

Development of a practical assessment method for basketball games in university PE classes

バスケットボール授業におけるゲームの簡易評価法の作成

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1. Introduction

Although PE teachers assess the skills of their students in PE classes as a matter of course, the teaching guidelines by the Ministry of Education, Culture, Sports, Science and Technology (MEXT, 2021) advise that students, as well as teachers, should assess their own skills. This is because assessing their own skills leads to knowing what they themselves should try to learn. For instance, taking the example of a basketball PE class, a checklist of whether you rebound the ball or not allows students to implicitly know that you should rebound the ball after somebody shoots the basketball. Teachers must be able to comprehensively assess their students' skills because they know the criteria for evaluation without a concrete check item for each, based on their expertise and long experience. However, when students assess their own skills, teachers must teach their students how to apply the criteria for evaluation. From a perspective like this, certain evaluation methods appear in supplementary reading materials. However, they are so simple that no useful finding can be obtained (Kimura, 1986; Seki, 1974).

Basketball skill assessment has been studied using skill tests since long ago taking reliability, objectivity, and validity into consideration (Brace 1924; Frier mood, 1934; Money, 1933; Young and Moser, 1934). In particular, although whether skill tests can measure even a high level of basketball skills applicable to games or not is debatable (Collins and Hodges, 1978), it is said to be a valid way to measure skills in PE classes in which only fundamental skills are used to perform (Barrow, 1959; Broer, 1958; Miller, 1954; Komure et al., 2012). However, skill tests are basically limited to the measurement of skills of an individual and not skills between

persons. That is to say, they measure the level of the skills of an individual, such as passing, dribbling, and shooting (Boyd et al., 1955; Chamber, 1952; Glassow et al., 1938). For example, if the passing skills between two persons are measured with a certain skill test, it does not measure the passing skills inherent to one of the two, and measurements can change because one person's performance is influenced by the skill of the other person. However, group skills in ball games, not limited to basketball, are exhibited as cooperation among teammates. In particular, assessments for ball games are not conducted just based on the sum of the individual assessments of players. However, group assessments for games are needed because games play a big role or meaning in basketball PE classes (Araki and Iseri, 1973; Teshima et al., 1986). In game situations, assessments cannot help but utilize a method by which a person observes game plays because it is hard to set measurement situations like skill tests that are fair and/or common to everybody, or to use a physical unit like length or time (Higashi and Ishimura, 1970; Higashigawa et al., 2007; Ohnishi and Ohba, 2007).

Again, when assessing students on the floor of a gymnasium, a simple and practical way using only paper and pencil, but not a personal computer or calculator, is required. Furthermore, the number of the assessment criteria (the number of scales) needs to be simple (i.e., a one-dimensional scale), but not a two- or more dimensional scale, an example of which is dribbling skills being excellent but rebounding ones poor.

Thus, this study aimed to statistically examine a method for university students to simply or practically assess basketball skills for games in PE classes.

2. Methods

(1) Targeted games and the implementation of observation/evaluation

The targeted games were 20 games played in PE classes at F-university and were examined using evaluation items after being videotaped. Two teams were separately evaluated per game. In order to study the reliability of evaluation, the same evaluator observed/evaluated the game twice at an interval of several days and the degree of agreement was examined. Again, after two different observers checking the same game, the objectivity was examined by the agreement between the two. The observers were both basketball experts, who are coaching university basketball teams. At the same time, outcomes were also

recorded.

(2) Evaluation/check items

The six skill areas of passing, dribbling, shooting, rebounding, fast breaking, and cooperation plays were roughly assumed to be personal and group skills in basketball games (Kimura, 1986; Seki 1974), and whether the following 39 plays/actions were found or not were checked: six passing plays, specifically “Desperate passing,” “Vertical long passing,” “Horizontal passing,” “Passing to change the offensive side,” “Passing to reorganize an offensive line,” and “Passing attacking opponents’ carelessness;” six dribbling plays, namely “Dribbling while watching the ball,” “Dribbling while protecting the ball,” “Dribbling while looking around,” “Changing direction while dribbling,” “Breaking through while dribbling,” and “Going away while dribbling;” five shooting plays, specifically “Dribbling and shooting,” “Lay-up shooting,” “Long-range shooting,” “Middle-range shooting,” and “Shooting after dodging the opponent;” five rebounding plays made up of “Rebounding by one player,” “Rebounding by two players,” “Trying to get the inside position,” “Rebounding by three players,” and “Jumping into a rebound by dodging the opponent,” nine fast-break plays, namely “A player who at first held the ball carried it by dribbling,” “A player who is good at ball-handling carried the ball,” “The ball was carried with passing,” “The ball was carried with a straight-line dribble,” “The ball was carried with a dribble,” “The ball was carried with dribbling while shaking the defensive players off,” “Steadily getting the basket when the offensive players were outnumbered,” “Three-line fast break,” and “A successive/secondary offense from a fast break;” and eight cooperative plays consisting of “Outlet passing,” “Pass-and-play,” “A cooperative play with a post man,” “A ball screen play,” “A cooperative play between two specific players,” “A cooperative play by two specific players,” “A cooperative play by three specific players,” and “A ball screen play among three players.” They were rated based on a 5-point scale with 5 being very good and 1 very poor. The check items are shown in Table 1.

(3) Statistical analysis

a) Item selection for constructing a scale

Although two or more dimensional skill factors can be assumed in basketball skills

Table 1. All evaluation items

no.	Skills	Evaluation items
1	Passing plays	Desperate passing
2		Vertical long passing
3		Horizontal passing
4		Passing to change the offensive side
5		Passing to reorganize an offensive line
6		Passing attacking opponents' carelessness
7	Dribbling plays	Dribbling while watching the ball
8		Dribbling while protecting the ball
9		Dribbling while looking around
10		Changing direction while dribbling
11		Breaking through while dribbling
12		Going away while dribbling
13	Shooting plays	Dribbling and shooting
14		Lay-up shooting
15		Long-range shooting
16		Middle-range shooting
17		Shooting after dodging the opponent
18	Rebounding plays	Rebounding by one player
19		Rebounding by two players
20		Trying to get the inside position
21		Rebounding by three players
22		Jumping into a rebound by dodging the opponent
23	Fast-break	A player who at first held the ball carried it by dribbling
24		A player who is good at ball-handling carried the ball
25		The ball was carried with passing
26		The ball was carried with a straight-line dribble
27		The ball was carried with a dribble
28		The ball was carried with dribbling while shaking the defensive players off
29		Steadily getting the basket when the offensive players were outnumbered
30		Three-line fast break
31		A successive/secondary offense from a fast break
32	Cooperative plays	Outlet passing
33		Pass-and-play
34		A cooperative play with a post man
35		A ball screen play
36		A cooperative play between two specific players
37		A cooperative play by two specific players
38		A cooperative play by three specific players
39		A ball screen play among three players

Note: Evaluation score 5:Very excellent, 4: Excellent, 3: Averaged, 2: Poor, 1: Very poor

(Hopkins, 1977), since this study aimed to construct a simple evaluation method, we adopted a one-dimensional skill factor, e.g., a general basketball skill factor commonly related to all basketball skills. In the case when a one-dimensional skill factor is supposed, if an item measures the same construct as others measured, a significant positive association between the item and the total score of them had to be found. This association is referred to as an item-total score correlation (an IT correlation; Kato et al., 2014). When this correlation was low or negative, the item had to measure skills different from the skills that other items tried to measure. However, since a correlation between an item and a total score (a simply summed score) cannot be maximized, we used Principal Component Analysis (Everitt and Dunn, 2001). That is to say, after applying Principal Component Analysis to all items, a scale was constructed using only items showing positive significant component loading, which is a correlation coefficient between items and component scores and corresponds to a total score in an IT correlation.

b) Reliability, objectivity, and validity coefficients

A reliability coefficient that shows the reproducibility of the assessment is computed by a Pearson correlation coefficient between two assessments conducted after a certain duration of time by the same person (Test-retest method; Ikeda, 1994; Izumi, 1970). Again, an objectivity coefficient that indicates the degree of agreement between different persons' evaluations is computed by a Pearson correlation coefficient between two sets of evaluations conducted by two evaluators. Then, based on the assumption that a high-skilled team will win and a low-skilled one loses, criterion-related validity was examined using a t-test between averages of winning and losing teams (Stroup, 1955). Two kinds of t-tests were conducted: a paired t-test to examine the difference between two teams that played and an unpaired t-test to examine the overall difference between winning and losing teams.

c) A simple and practical score table

A simple and practical score table was produced using weight vectors computing principal component scores. After only items showing significant principal component loadings were chosen, the table was produced by multiplying a certain value, adding a certain value, and

rounding the value off to the nearest whole number so that the summed maximum and minimum values were 100 and 0, respectively. By doing so, total evaluation could be easily computed by adding an applicable value to the table, even though on the basketball court of a gymnasium without an electric calculator or personal computer. Moreover, to make a 5-grade evaluation from the distribution of the total evaluation scores, a total evaluation is also produced.

3. Results

(1) Item selection from the perspective of whether items measure the same skills or not

Principal component analysis was conducted in order to select items from the perspective of whether items measured the same skills or not. Table 2 shows the obtained significant principal component loadings.

Significant principal component loadings were found in four passing plays, such as “Horizontal passing (Principal Component loading = 0.629),” “Passing to change the offensive side (0.720),” “Passing to reorganize an offensive line (0.745)” and “Passing attacking opponents’ carelessness (0.633);” five dribbling plays, namely “Dribbling while protecting the ball (0.590),” “Dribbling while looking around (0.797),” “Changing direction while dribbling (0.857),” “Breaking through while dribbling (0.793),” and “Going away while dribbling (0.626);” three shooting plays consisting of “Long-range shooting (0.673),” “Middle-range shooting (0.504),” and “Shooting after dodging the opponent (0.689);” three rebounding plays, specifically “Rebounding by one player (0.506),” “Rebounding by two players (0.314),” and “Rebounding by three players (0.300);” the four fast-break plays of “The ball was carried with a dribble (0.349),” “The ball is carried with dribbling while shaking the defensive players off (0.654),” “Steadily getting the basket when the offensive players are outnumbered (0.488);” and “Three-line fast break (0.379);” and three cooperative plays which were “Pass-and-play (0.457),” “A cooperative play between two certain players (0.497),” and “A cooperative play by certain two players (0.421).”

Table 2. Principal component loadings

no.	Skills	Evaluation items	Principal component loadings ^{note)}
1	Passing plays	Desperate passing	-
2		Vertical long passing	-
3		Horizontal passing	0.629
4		Passing to change the offensive side	0.720
5		Passing to reorganize an offensive line	0.745
6		Passing attacking opponents' carelessness	0.633
7	Dribbling plays	Dribbling while watching the ball	-
8		Dribbling while protecting the ball	0.590
9		Dribbling while looking around	0.797
10		Changing direction while dribbling	0.857
11		Breaking through while dribbling	0.793
12		Going away while dribbling	0.626
13	Shooting plays	Dribbling and shooting	-
14		Lay-up shooting	-
15		Long-range shooting	0.673
16		Middle-range shooting	0.504
17		Shooting after dodging the opponent	0.689
18	Rebounding plays	Rebounding by one player	0.506
19		Rebounding by two players	0.314
20		Trying to get the inside position	-
21		Rebounding by three players	0.300
22		Jumping into a rebound by dodging the opponent	-
23	Fast-break	A player who at first held the ball carried it by dribbling	-
24		A player who is good at ball-handling carried the ball	-
25		The ball was carried with passing	-
26		The ball was carried with a straight-line dribble	-
27		The ball was carried with a dribble	0.349
28		The ball was carried with dribbling while shaking the defensive players off	0.654
29		Steadily getting the basket when the offensive players were outnumbered	0.488
30		Three-line fast break	0.379
31		A successive/secondary offense from a fast break	-
32	Cooperative plays	Outlet passing	-
33		Pass-and-play	0.457
34		A cooperative play with a post man	-
35		A ball screen play	-
36		A cooperative play between two specific players	0.497
37		A cooperative play by two specific players	0.421
38		A cooperative play by three specific players	-
39		A ball screen play among three players	-

Note) - : Not significant

(2) Reliability, objectivity, and validity

Figure 1 shows the scatterplot of the two-time evaluations of the same evaluator assessing the same game after a certain duration of time. The reliability coefficient that showed the degree of reproducibility was 0.763. Again, Figure 2 shows the scatterplot between two evaluations by two different observers, of which the objectivity coefficient that indicated the degree of agreement was 0.612.

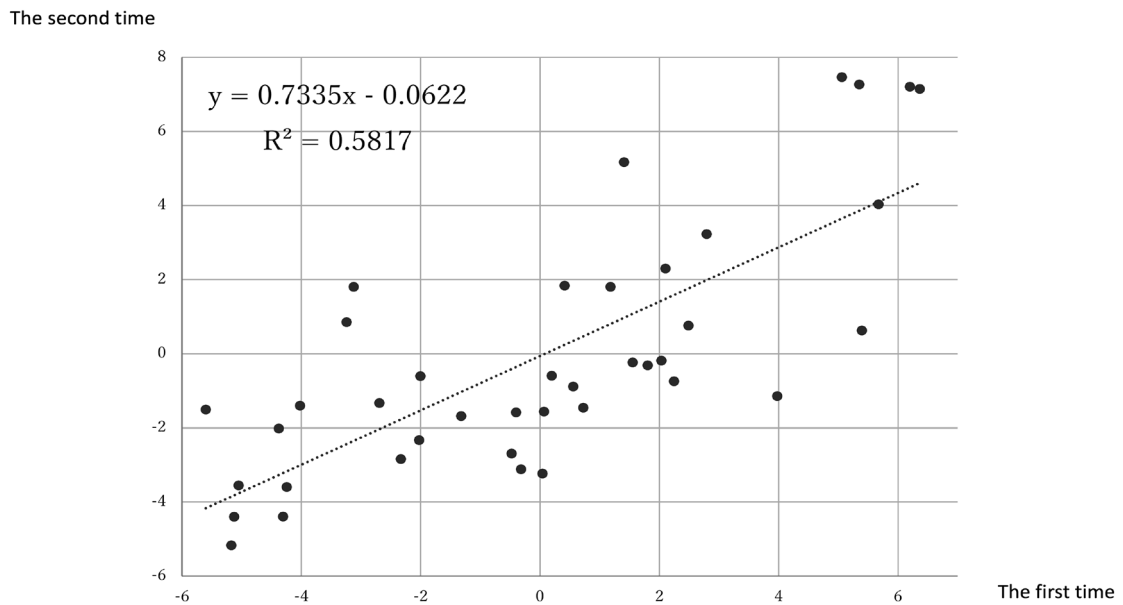


Figure 1. The reliability of evaluation

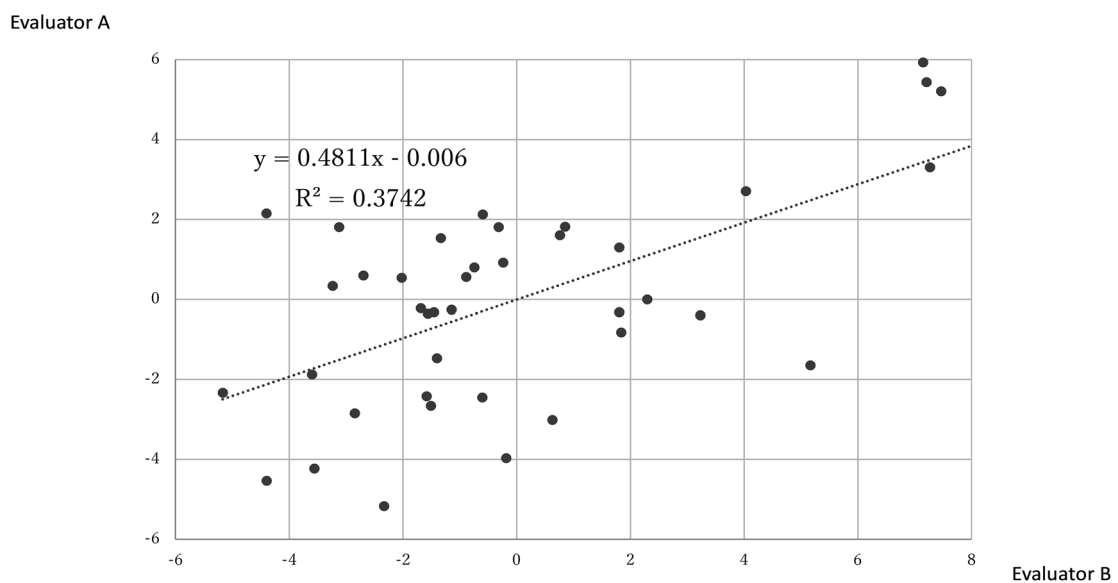


Figure 2. The objectivity of evaluation

In addition, based on the assumption that a team with excellent skills wins and a team whose skills are poor loses, a criterion-related validity that used the outcome of a game as a criterion was examined using a t-test between two averages of winning and losing teams. Figure 3 shows the average of two teams with standard deviations.

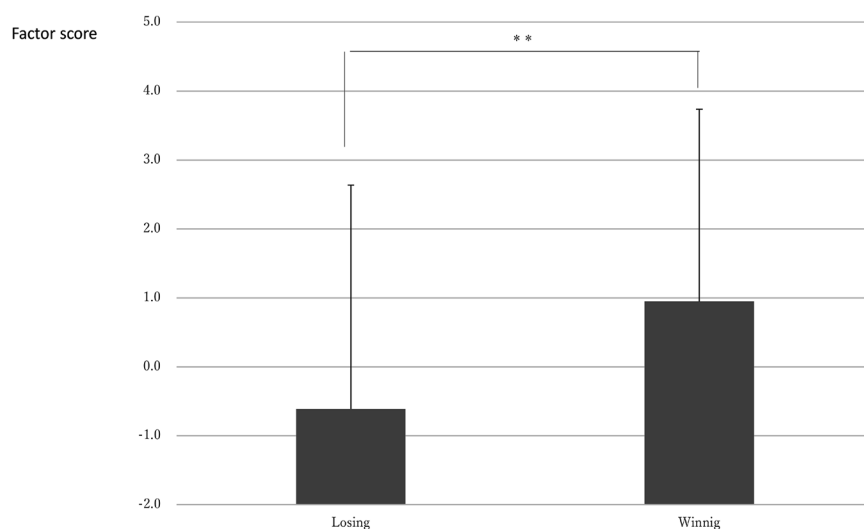


Figure 3. Averages of factor scores by winning and losing teams

After removing tie games and examining the equality of variance, paired and unpaired t-tests were conducted. After confirming the equality of variance using an F-test ($F_0=0.84$, $df=[56,56]$, $P=0.258$), the latter was conducted using an equal-variance t-test. Both tests of the former ($t_0=4.08$, $df=56$, $p<0.001$) and the latter ($t_0=2.75$, $df=112$, $p<0.01$) were significant, indicating that winning teams (average = 0.947, SD= 2.79) were superior over losing teams (average =0.612, SD=3.25).

(3) The development of a simple and practical evaluation table

Table 3 is a simple and practical evaluation table developed by the procedure mentioned above. The summed minimum value is 0 and the maximum is 100. Since the score is an integer, the calculation can be easily done by mental arithmetic even without a calculator.

Figure 4 is a histogram of evaluation points calculated with this simple and practical evaluation table. A mode was found around 40 points and greater, and more frequencies were found in under 40 points than over 40 points.

Table 3. A simple and practical evaluation table

no.	Skills	Items	Very poor	Poor	Averaged	Excellent	Very excellent
1	Passing plays	Horizontal passing	0	1	3	4	5
2		Passing to change the offensive side	0	2	3	5	6
3		Passing to reorganize an offensive line	0	2	3	5	6
4		Passing attacking opponents' carelessness	0	1	3	4	5
5	Dribbling plays	Dribbling while protecting the ball	0	1	2	4	5
6		Dribbling while looking around	0	2	4	5	7
7		Changing direction while dribbling	1	2	4	6	6
8		Breaking through while dribbling	0	2	4	5	7
9		Going away while dribbling	0	1	3	4	5
10	Shooting plays	Long-range shooting	0	2	3	4	6
11		Middle-range shooting	0	1	2	3	4
12		Shooting after dodging the opponent	0	2	3	4	6
13	Rebounding plays	Rebounding by one player	0	1	2	3	4
14		Rebounding by two players	0	0	1	1	2
15		Rebounding by three players	-1	0	1	1	2
16	Fast-break	The ball was carried with a dribble	0	0	1	2	2
17		The ball was carried with dribbling while shaking the defensive players off	0	1	3	4	5
18		Steadily getting the basket when the offensive players were outnumbered	0	1	2	3	4
19		Three-line fast break	0	0	1	2	3
20	Cooperative plays	Pass-and-play	0	1	2	3	3
21		A cooperative play between two specific players	0	1	2	3	4
22		A cooperative play by two specific players	0	1	1	2	3

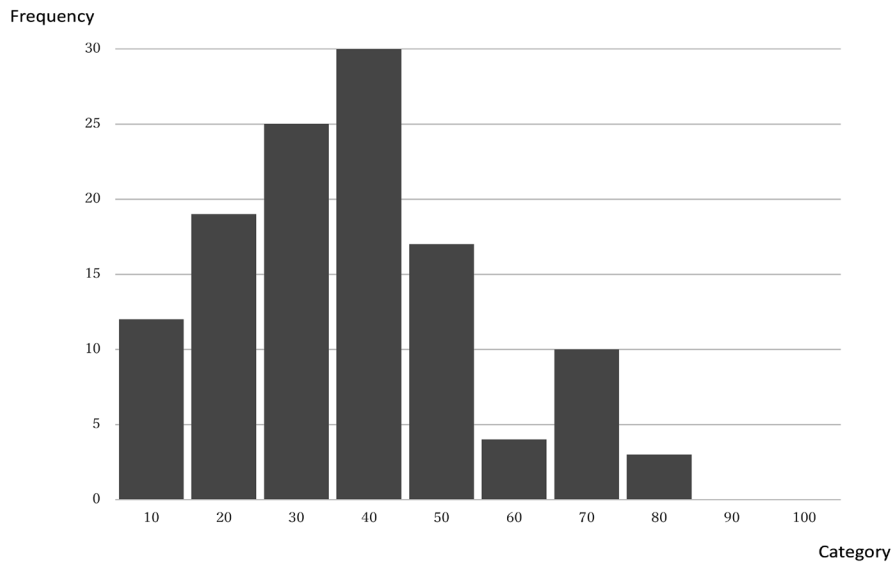


Figure 4. A histogram of evaluation scores

Table 4. Table of general evaluation

no.	Evaluation	Class interval
1	Very excellent	100 – 47
2	Excellent	46 – 37
3	Averaged	36 – 28
4	Poor	27 – 19
5	Very poor	18 – 0

In addition, Table 4 indicates the total-score evaluation table calculated so that the frequency of each category divided by 20, 40, 60, and 80 percentile values is the same (Iwahara, 1965). This table indicates a 5-scale evaluation of a calculated summed score.

4. Discussion

(1) Reliability, objectivity, and criterion-related validity

The reliability coefficient was 0.763, which is highly significant. However, this is the probability to reject a null hypothesis where a population correlation coefficient is 0. Originally, if reliability was perfect, it must be 1. For that reason, the evaluation in this study is not thought to be sufficiently reliable. It is usually said that 0.9 is desirable and at least 0.8 is needed for a group evaluation. In consideration of this fact, one cannot help but conclude that the reliability is insufficient. In addition, the same consideration can be said for objectivity. Namely, the objectivity coefficient in this study was 0.612, which was lower than that of reliability.

To elevate the reliability and objectivity, it is necessary to make an explanation about a checklist that is more than a standard to judge details and include a concrete example of marks. For instance, in the case of "Dribbling while protecting the ball," if the arm position opposite to the dribbling hand is low, three points should be allotted, while if the arm position opposite to the dribbling hand is high, five points should be allotted, and if no arm, one point, and so forth.

However, since significant t-values can be obtained in criterion-related validity using the game outcome as a criterion and there are indications that this evaluation is related to a win or lose, this evaluation method can be said to be valid.

(2) Items showing significant principal component loadings and content validity

After conducting principal component analysis in order to choose items measuring the same skills as other items measured, item selection was carried out based on whether the principal component loadings were significant or not. As a result, 22 items out of 39 items in total were chosen. In order not to be biased toward a certain skill area, the six skill areas of passing, dribbling, shooting, rebounding, fast breaking, and cooperative play were assumed to be the

subdomain and almost the same number of items were already allotted to them. The numbers of chosen items were four for passing, five for dribbling, three for shooting, three for rebounding, four for fast breaking, and three for cooperative play, indicating that almost the same number of items, i.e., three to five, was chosen for each skill area. Due to this fact, it is likely that content validity (Ikeda, 1973) was satisfied.

(3) The allotment of marks and difficulty

When focusing on the number of players rebounding the ball in the table, the tendency of lower marks from “One player” to “Two players” or from “Two players” to “Three players” was found. It is said that since one or two offensive players wait in their own court in case the defensive player gets the ball, it is not advisable to attempt to rebound the ball by all members. However, it is advised if there are three players or fewer because the chance to successfully rebound the ball is increased (Harada, 1986; Kasahara, 1987). However, the allotment of marks for rebounding in the table is not so. In principal component analysis, the loading of items that have the highest correlations with other items becomes high. That is to say, the allotment of marks for items that have a high commonality is high. Since the students targeted in this study were not basketball players and did not have a high level of skill, even rebounding the ball alone is a special skill and no more students rebounded the ball. That is to say, since these plays were special plays, it is thought that the principal component loadings were not significant. As an interpretation of this evaluation, not limited to the number of players, it is important whether to rebound the ball or not. About this point, high-level skills such as whether a three-line offense can be played or not for fast breaking can be interpreted like this.

4. Score distribution and discrimination power in the table

The score distribution obtained by applying the current data to the table has a maximum frequency of around 40 points, more are distributed to fewer than 40 points and less to greater than 40 points. This distribution was thought to occur because the targeted groups' skills were poor due to having no basketball experience.

Again, since the accuracy of measurement, i.e., discrimination becomes high within a range

of high frequencies, this evaluation method has a high discrimination power in a low-scoring group. For that reason, this method is suitable for students whose major is something other than physical education/sports science, but not for those who played basketball in junior high or high school, i.e., for PE basketball classes.

5. Summary

This study aimed to develop a simple and practical evaluation method for basketball skills for university basketball PE classes that students themselves could easily calculate without a calculator or personal computer, even on the floor of a gymnasium. While observing 20 basketball games held in F-university PE classes, 39 items were checked/evaluated with a 5-point scale. The 39 items were roughly comprised of passing, dribbling, shooting, rebounding, fast breaking, and cooperative play. A scale was constructed using only items showing significant positive loadings in principal component analysis. The reliability coefficient was computed using a correlation coefficient between two sets of evaluations by one evaluator and the objectivity coefficient was obtained from a correlation between observations of two evaluators. Also, for examining criterion-related validity, a t-test between averages of winning and losing teams was conducted. As a result, the following findings were obtained:

- 1) Since reliability and objectivity obtained were not sufficient, it is necessary to revise the explanation of the check items. However, criterion-related validity was sufficient.
- 2) Since the items chosen through a principal component analysis were distributed with almost the same number of items in each skill category, content validity was satisfied.
- 3) Since principal component analysis gave a significant positive loading to items that have high correlations with each other, high marks were allotted to items common to games. For that reason, a low mark was allotted to items of which skill levels were high but which were seldom found in the games.
- 4) Score distribution tended to center at around 40 points and many scores were allocated to fewer than 40 points. For this reason, since high discrimination of this method was at a low-skill level, this method is likely to be suitable for PE classes that students without basketball experience take.

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バスケットボール授業におけるゲームの簡易評価法の作成

本研究は、大学体育授業でのバスケットボールの技能評価を体育館のフロア上で、電卓やパソコンなしに学生自身が簡便に行える評価法を統計学に検討した。F大学の生涯スポーツ演習のバスケットボールの授業の中で行われたゲーム20試合を対象に、その様子をVTRに撮影し、39の観察項目について評価を行った。観察項目はバスケットボールのゲーム中の主な個人および集団技能として、大きく「パス」「ドリブル」「シュート」「速攻」「関係プレイ」の5領域を仮定し、主成分分析を行い、主成分負荷量が有意な正の値を示す項目のみをもって尺度を構成した。信頼性係数は同一評価者の2回の評価の相関係数より、また、客観性係数は異なる2名の評価者の行った評価の相関係数より検討した。また、基準関連妥当性は勝ちチームと負けチームの技能の平均値の差の検定を行った。その結果、以下のような結果を得た。

- 1) 得られた信頼性および客観性は十分な値ではなく、今後、観察項目の記述を詳細かつ具体的にするなどが必要であった。しかし、基準関連妥当性については十分な結果であった。
- 2) 主成分分析で選ばれた項目は、各技能下位領域で概ね3～5項目になり、下位領域ごとに項目数がほぼ均等になり、内容的妥当性は満たされていた。
- 3) 配点については、主成分分析がお互い相関が高い項目に有意な負荷量を示すため、共通して見られる項目に高い配点がなされ、対象集団では頻繁に見られない難易度の高い項目は配点が低かった。
- 4) 得点分の形状は40点を中心にそれよりも低い得点層で多い傾向がみられ、この評価法がバスケット未経験者に対して弁別力が高い特徴を示した。