Application of Teachable Machine Program for Developing Volleyball Skills

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Abstract
This study examines the use of the Teachable Machine program to facilitate the development of volleyball skills, with particular attention to assessing both the improvement of the skill and the satisfaction of the participants. Specifically, the Teachable Machine, an AI-powered platform, was integrated into volleyball training sessions to enhance serve, pass, and spike skills. Using 30 participants we performed pre- and post-test evaluations of the participants, using a 1 to 10 skill level rating to score for accuracy, technique, and consistency. Statistical analysis of the data was performed using means, standard deviation, and the t-test for independent samples. The results show that pretest scores for serving, passing, and spiking were, on average, 4.33, 3.70, and 3.93, respectively, which means they were intermediate. However, there was a significant increase in overall performance in the post-test scores immediately after they learned to use the Teachable Machine, which increased the performance score to 6.87 for the serve, 6.83 for the pass, and 0.73 for the spike. Furthermore, participant satisfaction was based on a 1-5 Likert scale, with an average satisfaction score of 4.68 on this scale, representing very high satisfaction with the program. The Teachable Machine program also helps improve technical performance and promotes the continuity of practice, as shown by the participants' engagement when handling the game environment. Studies have been conducted on how technology can enhance traditional coaching methods to design training programs better, and this study is supposed to add to that body of knowledge.

Keywords: Teachable Machine Program, Volleyball Skills

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Introduction

For this reason, technology is an integral part of training for athletes, where old methods are complemented with modern techniques, incorporating everything from skill progression to overall performance. Being the most multifaceted game, including balance, flexibility, and accuracy, volleyball puts undue pressure on players to update their strategies gradually. Core skills such as serving, passing, setting, spiking, and blocking are essential to success in the sport; however, they take time and repetition. Most importantly, quality feedback is needed to be mastered. Traditionally, volleyball instruction heavily depended on noticing and providing input from a coach, exercising while providing practical information, and potentially biasing experiences (Kirkpatrick, 2016). This dependence on human cognitive reasoning significantly restricts the efficiency of talent acquisition, where vast numbers of athletes require tailored attention. Emerging technologies such as artificial intelligence (AI) are potentially disruptive. They offer new ways to practice skills and instantaneous, data-driven feedback while practicing, which may lessen some of the constraints.

One significant breakthrough is the wearable Machine, an artificial intelligence tool from Google. It started as a novice machine learning ML command line for images, sounds, and poses so that users could build and train their unique models on how they'd like them to respond to unique inputs, with no coding required. Implemented across multiple fields, including education, fitness, and sports, this technology has the potential to provide individualized, dynamic feedback for practitioners of various skills, revolutionizing how we train. The Teachable Machine can be trained to sense movements and provides feedback, accompanied by the ability to define what information is sent to the athletes in terms of identifying volleyball behaviors, thus allowing for real-time intervention that can enhance ideal technique (Garcia & Turing, 2020).

AI adoption in sports training fits into larger trends of integrating digital tools into performance enhancement. Research indicates that systems built on artificial intelligence increase the accuracy of executing skills, and the effectiveness of training and provide athletes with more insight into their own movements when merging with traditional training methods (Johnson & Liu, 2021). Such systems can help reduce the repetitiveness of skill acquisition through trial and error by providing feedback based on real-world data. For example, volleyball players can use Crowd Control to receive immediate, objective feedback on their techniques to quickly correct bad habits and reinforce good ones, leading to quicker improvement in specific skill areas like serving, passing, and spiking.

Because of its flexibility and ease of use, the Teachable Machine is especially well-suited to this application. Using video inputs, the machine is trained to recognize specific volleyball motions, such as the proper serve form or the best spike technique. When trained, the machine can then tell whether athletes' movements match the desired model in real-time and deliver instant feedback. This ability to provide immediate feedback makes the Teachable Machine a valuable complement to traditional coaching, as athletes typically have to wait until post-training analysis for feedback (Tan & Yeo, 2019). Artificial intelligence-based tools have decreased the feedback loop, allowing athletes to amend flaws as they occur, which is crucial in building muscle memory and developing technical efficiency.

This is important as not only do AI-powered tools like the Teachable Machine facilitate better skill acquisition, but they also do wonders in creating a training space that is supportive and breaks the mold of traditional learning. Research has indicated that individualized and immediate feedback correlates positively with athletes' adherence to their training and their reported wellness (Wang et al., 2020). With validation methods, training can become more interactive since the proper techniques can be immediately reinforced beyond a simple visual representation of AI systems' general conditions, making them more energetic and fun. For volleyball players, this means focused, well-timed practice sessions in a data-supported environment with always progressing players.

This will definitely have a huge impact on sports. However, it should act as an improvement or supplementary tool to traditional coaching approaches rather than a substitute or negator. While AI tools can help a great deal in data analysis and strategy optimization (Schmidt & Miller, 2021), the subtle nuance of a human coach will always supersede any language model's prediction capabilities. Thus, AI is best regarded as a complementary device—a postmodern landscape yielding trains of thought for coaches and instilling them with additional devices to supervise the performance of athletes. In Teachable Machine, coaches can review data uploaded on the platform to detect trends in an athlete's statistics over time that might be difficult to notice by eye. This data could help spot superior therapies and training methods—optimizing an athlete's training as much as possible.

This study aims to apply the Teachable Machine program to building volleyball skills related to serving, passing, and spiking. The focus of the research is to determine the effectiveness of the program through skill level measurements before and after training sessions and evaluate athlete perceptions of AI technology use in their training. This research hopes to provide insights into how AI-powered platforms can facilitate a more innovative and engaging training experience for volleyball athletes.

It is not just merely a trend but the future of sports gaming. This work builds upon past work with the Teachable Machine for its use in volleyball training. It lays the foundation for more individualized, evidence-supported, and interactive practices in coaching that can keep up with the requirements thrust upon individuals in the modern age. Examining further the advantages offered through the use of AI concerning skill learning and satisfaction of athletes, this study adds to the existing literature concerning the importance of technology in aiding and expanding upon traditional coaching and developing more effective training practices.

Review of Literature and Related Research

Over the past few years, the use of artificial intelligence (AI) in sports training has begun to demonstrate its true impact and potential by providing athletes with sophisticated insights and new techniques that can take their performance to the next level. Traditional training methods often use repetitive drills, coach observations, and subjective feedback, which are effective but often lack the real-time and personalized feedback that athletes seek to test their boundaries. However, when it comes to training accuracy, efficiency, and athlete engagement, a machine-learning system such as the Teachable Machine could provide effective real-time data-based feedback for interfacing with AI technologies. This literature review will summarize existing literature that has been conducted on the subject of AI in sports (specifically volleyball), how it can or has influenced other research on athlete satisfaction, and whether technology-augmented training sessions can help develop said athlete skill.

Traditional Volleyball Training Methods

Until now, volleyball training has used conventional training methods; hence, these methods consisted of drill repetition, video analysis, and visual feedback (Kirkpatrick, 2016). Coaches then walk players through practice sessions designed to help them hone their technical ability (serving, passing, setting, spiking, etc.) and offer corrections based on their experience and observations. Although this technique does seem to work, its application has well-documented caveats. The size of the training group, an individual coach's biases, and plain human fallibility can limit a coach's capacity to provide individualized feedback. Also, there is a need to improve technique because athletes have to wait until the end of the session to be able to review what went wrong (Tan & Yeo, 2019). Such limitations emphasize the importance of more effective feedback mechanisms capable of providing accurate, unbiased, and on-time information about performance.

AI in Sports Training

Sports training is yet another vertical that AI has yet to explore. Conversely, data-driven coaching systems can process and analyze multiple data points, detect patterns, and provide real-time feedback as an interactive experience, allowing for a dynamic approach to coaching (Johnson & Liu, 2021). Even more precisely, machine learning algorithms can be trained to understand the movements that need to be made in a particular report so that the systems can adjust in real-time. This can be highly instructional in dynamic sports like volleyball, where players must constantly adjust their performance over short periods.

Studies have shown that AI-focused training tools can help enhance sports performance significantly. For example, Wang et al. (2020) observed that the level of technical accuracy and speed of improvement of an athlete trained by using AI-based systems was significantly higher than those trained with traditional systems. These systems allowed performers to receive real-time feedback on their movements, resulting in improved self-awareness of their technique and providing immediate correction, as opposed to time-consuming trial-and-error-based learning.

Teachable Machine in Sports

One of the AI platforms promising to provide some applications in sports training is Teachable Machine from Google. Thus, although the Teachable Machine originated as a simple illustration of machine learning regarding how computers interpret pictures, sounds, and poses, it has the potential to be used in other areas involving sports (Garcia & Turing, 2020). With the help of the Teachable Machine, coaches and players can train the system to recognize a few volleyball movements (what a powerful serve looks like, what a spike looks like) and track their performance during practice. The Falcon Gym application captures the user's location. It plays back in real-time so they can correct it immediately, providing instant feedback to the athlete. At the same time, they do their training, allowing for a more interactive experience that can take their training to another level.

Many studies have analyzed the advantages of artificial intelligence platforms like the Teachable Machine in various sports. Tan and Yeo (2019) also note a related issue regarding the use of AI in volleyball training, where a subset of athletes received real-time feedback on their technique from the AI system, while others relied on feedback from the coach and reported significantly greater improvement: The real-time feedback [from the virtual training platform] to the athletes on using the proper technique during training sessions significantly assisted these athletes to improve in the shortest possible time. It also noted the potential benefit of AI systems providing consistent and objective feedback, which may help reduce the variability that human coaching can sometimes create.

Athlete Satisfaction With AI-Assisted Training

AI can coach athletes better for optimal performance. Highly relevant feedback Most importantly, this feedback delivered in real-time makes it possible for the athlete to act; it gives them information that closely relates to their performance and leads to better mental states (i.e., engagement and motivation) (Schmidt et al., 2021). AI systems provide all athletes with accurate and unbiased feedback, generating a data-driven ecosystem for all in which athletes' ability to quantify their development in real time gives them insight into which and how efforts generated improvement. Studies show this is much more engaging and rewarding for the trainee, as they maintain much more influence over the progression.

In a study by Wang et al. (2020), the performance of athletes who benefited from AI-based supported systems was not only better, but many of them also mentioned being more satisfied with their training process when compared to their conventional counterparts. The athletes said they enjoyed the instant feedback and the objectivity of the information the A.I. system provided, and they thought it gave them a more accurate understanding of their performance. Since the way AIs work is interactive by design, providing more visual or audio feedback helped the athletes to make it a more iterative and thus granulated process.

Challenges and Limitations of AI in Sports

Despite many advantages of implementing AI in sports training, some challenges and limitations remain. One main challenge is properly integrating the AI system with traditional coaching methods. Half-baked tools like the Teachable Machine are not designed to replace coaches but to supplement their expertise (Johnson et al. Coaches shed light, help emotionally, and decode the knotty, non-technical aspects of performance, such as an athlete's mental state or team dynamics. That being said, the deployment of AI systems must be done thoughtfully to help the human side of coaching, not to supplant it.

A curveball is that the usefulness of the AI system depends on the data that it's trained on. Where feedback is calculated based on poor data or non-complete data sets, it merely results in misleading results that, if anything, detract from, instead of help, an athlete's progression. As such, training and using AI systems in the sports world must be cautiously approached (Schmidt & Miller, 2021). It can be studied through literature and related research that AI systems (like the Teachable Machine) are decisive in determining the quality of volleyball tools used in training because of the specific real-time input feedback they provide. Not only does this reduce the time spent developing a specific skill, but it also improves athlete satisfaction, as training is more enjoyable and tailored to individual preferences. That said, while the fusion of the fast-evolving world of AI and the still-early-stage world of traditional coaching still feels borderline science fiction and in its infancy, the playing field of AI as a supplement to data-driven insights is more straightforward and more transparent. AI has started to play a more prominent role in sports, from training and skill development for athletes with the continuous advancement of such technology.

Research Methodology

Participants

The study participants were undergraduate students enrolled in a volleyball course. The study involved 30 participants. Seven were male (23.33%), and 23 were female (76.67%). Their average age ranged from 18 to 20 years.

Research Stages

The following will explain the stages of the research that will be carried out to explain the flow of the facial recognition system framework by utilizing the open-source teachable machine service and the literature used to support the research theory.

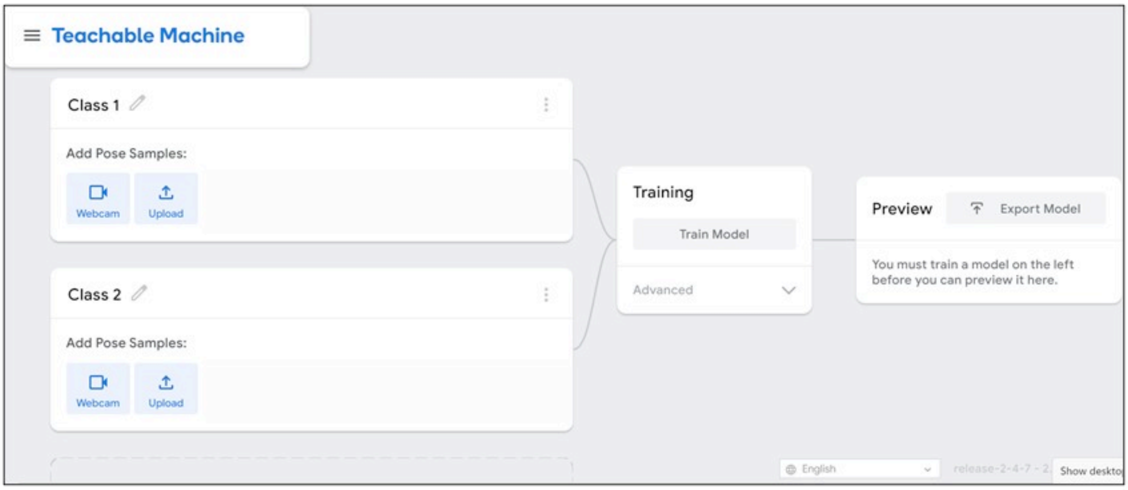


Figure 1: Teachable Machine User Interface

Figure 2: Image Recognition Stage (Teachable Machine)

This study's posture identification procedure used data from students who used to practice volleyball skills such as serving, passing, and spiking. Machine learning (ML) now allows these systems to analyze data and recognize patterns without being explicitly programmed to do so. The users can build and train their categorization models using a development platform like Teachable Machine (Carney et al., 2020). Teachers, designers, and students can all create and utilize their categorization using this model type.

Researchers first collect sample postures representing students' volleyball skills. These samples are then sent to the Teachable Machine platform for further classification and identification. This is followed by training, classifying, and testing the outputs. The phases of classification, training, and assessment leading to an ML classification model must be organized in a sequential order to establish a clear cause-and-effect relationship and facilitate use by novice users.

Users can select any model-building input, such as sounds, photos, or positions. Then, customers specify the classes that they want the model to learn and recognize (Pujari et al., 2022). We used webcam-captured poses to perform pose classification in this work. Using the Teachable Machine, each student entered poses that represented skills associated with volleyball that would submit to their respective classrooms. As many of the sessions were adjustable to suit different pupils, the methodology could train and identify positions during evaluation in an efficient manner.

TensorFlow trains power Teachable Machine and runs a model on your web browser: Js, a machine learning toolbox in JavaScript (Teachable Machine, 2022). Numerous models, such as GTM (Google Teachable Machine), use similar training methods, including CNN (Pujari et al., 2022). Training comes first, followed by evaluation (detection). Also Updated: Outputs now display the model's accuracy as a percentage instead of a ratio, and you can run the test using a camera or images from your sample. More development files, such as JavaScript, P5.js, Keras, Android, and other device system models, can also be exported as Coral files so that other programming languages can still run.

The first initial process is when the student logs in to verify the user's identity by entering the username and password. If successful, it will lead to the system meal, which will enter the attendance page. The face detection method in real-time uses the method that approaches the TensorFlow.js library previously created using The Teachable Machine service, exporting as *.js (JavaScript). Suppose the results of the face detection percentage have appeared. In that case, the student can save the student attendance data (ID, name, attendance time, face detection percentage, location, and other information) into the system database. The attendance process system is complete.

Results

The first step in building a website's system is to enter information data in the form of volleyball skills performed (with a range of 22–25 per class; more is better). This will train the sample data, which will then be organized and identified using a Convolutional Neural Network (CNN).

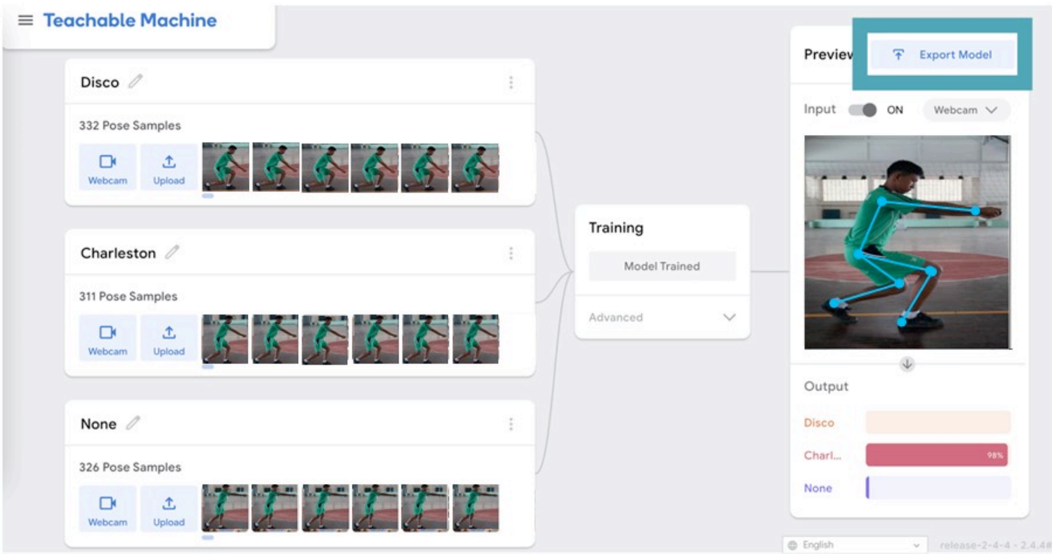


Figure 3: Input Data Sample and Testing (Simulation)

Figure 3 illustrates the composition of the test samples, which consist of three teams with varying volleyball experiences. Once we obtain the volleyball skills sample data, we train the data set using the default parameters (Epoch: 50, for example). Data till October 2023 is trained on this sample data and will improve that much till tested 50 times. Batch size: A single literacy instruction session uses 16 batches of samples. For example, this research considers 32 photos of each class. If we use a batch size of 16, then sample data will be divided into 32/16=2 batches. The second epoch will finish because the learning rate is 0.0001 (default), and both batches have been seen through the model (optimal value for batches=16, so do not touch it if possible—default). These will then be used as part of a JavaScript file, forming a student face detection-based website and displaying the results on the top right-hand side for testing before they are exported.

Once the class has trained all the data, the next step involves exporting the data. In this study, the author will take the source data in the form of a Javascript file (*.js). In the source file, the teachable machine service has prepared source code that will be connected to machine learning from TensorFlow using the Convolutional Neural Network (CNN) method approach. The file can be run on our localhost computer or cloud-based hosting later.

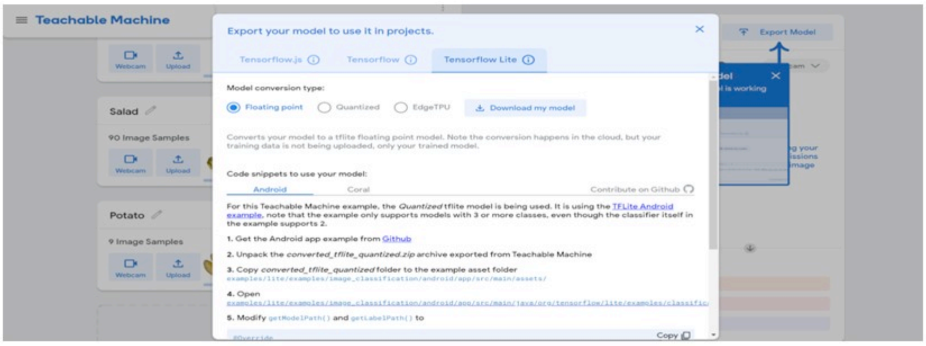
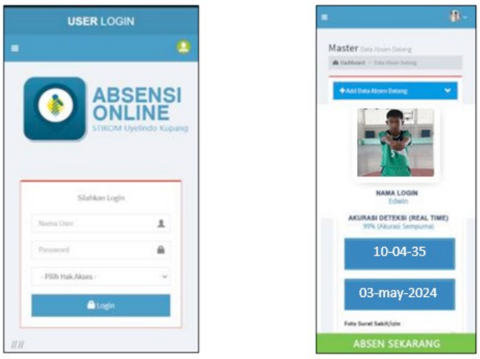


Figure 4: Export the Model and Download the Javascript.js File on the Teachable Machine

Figure 4 displays a script view of the Javascript language included with the Tensorflow.js package. This saves developers time scripting and enables them to understand the key characteristics of the downloaded script file (javascript.js).



(a) (b)

Figure 5: (a) Login System (b) Attendance Face Detection Online With Tenserflow.js (Teachable Machine)

Students will first log in and verify their identification in Figure 5 (a) using their username, password, and access privileges as either students or lecturers. They will enter the online attendance page that has been created and integrated with the Tensorflow.js library in Figure

(b) if this is accurate. Originally developed and exported as a javascript file from the Teachable Machine service, this library is subsequently altered on the previously stated website. By enabling students to take attendance in real-time, this tool enables the database to consistently record each student's attendance and determine the accuracy of each identified face.

Table 1: Distribution of Respondents by Key Skills

Key skills	N	Mean	SD	t	df	Sig.(2-tailed)
Pre_serving	30	4.33	1.49	-7.57	29	< .001
Post_ serving	30	6.87	1.04			
Pre_ passing	30	3.70	1.15	-9.36	29	< .001
Post_ passing	30	6.83	1.21			
Pre_ spiking	30	3.93	1.20	-7.99	29	< .001
Post_spiking	30	6.73	1.60			

Table 1 shows that an independent-sample t-test was conducted to compare the pre-and post-scores for serving, passing, and spiking regarding developing volleyball skills. There was a statistically significant difference in scores for Pre_ serving skill (M=4.33, SD=2.49) and Post_ serving skill (M=6.87, SD=1.04), t (30)=-7.57, p< .001, Pre_ passing skill (M=3.70, SD=1.15) and Post_ passing skill (M=6.83, SD=1.21), t (30)=-9.36, p< .001, and Pre_ spiking skill (M=3.93, SD=1.20) and Post_ spiking skill (M=6.73, SD=1.60), t (30)=-7.99, p< .001

Table 2: The Survey Results

Items	Mean	SD	Interpretation
1. The Teachable Machine program ideally suited my volleyball (serving, passing, spiking) skills.	4.83	0.37	Very high
2. The training sessions with the Teachable Machine program were engaging and interactive.	4.83	0.37	Very high
3. It provided a straightforward UI and easy commands through the Teachable Machine program.	4.63	0.60	Very high
4. The Teachable Machine program offered me personalized training based on my specific level of ability and needs.	4.33	0.47	high
5. It was creative and met the learning objectives, so I loved the Teachable Machine program's feedback, which was effortlessly provided as straightforward and constructive.	4.47	0.50	high
6. The skills I could learn through Teachable Machine I could apply to volleyball games in real life.	4.70	0.59	Very high
7. I was able to make the most use of my training time running the Teachable Machine program.	4.73	0.57	Very high
8. my experience with the Teaching Machine programs on volleyball training was quite satisfying.	4.77	0.50	Very high
9. If I could share the Teachable Machine with other volleyball players, I would.	4.60	0.49	Very high
10. If I were to implement this program through Teachable Machine into a volleyball training program I would give it a.	4.93	0.25	Very high
Total	**4.68**	**0.47**	**Very high**

As the survey results in Table 2 indicate, the Teachable Machine program is highly effective and well-received, making it a valuable tool for volleyball training. Respondents rated the program highly across all areas of the program, with an overall average score of 4.68 out of 5. It was engaging, simple to use, and catered to their individual needs. They experienced major enhancements, which they implemented with practical games (volleyball). The program provided clear and constructive feedback and effectively utilized the training time. Participants had a strong willingness to continue to use the program and recommend it. These findings indicate that the Teachable Machine program helps improve volleyball performance and training motivation.

Conclusion

Results of this study show that the Teachable Machine program is highly effective at developing serving, passing, and spiking, all key volleyball skills. Independent-sample t-tests confirmed significant differences between pre- and post-training scores for all skill areas. Serving skills, for example, rise from a mean score of 4.33 to 6.87; passing skills increase from 3.70 to 6.83; and spiking skills rise from 3.93 to 6.73, all statistically significant at the $p<.001$ level. These results indicate that the initiative has an important positive effect on skills development.

In addition to quantitative gain, qualitative follow-up comments revealed that the participants enjoyed the Teachable Machine program and had a fantastic learning experience. Its average satisfaction score of 4.68 out of 5 shows how users found the program engaging, user-friendly, and adjusted to their personal needs. Participants noted that the program provided clear and constructive feedback, which helped them apply the skills they learned in real games relatively quickly. Finally, the program's hands-on feature made training sessions engaging and effective, and participants were left with significant motivation to continue using the tool in the long run and recommend it to their peers.

In summary, this study concluded that the Teachable Machine has successfully been an appreciative program to support skill education in volleyball. It is a welcome addition to modern-day volleyball training methodologies, as not only does the sport itself rack up some impressive skill advances, but it is also a beautiful way to keep the training fun.

Implication

Application of findings for volleyball trainers and sports learning in general. The first and most important point to consider is that such major improvement regarding the serving, passing, and spiking skills in the game indicates the need for harnessing the power of AI-based tools, like that of the Teachable Machine, to be used in the sports training for yielding better results. While traditional coaching can be valuable, it does not measure up to the real-time, data-driven analysis that AI can deliver, resulting in more efficient learning and significantly speeding up athletes' technical skills.

For coaches, platforms using AI allow athletes' skills to be developed both during and outside of training through technology, providing real-time assessment and confirmation of what needs to be changed and how to do so, eliminating some human error and bias. This is especially useful for larger training groups, which can be challenging to deliver one-on-one attention. By integrating AI tools, coaches can track progress more diligently, and the training methodology by monitoring performance data skewed toward precision, making training better.

With the focus on the athlete, the high level of satisfaction reported in this study suggests that AI-based training programs can stimulate motivation and engagement. The interactive and individualized feedback for each user provides a much more dynamic learning process. It can help keep athletes engaged in the training process to create a more significant commitment over an extended period. Such findings imply that AI technologies can and should be implemented to benefit performance-related results and improve the general quality of the athlete's journey within sports organizations and training facilities.

The study's results also lay the groundwork for further studies of the use of AI in other sports and skills. Not that this has any impact on this discussion of volleyball, but the promise of AI-assisted training can be applied to any sport that requires repetitive, high-accuracy execution of an idealized motion. This means AI becomes an integral part of the delivery of the offer in the field, further training models with human coaching to make learning an event that is not just faster but also fun.

Not only that, but the study ultimately demonstrates how AI-powered tools like the Teachable Machine can be transformative and relevant, taking sports training to the next level and making it effective and individualized, along with actually fun. For specific organizations seeking to improve their training methods, incorporating AI can profoundly affect training results, increasing the speed of skills acquisition and overall satisfaction to develop a long-lasting commitment to the sport.

Limitation

This study has several limitations. First, the sample size is small, limiting the generalizability of the findings. Second, the study focused only on short-term skill improvements without examining long-term retention or application in real-game scenarios. Third, participants' varying levels of technological proficiency may have influenced their ability to use the Teachable Machine program effectively.

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