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Application example of key performance indicator (kpi) in maths contest rating process

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ABSTRACT

Normally the student teams are the basic participating units of college maths contest. A completed maths contest consists of various processes including topic selection, survey & investigation, modeling and oral defense, and usually a more superior team can gradually pass levels of contests, entering into more challenging contests. Each member's performance will affect the whole team performance, while the individual ability growth cannot be achieved without certain methods seeking basis and guidance. By adopting KPI system in college maths contest, it can make evaluation on performance of each member and whole team and give comments on the contribution of each member towards the team. Therefore, the role of each member towards the team can be evaluated, which providing basis for the future team development in the meantime of summarizing current performance.

KEYWORDS

Kpi indicator; Maths contest; Rating process; Application example.



INTRODUCTION

Like other types of contests, the final ranking of the teams is decided by the score in maths contests. On the other hand, in the maths contest participated by team as the basic unit, the performance and contribution proportion of each member towards the team plays a vital role in evaluating team efficiency and individual ability of each member. Therefore, there is a need of certain system for the quantitative assessment of each member's contribution, and thus providing theoretic guidance for increasing whole team operation efficiency and individual ability of each member.

Similar with the standard of giving scores to teams, each member's contribution level will be considered in terms of final contest results, contest holding time, anticipation level before contest, which not solely points out the future training direction for each contestant, but also seeks auxiliary basis for evaluating whole team performance.

As an assessment tool, KPI system is normally used for performance evaluation of each member. After setting up KPI method, the final contribution proportion of each member will be determined according to decomposition and extraction of assessment index, weight ratio, and realization rate^[1]. In the case of evaluating each member's contribution using KPI index, the vital role of each member and be measured, thus giving experimental basis for more effective task allocation^[2].

KPI BASED MARKING CRITERION IN MATHS CONTEST

Competence Model

In Maths Contest, there are three major factors that affect performance of each contestant team.

(1) In contest external environment and external polices including contest principle, contest regulation, development degree of selected contest item, and current industry development degree. For most maths contests, participating teams are approximately equally affected by these external issues

(2) Internal structure of contestant team. Take college maths contestant team as example. Constructed by important factors including familiarity degree among members, professional knowledge structure, team overall ability and member matchup, the internal environment of contestant teams vary from team to team.

(3) In terms of participation motivations, participation positivity and self-development needs, each member of the same team vary a lot.

By adopting the common basis for performance assessment in human resource, a competence model can be established with the application of the losed-loop management principle for performance planning, performance coaching, performance assessment and performance feedback. From the dimension of competence, working performance and basic quality, it can give scores regard the contribution of each member, which is shown in Figure 1. On the other hand, each member can recognize their own ability and the value they have brought for the team, thus seeking self-development direction and self-improvement measures in the hope of making preparation for improving the overall strength of the team.

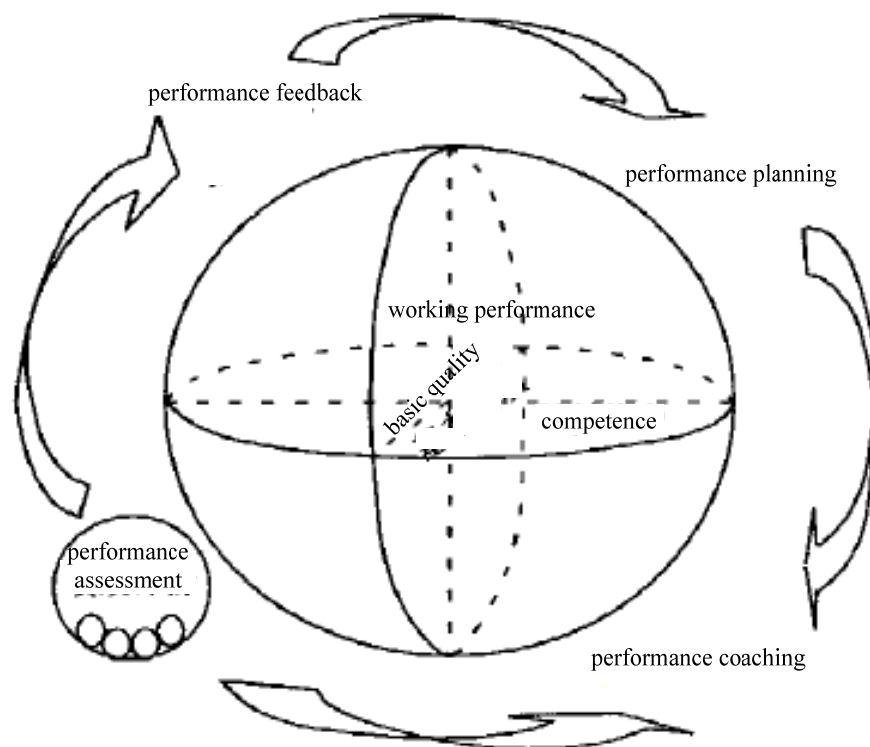


Figure 1 : Competence Based Assessment Model of Team Performance

KPI Index Establishment

As a key performance indicator, KPI (Key Performance Indicator) is commonly used in performance management as a quality evaluation method [3]. Through conducting processes of determination, extraction and analysis on the key factors in input & output terminals of target task, and by setting up the indicator, this method can realize the target quantitative management for each member's performance, breaking the organization strategic planning into practicable tool for working targets. There are majorly three kinds of key performance indexes including benefit indexes (assets profit efficiency, profit level), operation indexes (condition security, market share), and organization indexes (satisfaction level and service efficiency). The characteristics of KPI can be divided into three aspects.

- (1) KPI only evaluates the key jobs in organization target task, rather than evaluate all kinds of work.
- (2) Far from unilateral and mandatory system, the setting up of KPI indexes needs the approval from all members in the organization.
- (3)The systematicity and graduality should be emphasized while setting the KPI index. After finding out organization strategic goal, then set up the strategic goal, and extract the KPI of key working area.

There are three approaches for starting KPI performance management in maths contest. Firstly set performance goal and ability development goal according to requirements of contest and the limitations of selected topic, and determine the performance criteria by based on work analysis model and competence model. Secondly, orienting on whole team performance, focusing the formation and development of teamwork and collaboration ability, and holding the ultimate goal of improving team's overall performance, allocate various resources properly. Finally, in view of complete status of contest goal, improvement of team overall strength and improvement of individual quality, give proper assessment on the final result so as to guarantee the systematicity and integrity of rating system.

In order to conduct more specific control on management process of KIP rating system used in contestant team, the competence based organization performance management and random process control must be conducted. On the basis of clearing about contest goal, establish KPI system and breakdown the goal layer by layer, forming the KPI for each member. The KPI system is designed into multi-level of indexes according to evaluation layers, which is shown in TABLE.1. With mutual coordination among different levels of KPI system, by conducting qualitative & quantitative measurements, and combining internal & external evaluation, the current team performance can be attached with importance and the team potential can be accurately evaluated. The key of establishing KPI lies in its graduality, planning and systematicity, and the measurability as well, moreover there are certain independence and hierarchy among indicators. The selected KPI indicator is shown as TABLE 1.

TABLE 1 : Establishment of KPI

	Team contribution (C)		Individual competence			
	Teamwork	Team strength	overall	Individual value	Task contribution	Innovation ability
Scientific research	√	√	√	√	√	√
Technological ability	√	√	√	√		√
Process efficiency	√	√	√	√	√	
Promotion practicability	√	√				

KPI Rating System

There are three steps in the application of KPI rating system used in maths contest.

First step is to establish the performance goal and ability development goal of each member in the team. The individual result KPI and individual behavior KPI constitute the individual performance indicator. Through a passing process from team goal to team anticipation and to external demanding pressure, the establishment of performance goal is achieved, which also plays a vital role in driving the task forward. With this driving force, each member will concert the individual effort into a same direction, forming a common goal achieved by all members' full effort. The performance goal stems from the overall goal being through specific decomposition and decomposition of responsibility. The establishment of performance goal is a kind of coordination involved with score distribution of contest itself, testing requirement, strategic goal and KPI. According to the coordination, the plan of individual goal can be formulated and led to the way of guaranteeing the development of overall goals

Second step is to form organization performance criteria. Based on explicit and implicit content of post competence model and in consideration of post competence requirements, normally the organization performance criteria can be divided into ordinary post competence performance criteria and extraordinary post competence performance criteria, and the ordinary one includes: various knowledge and skills as most basic requirements for completing contest, which vary according to the role and allocated task each member take charge of in the team. In the early stage of selecting members, it can be more correct and explicit by taking evaluation on professions, academic degree and working experience of the members. The performance criteria of extraordinary post competence mainly includes internal anticipation and motivation such as values, attitudes, personality for reaching excellent goals, which should not be changed as the variation of contest itself. By

behavioral event interview, these criteria can be determined, and extraordinary post competence characteristics of those who got excellent performance can be formulated, which will be consolidated normally through further training and mutual collaboration of members after being selected.

The last step is the monitoring and evaluation of performance operation, which functions as a middle section in the whole performance management process. Compared with other two steps, the monitoring and evaluation of performance operation costs the longest time period and plays an vital role in determining the stand or fall of the whole performance management. Normally this section is conducted by the decision-maker of the team, who will give solution to the current problems in time and make adjustment on performance planning. During the whole performance period, the decision-maker need to continuously give guidance and feedback to members, in addition, the decision-maker should interview members according to the evaluation results and performance feedback in the hope of increasing team performance level.

In the KIP based evaluation system for contribution situation of team members in maths contest, the key point is the introduction of team contribution and the establishment of KPIs of different members. In the system, the KPI includes two aspects of evaluation data, one is scientific performance P, the other is team contribution C. By integrating quantitative evaluation result of P and qualitative evaluation result of C, the final score of each member can be obtained, which is shown as follow:

$$\text{Rating score of member's contribution towards team} = xP_i + yC_i \quad (1)$$

In the equation, i is the team overall rating score, x is the weight ratio of P index in KPI system, y is the weight ratio of C index in KPI system. The specific determination of P index and C index will be achieved through quantitative and non-quantitative evaluation method. Establish different rating index regarding different types of members, which will make members more goal-oriented during the contest, and thus achievements output will be more excellent and effective.

(1) Quantitative index system

As a quantitative index, the evaluation data P was established on the basis of scientific accumulation of maths contest item. Through quantization of accumulation numbers, the goal of rating can be realized. The key point of scientific quantitative rating score is to quantify all relevant parameters, to be specific, Through multiplication and addition of competence index P and contribution index C, a particular value can be obtained, the normal scoring method shows below.

$$P = \Sigma(A \cdot G \cdot R) \quad (2)$$

In the equation, A (Achievement) represents the performance score, G (Grade) represents performance-related grade, R (Rank) represents the achieved performance rank (scientific ability grade), and P is the final quantified value through multiplication and addition of the three parameters. Unlike other types of scientific project, participants in maths contest should be equipped with combined ability of application and basic research, therefore, the major performance of participants could be measured through process effectiveness and practicability of promotion.

(2) Qualitative Index System

The introduction of C index can enhance the relation between whole team and team members, consolidate the team management and help to upgrade team innovation ability. The non-quantitative evaluation is the major data in team contribution evaluation, of which the KPI factors are mainly evaluated in terms of team ability, teamwork spirit and task completion situation. The specific results are show in TABLE.2. Regarding team ability, the KPI elements of C index include team ranks, team influence, and team potential; While in terms of teamwork spirit, the KPI elements in KPI factors of C index include team collaboration, team atmosphere and team member working attitude; The completion situation of team task include the completion situation of goal, initiative of participation and participation degree. Through determination of KPI elements and KPI factors of contribution index C, with application of non-quantitative rating method, a comprehensive evaluation can be realized regarding member's contribution towards team, and the team influence on members.

TABLE 2 : KPI Elements of Team Contribution

Team ability	Team collaboration spirit	Completion situation of team task
Team ranking	Collaboration degree	Completion situation of task
Team influence	Team atmosphere	Initiative of participation
Team potential	Working attitude	Participation degree

The introduction of team contribution index C can give a series of benefits including enrichment of evaluation modes, more objective assessment of individual performance, consolidated links between team and members, improved management of internal members and upgrade of team innovation ability. In addition, the introduction of team contribution index C can also strengthen the sense of responsibility and mission of team members and stimulate individuals to make contribution for the team development.

THE APPLICATION OF KPI IN RATING SYSTEM OF MATHS CONTEST

Rate of Self-accusation

“The concept of "self-accusation rate" stems from the baseball term-"Earned Run Average"(ERA), which is used to describe the lost score due to blame of the pitcher himself. In maths contest, "self-accusation rate" can be understood as practical accountability of each member regarding the gap between practical results and anticipated results.

self-accusation rate =100% (3)

self-accusation rate =n·10% (4)

self-accusation rate =0% (5)

In equation (1), when KPI is accounted by a certain member, the self-accusation rate is 100%

In equation (3), when KPI is completely unrelated to a certain member, the self-accusation rate is 0%

In equation (2), n is the integer from 1-9, representing the closeness between member and KPI. It can be seen that in a particular task or section of the contest, the closeness between member and KPI is in proportion to the self-accusation rate of the member.

Take question-and-answer session as example, suppose the answers score is 20 points, which is to say the KPI of this item represents "scoring 20 points in the question-and-answer session", if the index is fully accounted by a certain member, the self-accusation rate is 100% ; In the case that the self accusation rate is too low, under 40% for instance, it is suggested to further measure the properness of KPI setting, and judge whether the index should be accounted by a single member. What calls for attention is that the KPI task or project undertaken by team members is by no means changeless, instead it varies according to different contest requirements and different contest sections. In addition, when the situation with self-accusation rate of 0% emerges, it means a certain KPI cannot be controlled by team members any more, therefore elimination of this KPI should be considered.

Linear Scoring

The linear scoring system reflects the lowest level of anticipation criteria of each KPI. In previously mentioned cases, when self-accusation of 0% appears in the situation of lowest level of anticipation criteria. In order to further quantify the contribution situation of contestant members, the lowest level of anticipation criteria can be set as 40% realization of KPI, and is granted with 0 points, while the 80% realization of KPI is granted with 15 points. Conducting linear scoring according to the practical completion level of KPI, it can even realize the situation that practical KPI completion level is higher than standard KPI completion level, which will be awarded with additional 5 points.

After adopting linear scoring, in the case of giving scores to member of maths contest, when the self-accusation rate of a certain member possesses is 30%, which can be deemed as getting 0 point. While if a certain member with self-accusation rate of 60% is granted with 7.5 points, by which the scores of each member's contribution can be differed, the functional role of each member and their effort can be evaluated more easily. The scoring criterion is shown as Figure 2.

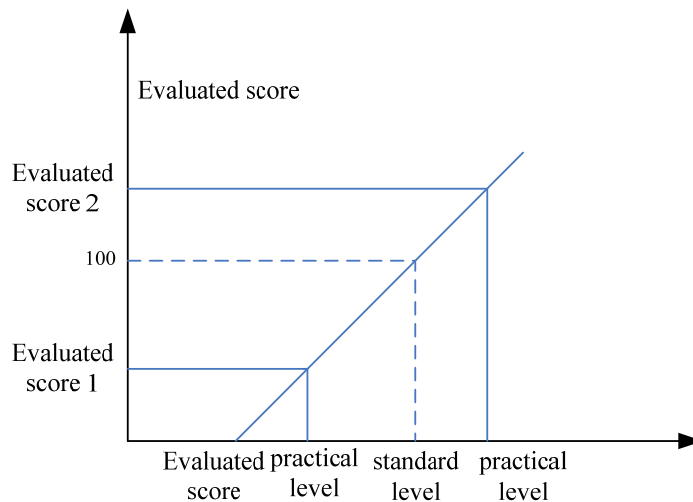


Figure 2 : Computing Criteria of Linear Scoring

Evaluated score=(practical level – lowest level)/(standard level – lowest lever)×100% (6)

Taking application of linear scoring system into practical works, after setting the index system, the lowest level and standard level are not as easy as above mentioned case at all, instead it need to take consideration of weight ratio, difficulty level and degree of completion. Among which, the weight ratio can normally be set according to contest requirement and contest importance, and is not directly related to completion situation of contest requirement. Therefore when setting the lowest level and standard level, normally only difficulty degree and completion degree are involved.

The lowest level of completion situation of a certain maths contest project represents KPI difficulty degree of 40%, completion degree of 50, while the standard level represents the KPI difficulty degree of a certain project is 100%, and completion degree is 100% as well. After introducing self-accusation rate and linear scoring system, the self-accusation rate can be defined into the regulation of lowest level and standard level, therefore, 40% of team self-accusation rate represents the lowest level, 100% of team self-accusation rate represents the standard level, hence a equation can be obtained shown below:

$$\text{Lowest level} = \text{Weight ratio} \times \text{Difficulty degree (40\%)} \times \text{Completion degree (50\%)} \times \text{Self-accusation rate (40\%)} \quad (7)$$

$$\text{Standard level} = \text{Weight ratio} \times \text{Difficulty degree (100\%)} \times \text{Completion degree (100\%)} \times \text{Self-accusation rate (100\%)} \quad (8)$$

To evaluate a member's practical level of a certain KPI, the closely related issues of all KPI should be considered such as difficulty degree, completion degree and self-accusation rate of all KPIs.

$$\text{Practical level} = \text{Weight ratio} \times \text{Practical difficulty degree} \times \text{Practical completion degree} \times \text{Practical self-accusation rate} \quad (9)$$

According to previously mentioned scoring equation, the KPI of the tested member can be linear scored.

CONCLUSIONS

By taking application of KPI index into the scoring system for team members in maths contest, not only the improvement of team overall ability can be provided with data basis, but also the individual ability of each member can be explored by a larger pace. Setting a integrated quantitative & qualitative index as scoring criteria, the contribution degree of whole team and each member can be more objectively evaluated. After the introduction of self-accusation rate and linear scoring method, not solely each member's contribution proportion can be specified, but also the job allocation situation and responsibility range can be defined, which is served as basis for more effectively allocating the role and task of each member in the contest.

What calls for attention is that, in the practical application of "self-accusation rate", if the member self-accusation rate is generally low after the contest, the decision-maker should reconsider the properness of KPI settings and the implement status of pre-contest training and collaboration.

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