ISBN: 978-989-8533-81-4 © 2018

SUITABLE JUDGEMENT ASSISTANCE OF VISUALIZATION METHOD FOR SENSOR LOG OVERLAPPING ON DAILY VIDEO

Takuya Ishioka[1], Naka Gotoda[2], Christian Alo[3], Takayuki Kunieda[2], Rihito Yaegashi[2] and Toshihiro Hayashi[2]
[1]*Kagawa University, 2217-20 Hayashi-cho, Takamatsu, Kagawa, 761-0396 Japan*
[2]*Kagawa University, 1-1 Saiwai-cho, Takamatsu, Kagawa, 760-8521 Japan*
[3]*University of Applied Sciences, Bonn-Rhein-Sieg, Grantham-Alle 20, 53757 Sankt Augustin, Germany*

ABSTRACT

Obtaining tacit knowledge in sports skill learning is difficult. Although, coaches can give their learners easy to understand instructions to obtain the tacit knowledge. The coaches monitor, analyse and interpret learners' physical movement based on the coaches' experiences, then they give the instruction. In self-training without coaches, it is difficult for learners to analyse own growing status and interpret their achievement goal. We developed an Automatically Superimposed-video Creating System (ASCS) in order to support analysis and interpret the learners' status and achievement level of the skill. Our system has several independent modules to create each instruction, and the learners can choose one module. We assume two achievement models to select suitable modules. Achievement models show a growing process of learners' skills in time series. We conducted a survey to find out the models. We found combined growth patterns which consisted of two assumed models. It suggests a possibility of the two assumed models. In addition, the survey suggested the relationship between modules and models.

KEYWORDS

Individual Training, Achievement Model, Tacit Knowledge, Status Prediction, Module Candidates

1. INTRODUCTION

It is important to obtain tacit knowledge of physical movement in sports technical skills learning (Schmidt and Wrisberg, 2004). However, obtaining tacit knowledge is one of the most difficult factors. Coaches monitor, analyse and interpret learners' achievement status of the goal skills through observing their movement. The coaches instruct them based on the status to transfer the coaches' tacit knowledge to them, giving the learners easy to understand instructions by face-to-face. Recently, the learners of sports techniques watch video learning materials created by experienced players, on web services such as YouTube, and they equip wearable sensors to monitor their own physical movement. These environments are constantly evolving and enable daily self-training without coaches. However, It is difficult for the learners to predict own achievement status through analysing the monitored data, and interpret the result of the analysis. Thus, they could not figure out how they should change their movement. For example, if the learner is not aware of their current achievement level, they cannot correctly evaluate own training to improve own skills, then they cannot figure out what action is suitable for them. Therefore, we believe it is useful for the self-training to introduce a system which observes the learner's achievement and presents suitable kind of instruction. The system creates instructions based on the analysis of the leaner's achievement level and the interpretation of the achievement status. Then it can support learners instead of human coaches.

The videos which are superimposed instruction can use for the easy to understand instruction. The superimposed-video can communicate instruction synchronous with video, and it is intensely. We propose an Automatically Superimposed-video Creating System (ASCS) to support the individual physical training. ASCS can superimpose the differences between trials of experienced players and learners in videos to give suitable teaching for the learners. ASCS generates superimposing information dependent on the learner's characteristics and preferences. ASCS-Engine interprets the learner's achievement status. The status consists of the learner's progress, and the progress shows a pattern of the learner's achievement. We assumed that the pattern consists of two models. If the difference between the learner's current achievement and the achievement goal is significant, the learners probably take a big change in their movement. If the difference is small, they take small steps, and it perturbates around the goal. The ASCS-Modules can interpret the models and display proper viewable instruction and superimpose on a target learning-material video. When watching those videos, the change of the learner's progress might be different depending on preferences and characteristics of the learner. ASCS-Engine predicts the learner's characteristics by comparing their achievement status and the models. Each ASCS-Module might have specific characteristics whose attach the module. There is a much different candidate of teaching method. However, we assumed two species of modules. One species modules create an instruction to show the learner's current achievement level, and other modules create an instruction to show the change of direction in their training. The preference has the relationship between characteristics and the suitable species of modules. The preference also has different selective candidate modules as ASCS-Modules.

We tackled to find out the relationship between characteristics and preferences. We developed three ASCS-Modules include typical methods (numeric displaying and sentence instruction displaying method), and a proposed method compared with advanced methods which use onomatopoeias and those font shape. The onomatopoeia can express the scale of change and change of direction of physical movement briefly.

In this study, we set the forehand stroke in tennis as the learning topic and surveyed the learner's achievement pattern. The survey found different achievement patterns in each learning which use different modules. We observed the possibility of the models through the patterns. Also, we observed the suggestion of the relationship between the characteristic and the preference.

2. RELATED WORKS REGARDING TO E-LEARNING ON SPORTS

2.1 An Approach to Display Information for Trainings

Matsuura et. al. applied a superimposed approach for the skipping-rope (Matsuura et al., 2010). In this study, the system creates graphs which reflects the learner's position of the head. The graphs are superimposed in videos which are taken while the user's training. The users watch a wave which appears on the graph in the video. The wave shows the consistency of a frequency and an amplitude. The learners master the skipping-rope by observing the wave and adjusting their movements. The system in the study displays the monitoring results, however, it does not give instructions based on the relationship between the characteristics and the references. We tried to give the learners appropriate instruction based on the relationship, predicting achievement status.

2.2 The Attachment of Visual Aspect with Onomatopoeia for Instruction

Jimenez et al. defined the onomatopoeia as "Generic term for an "echoic word" or "imitation word"" (Jimenez et al., 2014). They showed that it was possible to maintain the learner's motivation, using the onomatopoeia. In comparison to the general vocabulary, they mentioned that the onomatopoeia can express the reality more effectively. For example, the onomatopoeia can express a bold movement with short and easy word. Also it can express minute movement.

The research topic of Fujino et al. focused on the usage of onomatopoeias as a vocal instruction approach in Japanese sports (Fujino and Yamada, 2006). They defined "The Sports Onomatopoeia", and they researched to find out the learning effects of the onomatopoeias in addition to organising the onomatopoeias used in sports. In the research, the onomatopoeia was used as a tool to communicate movement by voice.

If we express onomatopoeia with letters, the onomatopoeia might gain both feature, voice and visual. The feature of visual is that when put it on a picture, it can improve the reality of the picture as a moment in the video. For example, the onomatopoeia is used in comics to express visual scene and movements through instinct. Expressing like that is difficult for the non-onomatopoeia words. Mixing the voice and vision of onomatopoeias, promote the effect of onomatopoeia in the instruction. The shape of fonts and arrangement of letters with onomatopoeia are used to make the way to movements more clearly, adjusting the nuance of the onomatopoeia. We tackled to set the onomatopoeia which instructs sports skill by voice into the learning video. To add the onomatopoeia instruction into the learning video, we combined letter of onomatopoeia and suitable shape of the letter appropriately. Moreover, we proposed a new teaching method using combined the letter and shape. The vital point to employee onomatopoeias into the method is to connect the instruction information with onomatopoeias appropriately to present the instruction impressively to the learners. We focused on the learner's characteristics at the time which the remarkable event is happened (e.g. The racket shoot the ball in tennis) because every moments are factor which configure a motion.

2.3 The ASCS: Focusing Judgement Assistance for Choosing Modules

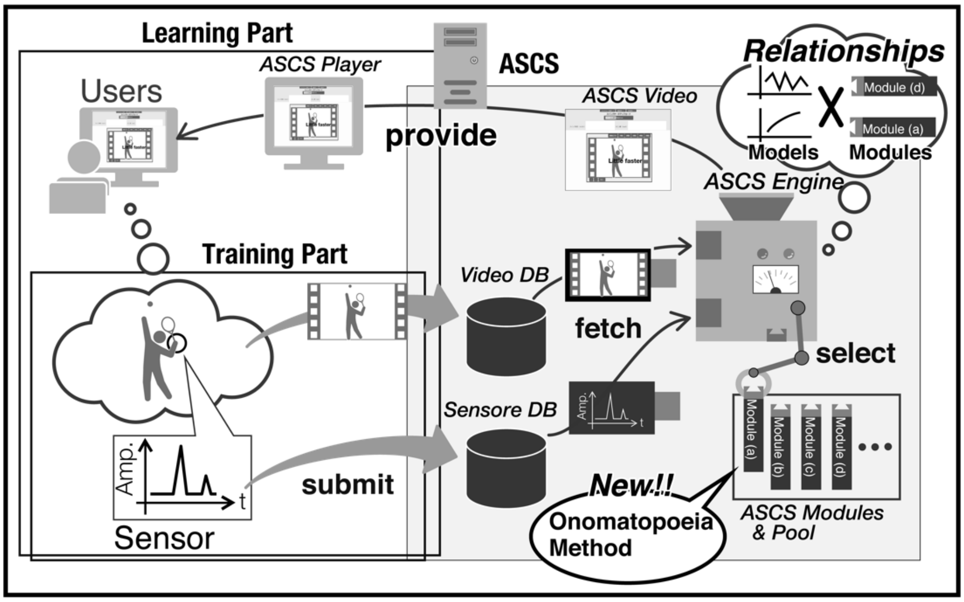

Figure 1. An Overview of Automatically Superimposed-video Creating System (ASCS)

Figure 1 shows the overview of the structure of Automatically Superimposed-video Creating System (ASCS) which we proposed in this research project. The system has a coach's trial video and sensor data to assistant the judgement of the learner. In the sports learning, the learner has several achievement statuses such as improving, decreasing and stable status. Regarding to the stable status, concretely speaking, there is two kind of stable status. We defined high level stable status as the status which keeps high achievement level and low level stable status as the status which keeps low achievement level. One of most worrying status is low level stable status because if the learner is not aware this status, the learner might not improve the learner's skill in the feature.

The ASCS predicts the learner's achievement status and supports to make the learners notice the status using characteristics. Also, ASCS can select the instruction species which are suitable for the leaner's achievement status, and provide suitable candidates of ASCS Modules for the learners. It enables the learners to choice a prefer instruction method from appropriate candidates at the current achievement. The ASCS Module is implemented based on the specific instruction method, and ASCS chooses the module based on the learner's characteristics. ASCS Modules refers to the coach's video and movement which is obtained by sensor log, and create instruction and superimposed-video. Generally, if the coach aware the gap between the achievement goal and the learner's achievement level, the coach communicate the change of direction for the learner's movement (e.g. swing the racket faster or swinging the racket slower) to the learner. Besides, if the coach observes that the learner's achievement is close to the goal, the coach communicates the current status of the learner's movement (e.g. your swing is a little bit faster) to the learner to adjust the learner's movement. Based on this discussion, in order to complement without coaches, the target of the system is to observe the learner's achievement level and predict the learner's status and provide appropriate instruction like the coach. If the learner uses ASCS, ASCS monitors the achievement levels and predicts the status. The learner gets appropriate instruction based on own status. Superimposed-videos is applied to the instruction in ASCS. The video contains the instruction which is created based on the learner's status and communicates differences between the learner's achievement level and coach's achievement level. The learners can gain the change of direction and the achievement level from the superimposed-video. The learner tries to improve movement at the next learning. In this study, the vital point is the relationship between the characteristics and the preferences. The characteristic is needed to determine the learner's status as a coach, and the characteristic needs models of achievement status. The preference is needed to feature the instruction method. the preference considers the distance between the leaner's achievement and the achievement goal and give instructions. Thus we survey the learner's achievement models and the preference of the modules. We tackled to find out the fundamental achievement model to design ASCS-Engine and ASCS-Modules.

The ASCS is designed based on a hypothesis that providing annotated videos to the learners and interactive changing of the instruction depending on the learner's status promotes and maintains the learner's motivations by the preferences. Thus we propose the ASCS-Video and functions of ASCS. We confirm the hypothesis throw a pre-study, and we design ASCS-Modules.

3. THE ASCS-MODULES TO PROVIDE JUDGEMENT METHOD

3.1 The Pre-Study: the Base of the Achievement Models Assumption

In this study, we assumed that the video which is extended by the instructional annotation for the learners promotes and maintains learner's motivations. The reason is that if the learner takes an instruction based on both, the characteristic and preference, the training might be more effective, and the motivation for the learning will maintain. We have conducted a pre-study to verify the hypothesis. Four tennis learners participated in this study. The participants divided into two groups. Both groups were given the same learning videos of forehand stroke. Only one group was given feedback which shows differences between the experienced player's movements and learner's movements. The learning targets of this pre-study were swing speed and spinning amount of ball on the forehand swing. These learning targets are fundamental techniques which are developed through iterative training. We monitored the participants' achievements process and conducted a questionnaire survey. Figure 2 and 3 show the growth process of swing speed. The line types shows the achievement models which configure the achievement process. The Figure 2 shows that both participants maintain the high level stable status in compare with Figure 3. Therefore, the instructional annotated video affects the physical training. Moreover, to maintain the high level stable status of the learner, would maintain the learner's motivation consequently.

From the graphs, we observed the two models: the exponentially growing model and the perturbational aspect model. The result of the survey shows that the solid line in figure 2 and 3 mainly consists of the exponentially growing model. Also, the broken line in the figures consists mostly of perturbational aspect model. The perturbating part in the figures is shown at trial 2 to 10 on figure 2 and trial 4 to 10 on figure 3. In this study, we defined the perturbation as a wavering state around a constant achievement level. The perturbation status is related to the stable status of the achievement status.

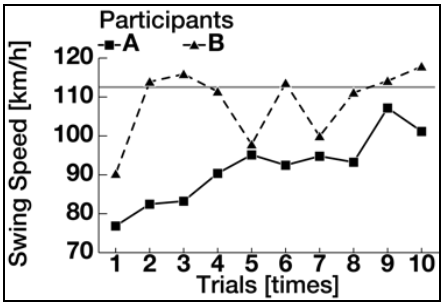

Figure 2. The result of swing learning with feedback

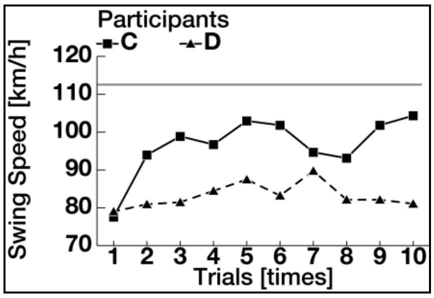

Figure 3. The result of swing learning, only watching videos

From the observation, we assumed two models which configure the achievement models: "Perturbation model" and "Exponential model". Also, we assumed that monitoring the model in the patterns, ASCS can predict the status the achievement status. The purpose of this study was to confirm that the achievement process pattern consists of two models, also, to find out the relationship between the characteristics and the preference.

We develop ASCS-Modules which were implemented based on four requirements which are needed to create instruction, for the experiment.

3.2 Module Definitions

This section describes the requirements for the ASCS-Modules. We defined these following four requirements;

a.) The modules accept two inputs of monitoring data.
b.) The modules should compare and interpret these monitoring data.
c.) The modules generate feedback instruction based on the comparison.
d.) The modules are able to superimpose the information in the videos.

Modules fetch in two sensor data: The coach's data and the learner's data. The system uses the coach's data as the achievement goal. The ASCS-Modules receive the current characteristic of learner's which the system determines from the achievement process. The modules create instruction information using the reference and the characteristic. The system monitors the learner's achievement process and determines current achievement status by predicting the current achievement model and comparing the achievement and the achievement goal to check the amount of difference.

The modules have preferences. The preference has the property of the instruction method. The property has two specifies. One specifies method's instruction communicates the leaner's achievement status to adjust the leaner's movement, and other species to communicate the change of direction to let leaner's movement change. We developed three different kind of ASCS-Modules includes two advanced methods and one proposed method whose have the preference. This study surveyed to confirm the possibility of the achievement models and find out the relationship between the characteristics and the preferences observing the learner's achievement progress using the developed ASCS-Modules.

3.3 The Implementation of ASCS-Modules

We developed three different kinds of ASCS-Modules. This section describes a used sensor for the examination in addition to three ASCS-Modules, Module (a), Module (b) and Module (c), which presents the instruction in different ways. We adopted Smart Tennis Sensor, produced by Sony Corporation, to monitor technical levels of learners. The sensor is attached to the butt cap of tennis rackets, it detects ball speeds, ball spinning levels when the racket hits the ball. The unit of the speed is km/h, and the level is shown by 21 gradations from -10 to 10. This study use the speeds and levels to develop instructions.

The modules were implemented with one proposed and two advanced annotation methods. The module (a) and (b) were implemented with showing differences from coaches by numeric instruction and sentence instruction method respectively, and the module (c) employed the proposed method which uses onomatopoeias and its font shapes. The feature of the proposed method is able to present the gaps in a visual and instinctive way. Figure 4 shows ASCS-Player and the superimposed video which is created by module (a). The learners use ASCS-Player not only to play ASCS-video (superimposed learning video) but also to play learning material videos and to upload the own sensor monitoring data to generate ASCS-Videos which is detected and monitored by Smart Tennis Sensor while training. Module (a) creates numeric instructing ASCS-Videos like shown on Figure 4. The instruction is showing the difference between coaches' target values and the learner's ball speed and ball spinning level. The instruction of speed is indicated on left hand side in km/h, and the difference of spinning level is indicated on right hand side in ASCS-Player. Figure 5 shows an instance of ASCS-videos created by module (b). The module (b) expresses the difference of sensor values between coaches and learners with sentence. The module expresses the difference of speed using "faster" or "slower" with 5 gradating words. The difference of spinning level is expressed by using "more spin" or "less spin" with 4 gradating words. When the learner's speed ball and spinning level are close to the coach's one, the module indicates "Hold it." In the ASCS-video, two sentences are superimposed in the video.

These sentences display to what extend speeds and spinning levels have to change. Figure 6 shows an instance of ASCS-video created by module (c). Module (c) is implemented with proposed method which uses onomatopoeias and its font shape. We proposed this method to present the difference between coaches and learners in a visual and instinctive approach. Module (c) adopted echoic words “Syuuu” as an onomatopoeia to express swing speeds of tennis racket, and the font shape and arrangement express pitch of instruction and positive or negative of modifying directions. The shape of the font is connected to the difference of the sensor values. For example, the fonts’ shape change like shown on Figure 7, the thickness of the font expresses the perception of speed. the font’s shape shifts to the right direction on the figure when the learner’s speed is slower than the experienced player’s speed, and it shifts to left direction on the figure when the learner’s speed is faster than the experienced player’s speed. Figure 8 and 9 shows relationship between the sensor values differences of the spinning levels and the letter arrangement. The curvier the letter arrangement the more spinning speed is needed. When the learner’s spinning level is stronger than the experienced player’s one, the font shape is generated like shown on Figure 8. On the other hand, when the learner’s spinning level is weaker than the experienced player’s one, the font shape is generated like shown on Figure 9.

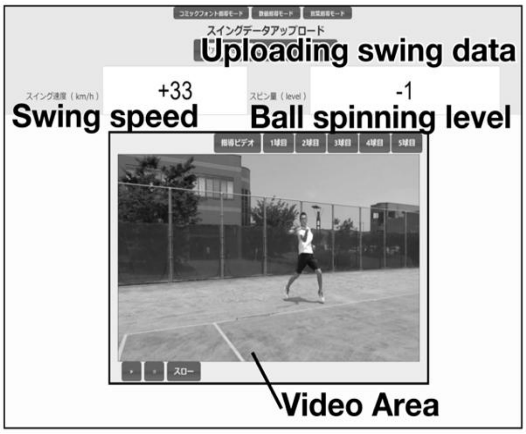

Figure 4. ASCS-Player and ASCS-video with module(a)

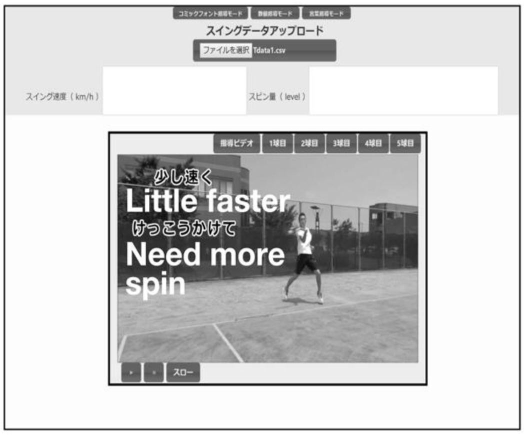

Figure 5. ASCS-video with module(b)

Figure 6. ASCS-video with module(c)

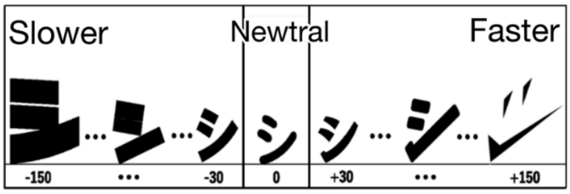

Figure 7. The Shifting of Fonts on Speed

ISBN: 978-989-8533-81-4 © 2018

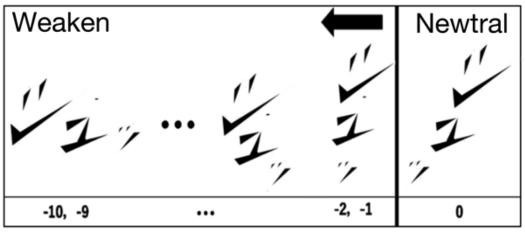

Figure 8. The Shifting of Fonts on Weaken Spinning Levels

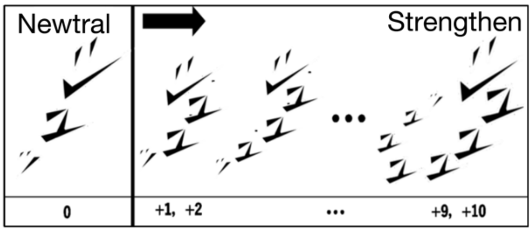

Figure 9. The Shifting of Fonts on Strengthen Spinning Levels

When the module (c) generates the instruction information, shapes and arrangements are combined, and the instruction is shown on Figure 6. In this study, we conducted a survey to find out the relationship between the characteristics and the preferences. The preference of module (a) is to show the achievement status. The preferences of the others are to show the change of direction. We tackled to figure out that either the achievement process pattern consists of the models which consist characteristics and how to affect the modules on the particular achievement status.

4. EXPERIMENT

4.1 Subject

Six male tennis players participated in this study (age: 21.83±0.69 years). We referred to National Tennis Rating Program (United States Tennis Association, 2005) to determine experience levels of the participants. Every participant‘s level was 4. We treated them as middle level tennis players.

4.2 Protocol

The participants were divided into 3 groups; Group A, Group B and Group C which were assigned to Module (a), Module (b) and Module (c) respectively. In this experiment, the participants' learning target was the balls speed of 112 km/h and the spinning level of +8. The procedure of this experimental training is 1) Warming-up (exercise and light tennis training), 2) Taking instruction of the experiment (how to use ASCS, and specifications of the sensor), 3) Watching learning video twice, 4) Training forehand-stroke (three times trial per a loop). 5)Taking ASCS-video instruction.

The participants repeat procedure 4) and 5) 10 times, the speed and spinning level is monitored every time.

4.3 Result

Figure 10 to 12 show the result of the experiment and the grey horizontal lines on each graph show the achievement goal of the learning in this study. Figure 10 to 12 show that every module has the positive effect on the learning. However, only participant E who module (c) was assigned, shows growth and the other learners did not show massive growth on the learning.

Regarding the achievement model, every result shows both models. Also, the growth patterns are different between the assigned modules.

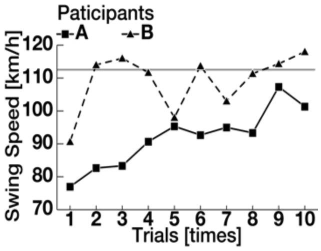

Figure 10. Swing-Module(a)

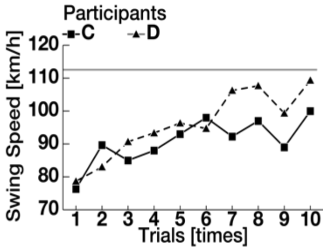

Figure 11. Swing-Module(b)

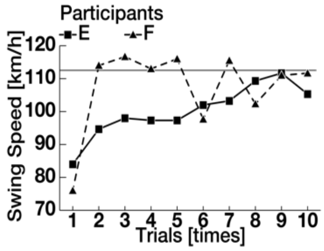

Figure 12. Swing-Module(c)

5. DISCUSSION

The result suggested that the achievement process consists of the assumption models: "Exponential model" and "Perturbation model".

The achievement process of the participant B, C and F considered to include the perturbation models noticeably from Figure 10 to 12. The process of participant D perturbated under the achievement goal. Thus it suggested that the stable achievement level status appears away from the goal. We confirmed the achievement progress which consists of "Exponential model" from all of result. The survey shows that the exponential model appears when the learner's achievement is improving, and the perturbation model appears when the learner's achievement status is stable status.

Regarding the modules, module (a) and module (c) brought huge change for the movement of participants B and F in Figure 10 and 12, and the participants reached to the achievement goal. The difference between the goal and first achievement is big on both participants, and at first trial, the modules brought a big change for the learners. However, the participants B did not take a big change. Thus, the participants A seems to gain the change of direction from the indicated instruction. Although the module indicates the learner's achievement status directly, it might be useful when the achievement status is stable status, and the level is close to the goal.

Regarding module (c), both participants almost reached to the goal. Moreover, on spinning learning, the participant grew. Therefore the module (c) might be useful for the improving achievement status. On the learning of swing, the participants who use module (b) did not reach to the goal. Although the participants D was continuously improving. Therefore, the module (b) might be useful for the improving state.

The survey showed that the module(b) and (c) might be useful when the learner's status is improving. The module (a) might be useful when the learner's status is stable status.. Moreover, module(c) has a possibility that it is useful for the stable state. The two models "exponential model" and "perturbation model" appeared on the learner's achievement process. The process suggested that "exponential model" appears when the status is improving, and "perturbation model" appears when the status is stable status. Also, we confirmed that the stable status has "high level stable status" and "low level stable status".

6. CONCLUSION

In this paper, we assumed that the relationship between the characteristics and the preferences. The characteristics predict the learner’s achievement status based on the achievement models. “Perturbation model”, “Exponential model”. The preference is important to choose the ASCS-modules which provide instruction. The ASCS uses characteristics to select the different candidates of the ASCS-modules. We assumed the preferences of the modules and developed three ASCS-modules include one proposed method.

We surveyed to confirm the models and the relationship. The survey showed the models through the achievement pattern. The models suggested that the learner's achievement status: improving status, stable status. Also, the survey shows the possibility of the relationship.

In future work, we are going to conduct a study to confirm the suggestions by a bigger number of participants.

ACKNOWLEDGEMENT

This work was supported by JSPS KAKENHI Grant Numbers JP16K16321, JP18H03344, JP16H03089 and this research is also jointed work with Ricoh Co., Ltd.

REFERENCES

Schmidt, R. A. and Wrisberg, C. A., 2004. *Motor Learning and Performance.* Human Kinetics Publishers, Champaign USA.

Matsuura, K., et al, 2010. Learning and Competing Rope-Skipping Skills on a Community Site, *Proceedings of ED-MEDIA2010*, Tronto, Canada, pp.3204-3209.

Jimenez, F. et al, 2014. Effect Of Robot Utterances Using Onomatopoeia On Collaborative Learning. *Journal of Artificial Intelligence and Soft Computing Research*, Vol. 4, No. 2, pp 125-131.

Fujino, Y. and Yamada, T., 2006. Development of a "Japanese Sports Onomatopoeias" Computerized Dictionary for Understanding of Subtle Movement, *Proceedings of ED-MEDIA 2006--World Conference on Educational Multimedia, Hypermedia & Telecommunications*, Orlando, FL USA , pp. 1034-1041.

UNITED STATES TENNIS ASSOCIATION, 2005. NATIONAL TENNIS RATING PROGRAM https://assets.usta.com/assets/639/15/National%20tennis%20Rating%20Program.pdf > (2018-08-26)