving feedback, it is often confusing for the receiver to know what to focus on the most. One of the points that I noticed again with the objective database is that team members are always contributing in some way, so I think it is important to tell them about it and give them feedback on what they need to improve. Also, no player makes mistakes on purpose, so after the data is provided, the players should be able to think for themselves and explain why they made a mistake or why their contribution level decreased. We think this is very important, so we would like to make sure that every member of the team is able to give feedback in a consistent manner so that the data will be effective.

4. Other information

This time, we tried to develop some improvements for the final version based on the issues we identified in the trial version, but in the process of developing the final version, there were some things we had to give up. This included the ability to save the program. We heard that it would take a lot of time to develop the saving function, so we decided to prioritize the improvement of the program, which was directly related to the purpose of this development, rather than devote our limited time to it. In a meeting with Mr. Teramoto in the final phase of development, he told me that most programming projects tend to be too ambitious and developers end up spending time and effort on developing unnecessary functions, and there are even instances when 99% of the projects are unnecessary. This made me think again about how much of a priority the development of the save function should be for this analysis program. In the last part of the development process, according to our priorities, we realized that the level of screenshot saving would not be a major obstacle for real-time and scouting analysis. As we continue to develop the program, we will consider whether there is a need to develop a save function.

III Challenges and the future

There are two main issues.The first is that in order to use this analysis program effectively, the data must be entered accurately. In order to enter the data accurately, you need to be familiar with the complex rules of water polo. If this analysis program is used in a tournament at a junior high school, the members who are familiar with the rules are probably all starters and immersed in the game. Even those members who are somewhat familiar with the rules are likely to be on the bench at the tournament and not in a position to enter data. Data entry for scouting can be done by the captain and others after the game and before the meeting while watching the recorded video, but a person specializing in real-time data entry needs to be trained separately. Traditionally, the water polo team comes to watch games from the first year of junior high school, so we need to think of a way to provide an opportunity for junior high school students to learn the rules of water polo at the same time as entering data.

Nobuhiko Kiyohara, a former water polo coach at the Japan University of Health and Sport Sciences, used to tell his students that water polo games were played with seven players per team, with only thirteen regular players. The thirteen players in the water can be considered "water players" and the rest of the team are "land players". The "land players" were told that if their teammate scores a point, they should stand up, and clap their hands so hard they would swell as if they had scored the point themselves. He told them that the "water players" who heard the cheers should always play in a way worthy of those cheers in response and talked about the importance of everyone being in the spotlight in team sports (Kuroi 2018). In a team without a coach such as ours, having analytical players in addition to the land players seems to make the team stronger.

The second issue is how to give feedback. If the data is fed back incorrectly in the absence of a supervisor, there is a risk that it will instead lead to mistakes. The entire team needs to understand the meaning of data, how to look at it, and how to handle it. In other words, it is necessary to thoroughly understand that the data is not there to point out mistakes, but to help each individual face and solve his or her own problems, and that objective data should be used from the perspective of how to make the most of it in order to develop strategies for the next game.

When we introduce the completed program to the team, we will solve these issues and practice real-time analysis immediately after our own games at the Tokyo Junior Games in September, as well as record all the games of all the teams, including our own games, to take full advantage of the counting analysis program

later. We want to promote the practice of meetings, and really try to break through to the qualifying round of the Junior Olympics in the spring of January 2019.

There are two things to look forward to in the future. According to Mr. Teramoto, the world changes once you start getting users for your program. The first users of the "Water Polo Real-time Analysis & Scouting Analysis SND Formula" are the team members. While improving the programming skills to make it easier for the team members to use, I hope to eventually bring this analysis program to a level where it can be offered to external users.

Another new fact that I learned from my interview with Dr. Enomoto is that water polo still does not allow electronic devices to be brought into the poolside, and this is a problem that cannot be left unaddressed. This rule in Japan may be the only reason why the development of analytical tools has been delayed in water polo, which is supposed to be a representative of scientific sports.

Therefore, in order to promote the use of analysis programs in water polo, we will continue to investigate in more detail why this rule is in place and whether the same rule applies to junior high and high schools.

IV Conclusion

In 2018, I asked Mr. Teramoto again to take a look at the program I had continued to develop after my free research in 2017. I told him the final image of the real-time analysis program I had in mind and confirmed how much learning and effort would be required. His answer was as follows. The answer was, "This project is difficult to achieve unless you upgrade yourself to a very high level. For example, if Sonoda's current level is 1, he will find it difficult unless he can get it to 10." When I asked him if this was actually possible, he assured me that it would be, but I would have to be prepared to complete the program one by one every week through trial and error. Completing a program every week means that you have to find a few hours of programming time every week. Naturally, when I ran into something I didn't understand, I had to have a video conference with the busy Mr. Teramoto. During this period, I was in my off-season training with a club team which means I am visiting another swimming school which is very far from school and my home, so I would come home after around 9:30 p.m. almost every day, including weekends, so I was finding it difficult to find more time. I wondered if I could really complete the project. However, he also encouraged me by saying, "The real-time analysis program for water polo that you are developing is a project that may be selected by the Japanese

Ministry of Economy, Trade, and Industry as an 'unexplored project' in the future. This made me think again about the value of this research and development, even though I did not realize it at the time.

When I met with Mr.Yusuke Shimizu, the captain of the Japan National Men's Water Polo team at the Rio de Janeiro Olympics, to review a paper I wrote in 2016 on the analysis of Japan's water polo matches, I told him that I wanted to develop a match analysis program this year. I told him that I was thinking of developing a match analysis program this year, and he said, "This is absolutely necessary for Japan's water polo to become stronger, and I hope that the program you are developing will be used by the Japane National Team in the future. I also remembered that my seniors and team members asked me to make this program available to them. I am determined to complete this program by the end of the summer of 2018.

In the midst of studying, practicing water polo, and fulfilling my new responsibilities as captain, I had to manage my time and self-discipline in order to complete the development of this program. I decided to spend each week managing my life by listing my schedule and tasks for the week so that I could find the time I needed. In order to set up phone meetings with Mr. Teramoto on a somewhat regular basis, I asked him to give me his schedule for the month in advance and to use Discord to arrange a meeting at a time when Mr. Teramoto was available. In order to be able to make it to the meeting in time, I proceeded with the program one by one and put together questions so that I could use the time efficiently. I also tried to record everything I learned in Scrapbox so that I could use it to improve my skills.

In my first year of junior high school, I started with a free research project titled "An Attempt to Analyze the Game of Water Polo," which was a summary of my research on the game analysis of the Japanese men's national water polo team at the Rio Olympics. In the second year, I wondered if it would be possible to convert the analog method of game analysis into a program. In the second year, we started with "An Attempt to Develop a Real-Time Analysis Program," and in the third year, we started with "An Attempt to Develop a Real-Time Analysis Program". In the third year, I was able to complete a program that was quite close to the image I had in my mind a year and a half before, and I was able to summarize the entire process of research and development in a single paper. When I look back at the paper I wrote in the first year of junior high school, I had to input all the analysis by hand and draw the graphs by hand, but now I can output all these contents in no time by using the program I developed. When I think about it, I feel an indescribable sense of elation.

The paper that summarizes this

research and development, which can be said to be the culmination of my days of devoting myself to water polo and study since entering Toho Junior High School, was built on many thoughts and opportunities of meeting people.

In the spring of 2017, I came up with the idea of developing an analysis program, and as a beginner, I contacted Mr. Teramoto, who teaches IT to elementary and junior high school students and won the Grand Prize of the Minister of Internal Affairs and Communications Award at the IT Entrepreneur Koshien in 2016. Since then, he has appreciated the value of my motto of "not for myself, but for the team" and my perspective of developing programming that has yet to be seen in Japan. Although he was not originally a tutor, he kindly took the time to meet with me throughout the year whenever I stumbled over something in my study, through Discord, on line, and sometimes in person.

In addition, Mr. Itaru Enomoto took time out of his busy schedule during the training camp for the Asian Games for the Japanese national water polo team members to be held from August 25, 2018, to teach me directly, and I learned a lot from him. Perhaps it was because Dr. Enomoto was a Toho graduate and a senior colleague of mine, but he was very friendly and talked to me throughout the meeting, and I had many questions that I wanted to ask him. He also asked me to continue developing the analysis program and promised to make time to attend the Toho swim team's practice in the future. I am grateful for the opportunity to learn directly from a leading expert in water polo data analysis.

Mr. Shimizu, who was the captain of the Japanese men's national water polo team at the Rio de Janeiro Olympics, also took time out of his busy schedule to read through my paper that I had written in my first year of junior high school. He said he wanted to show it to all the members of the Japanese national water polo team, so I gave him a copy of my paper and also received a all Japan members' autography. I was thrilled by that alone, but later on, he gave me a chance to have dinner with him directly, and he taught me many things about how to grow as a floater back and the necessity of real-time analysis program. That time remains a valuable memory for me.

At Toho Junior High School, I had the opportunity to pursue my favorite things to the fullest, and the teachers were very supportive of my research. Not only was I able to fully delve into the world of my interests, but as I pursued my research, I was also able to make connections with new people I had never thought possible. Every year, the opportunity to do summer research project expanded my world in many ways.

I have completed the program to the point where it can be completed within the framework of this summer research project. However, I would like to continue practicing the effects of developing a water polo match

analysis program, while continuing my research and developing a more effective program. Also, when Mr. Teramoto gave me a final look at the completed analysis program, he said that if I continue to learn programming at my current pace, acquire skills, and increase my experience, it would be possible to create a program that exceeds the level of Huddle, the company used by the Japanese national team, while I am still in high school. I don't know how far I can go, but I think it's not impossible to study the technology and accumulate experience at my current pace, so if I can, I'd like to accumulate a lot of analysis experience with my own team, try to improve the program, and eventually make it available not only to my own team, but also to people involved in water polo in Japan. As I wrote in last year's paper, the world of programming has infinite possibilities, and I would like to continue to make improvements so that I can eventually complete a program that the Japanese national water polo team would want to use. I would like to make this program open source* so that I can get advice from many water polo programming experts around the world, although there are still few in Japan, and improve my skills. Then, I would like to complete the program in such a way that the Japanese national water polo team would want to use it in the future.

The summer of my third year of junior high school (9th grade) marked the end of my summer research project as Toho high school do not have the projec. However, what I have learned from my hard work on this project is that, In addition to the completion of this program, I have learned that it is important to keep the desire to "definitely accomplish" when you are committed to something. I think there are two main reasons why I was able to maintain that desire this time.

The first was the experience of being able to do things that I could not do on my own by getting opinions, advice, and suggestions from people around me, rather than trying to do everything on my own. When I hit a wall, being able to ask for help and having people around me who were willing to help me gave me the underlying strength to know that I was not alone.

Secondly, I thought that if this program was actually completed, it would bring about a big change in the team and make the team stronger. In other words, "the program I'm making now doesn't stop at making, there's more to it. I also carried the desire of many team members to become stronger, which became the driving force to accelerate the completion of this program. This was an experience that will come in handy not only in the future when I continue programming development, but also in many other situations.

Since entering junior high school, I have been able to continue playing water polo, studying, and doing this research and

development with the support of so many people. I have been supported by my team members, coaches, teachers who have been interested in my research and have given me serious evaluations, and the parents of the junior high school members who have come to support me every time, including my parents. This thesis was displayed at the Toho Festival and the free research exhibition, and was published in "Toho Kiri no Tomo", which brought it to the attention of many people. As a result, I was able to meet many people, including the person who gave me the opportunity to meet Yusuke Shimizu, as well as his wife and her family, too many to mention here. Again, I would like to thank all of them.

Finally, I would like to conclude my three-year free research project by posting the photos of the main people who supported my research with my heartfelt gratitude.

■ With Mr. Teramoto. Summer of 2018 年

■With Former Japan National Water Polo Team Captain, Mr. Yusuke Shimizu, Summer of 2017

■With Mr. Enomoto. Summer of 2018

■A Autographs of all members of Japan National Water Polo Team for Rio de Janeiro Olympic

■Toho High School Water Polo Team with Junior high team members, alumni and managers

■ Toho Junior High School Water Polo Team at Tokyo Championship in fall of 2018

References

1. Enomoto I : Suikyu Kyougi senshu Team Koukendo ni kannsuru Game bunnseki [Methodology research of game analysis about a water polo competition player's team contribution]. Methodology of Sports Research Bulltein Vol14, 2001

2. Enomoto I : Offence ni Chakumokushita Game Bunseki[A Game Analysis to Have Aimed at an Offense].Tokyo Gakugei university of bulletin 5th subdivision art/health/sports, 1998

3. Enomoto I : Suikyu Kyougi ni okeru Top Team no Kougeki keikou[The water polo competition of top teams based on result of the world championship of 1998　and it's tendency of attack style] Taiiku Kenkyu, 2000

4. Enomoto I e. al: Game Bunseki karamita1998 nenn Sekai Senshuken Suikyuu Kyougi ni okeru Elite Team no Kougeki Keikou[attack tendency sports methodology research on an elite teams in the 1998 World Championship Water Polo Competition]. Sports Methology Research Vol 13, 2000

5. Enomoto I : Suikyu kyougi ni okeru SakusennShienn no tame no Game Bunseki [Game analysis for the creating support in the water polo competition].Taiiku Kenkyu Vol 32, 1998

6. Enomoto .I. et al.:Suikyu Kyoui no GameBunseki Ni tuite 1997 nen Kyoutosoutai ni okeru Kokoromi[The game analysis of the water polo competition in 1997 in the Kyoto National Championship]. Suiei Suichuu Unndou Kagaku Vol 1, 1998

7. Enomoto I : SuikyuuKyougi Nautical Chart Sekai no chouryuu to Nihon no Kyougisha Ikusei System no Kadai. [Trend of Upbringing athlete compare to Japan and other countries. The importance of using the Nautical Chart] Suiei Suichuu Unndou Kagaku Vol 8, 2005

8. Hattori Y : HTML &CSS to Web Design ga issatsu de kichinn to minituku honn[HTML and CSS and Web design is neatly acquired book] Gijyutsu Hyoron sha, 2017.

9. Horita N. :　Koukou Ichiryu Suikyyu senshu no keitaito tairyoku [Physical Strength and Body Form of the Water Polo Player of High School Students].Kyushuu University Health ScienceVol 13, 1991

Ichimura S : Hand Ball Danshi Daihyou Team deno Eizou /Data Bunseki no Feedback no shikata[How to give Feedback based on Video taped and Data analysis in Men's National team for Hand Ball] Japanese Society of Physical Education rally manuscript collection vol 67, 2016

Iwata U. : Ichiban Yasashii Javascript [The most easy to learn about Java script] Mie University, Inpress, 2017

Japan Amateur Swimming Federation :Suikyu Kyougi Hand Book [Hand Book for Water Polo Competition].Public interest corporation Japan Amateur Swimming Federation, 2015

Kasai T.:Basket Ball Game chuu ni okeru Scouting Jyouhou no Feed back[Giving scouting information in a basketball middle of the game]. Sendai Graduate University Sports Science Thesis Proceedings Vol 17, 2006

Kawakami S. et al: Suikyuu Danshi Junior Player ni okeru Shinriteki Kyougi nouryoku ni tuite [Research on the psychological competition ability in a water polo male Junior player]. Kyorin University research report, 2009

Kuroi K. : Hito wo sodateru Ryugi [Style of bringing up Human beings] .Shincho 45 , Shicho sha,2018

Maegusuku T. et.al: Soccer no Game Bunseki ni kannsuru Kenkyu. Attackking zone heno Semekomi to Sono Yukousei ni tuite[A Game Analysis About a research on Attacking zone of the soccer and its effectivity].Ehime University Education Dept. Bulletin. 1982

Naganuma A. : Suikyuu Kyouino Gennjou to Top Level Sensh no Conditioning[The Present Situation of the Water polo Competition and Top Level Player's Conditioning]. Japan Strength and Conditioning Society bulletin No. 160, 2011

Nagaoka M et al: Hand Ball ni okeru Game Bunseki Dai 10 kai joshi senshuken taikai wo Jirei to shite[Making a case the Woman Hand Ball Competition's data alalysis]. Osaka Kyoiku University bulletin No. 1, 1993

Otomo N. et. al. : Nihon Suiei Remmei Suikyuu Iinkai houkoku, Dai 36 kai (2013 nendo) Vol 36, 2013 Zenkoku Junior Olympic Cup Suikyuu Kyougi niokeru Game bunseki Support[Japan Amateur Swimming Federation water polo committee report: The game analysis support in water

polo junior Olympic competition (fiscal year 2013)]. Suiei Suichuu Unndou Kagaku Vol 17, 2014

Ono G:Soccer Scouting Report.Chou Ichiryu no Game Bunseki [Soccer Scounting Report. Game Analysis on Super star player]　Kanzen 2010

Raiki B : Raiki no Suikyuu Gijutu /Senjutu/Training [Raiki's Water polo and it's technology/tactic/training] Ed. Fujita Baseball Magazine sha, 1923

Sasaki M.: Sounting Sheet ni yoru Basket Ball no Game Bunseki[Game analysis of Basket Ball by Scouting Sheet]. Taiiku Kenkyuu Bulletin Vol 18, 1978

Sonoda R.: Suikyu Kyougi -Water Polo -no Game Bunseki no Kokoromi [Analysis of the Japanese Men's National Water Polo Team at the Rio de Janeiro Olympics] Kiri no Tomo, Toho Junior/ high school, 2017 i

Sonoda R : Real-time Bunseki Program Kaihatsu no Kokoromi[An Attempt to Develop a Real- time Analysis Program] Kiri no Tomo, Toho Junior/ high school, 2018

Su M. Suikyu Kyougi ni okeru Aite Tiasuiji No Kougeki Bunseki[An Attack analysis on Exclution time in water polo competition] Ooitakenritu Art and Culture Junior College Research Bullten Vol 55, 2017

Su M.: London Olympic ni okeru Suikyuu Kyougi no Data Bunseki[The data analysis of the water polo competition in the London Olympics] Ooitakenritu Art and Culture Junior College Research Bullten Vol 50, 2012

Su M.:Suiky Kyougi ni okeru Taisuiji Kougeki no Difensu no Kuzushi nitite[Research on the destruction of the defence of exclution time in the water polo competition]. Ooitakenritu Art and Culture Junior College Research Bullten Vol 53, 2016

Su M. et. al.: Suikyu Kyougi ni okeru Game Bunseki to Internet wo Riyoushita Data Koukai[An exhibition of the data that used a game analysis and Internet in the Water Polo Competition].Nihon Suiei Kagaku Kenkyuukai Proceedings, 2003

Sudo S.: Soccer-Eizoukara Game Bunseki Shien System[Providing Support System using Data analysis from Video Taped game].Shoubi Gakuen university art information research No. 12, 2007

Suiei Suichuu Unndou Kagaku Vol 17, 2014

Su. M. et. al.:ol. Suikyu Kyougi ni okeru Internet wo Riyou shita Game Bunseki [A Game Analysis using the Internet in the water polo competition]. Suiei Suichuu Unndou Kagaku Vol 7, 2004

Suzuki S. et al: Suikyuu Kyougi Real Time game Bunseki system Kaihatu[The Development of Water polo Competition Realtime Game Analysis system]. Japanese society of Physical Education, 1991

Snyeder,P.: Water Polo For Players & Teachers of Aquatics LA84. Ed. Nagata, Foundation, 2008

Takagi . H. et. al. : SIt is 1992 of the natural scieuikyu Kyougi ni okeru Shiaino Shouhai wo ketteisuru Youin ni Kansuru Kenkyuu Sekai Senshuken Perth Taikai[Research on world championship in Perth about a factor to fix relates victory or defeat of a game in the competition]. Mie University Educational Dept. Research Bulletin Vol 43, 1992.

Takagi H. et al; Suikyu Sekai Senshuken 91 nen ni okeru kinnsa shiai no sousai wo ketteisuru youin[What is the factor when both teams points are narrow margin to win or lose].Japanese society of Physical Education ,1991

Takahashi T. et al: Tsukuri nagara Manabu HTML/CSS[HTML/CSS design to learn in spite of the making] Textbook Design SB Creative, 2017

ProgateHttps://prog-8.com/, Progate Inc.

Raw Data

Source Code for SND Real Time Analysis and Post Game Analysis Program

（Updated, Dec.2021）