

THE INDIVIDUAL PERFORMANCE MEASUREMENT FRAMEWORK IN VIRTUAL TEAM LEARNING

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Abstract: Learning in teams is aimed to develop skills of solving problem-based tasks by using various competences, performing effective virtual communication and knowledge exchange activities. The problem analysed in this article deals with the individual performance measurement for students working in virtual teams. The evaluation and management of learning processes in virtual teams has many specific features, as compared to the face-to-face learning mode. The goal of the article is to present evaluation framework, which could allow us to estimate performance indicators, not only by measuring efforts of teams or individuals by finding specific variables of virtual communication, but also by revealing their causal relationships to the final outcome of the virtual project work. Therefore the suggested method is based on the balanced scorecard concept, applied for virtual teamwork evaluation along analysed dimensions of the teamwork. The balanced values are included to the compound grade for individual performance evaluation, which is designed by calculating the teamwork grade and multiplying it to individual performance coefficient. These evaluation compounds consist of grades, estimated of individual and team input variables, and the results of internal self-assessment of the virtual team members. The experimental data of the real virtual teamwork was applied for analysis of the quality of suggested method, aimed to ensure that the final grade of the project assessment reveals the individual progress of each learner related to team performance.

1 INTRODUCTION

Enterprises need workers with high level skills of solving problems while acting in virtual teams, formed for a particular project. Therefore such skills are urgently needed for building students' future career and should be effectively developed by managing virtual team learning framework, of improving knowledge exchange tools, development communication environment and assessment system, aimed to evaluation both performance of the team and of the individual learner.

Learning in virtual teams creates need for powerful learning environment, where skills of cooperative work, and combining efforts towards reaching learning goals and common tasks fulfilment could be formed (Van Merriënboer & Paas 2003). The teamwork processes can rarely be evaluated by quantitative characteristics, except of the time management and resource management indicators. Performance measurement is important, as it reveals negative and positive outcomes, measures satisfaction and brings the result as

feedback to the system (Qiu et al, 2004). Yet, the quality of the project result and of the teamwork success can only be compared to the preset goals and evaluated only after the final deadline of its completion. Lack of possibilities to evaluate project development and interrelatedness of the common work bears problems, which are addressed in this article: how to evaluate progress of the learner, acting as the member of the team, and what indicators could allow monitoring team project and individual progress early since its starting phases.

In the following chapters we will present the entity–relationships diagram of the virtual teamwork learning environment, leading to the design of the evaluation framework, based on concept of the balanced scorecard. It integrates dimensions, factors and indicators, applied for evaluation of the entities of the virtual teamwork, by exploring their cause-effect relationships as well. It is researched, how the balanced scorecard approach can be applied for designing framework of evaluating individual learners. The calculated compound individual grade integrates the tutors' grades, and estimated efforts of

the team, multiplied to the performance coefficient of each member, joining individual measures and evaluation grades. The experimental study presents experiences of individual evaluation possibilities of the teamwork, which involved 40 learners, arranged in 7 teams, joining international students from 3 countries. The results and conclusions are summarized in the final part of the article.

2 DIMENSIONS OF VIRTUAL TEAM LEARNING

As the main goal of organizing team learning is to prepare specialists for their career in contemporary organizations, the tasks for learning should be prepared according to their work specifics. The organization of working teams are mostly related to the project type of work for solving the problem, acknowledged at the enterprise.

The problem-based learning is based on analysis and solution of the real or prototype business case, while traditional learning is based on finding a solution of the unambiguous and defined task. Therefore the organization and evaluation of team learning is affected by specific conditions of communication in virtual environment, sharing responsibilities in groups, comprehension of specific features of the problem-based task, and monitoring possibilities of the learners, organized in virtual teamwork project.

The understanding of virtual teamwork processes can be revealed as the communication between the following entities: tutor, team and individual learners, and it is mostly expressed by the messages of various types, submitted to the virtual environment. The entity-relationship diagram of problem-based learning in virtual teamwork is presented in Fig.1., where the problem-based virtual learning is supervised by the tutor. He presents the learning curriculum and the undefined problem, usually described as a business case which has to be clarified and defined for the further solution within the learning team, which has to discuss and set the project goal according to the time resources and competences of the team members.

The activities of the virtual team are monitored by the tutor, who observes, adjusts and evaluates the learning processes. The virtual teams consist of members who play the assigned roles within the team (leader, researcher, editor, etc.) In the virtual environment there is no possibility to interact in the face-to-face mode. Lack of this type of

communication is compensated by organizing the video conferences for starting the learning session and for presenting the final results. The main tool for communication is writing messages in the virtual environment. The variety of categories of the messages is decided by the individual learners and the team. They include online messages (online chats) and offline messages in virtual environment (forums).

The messages can be used for knowledge exchange by presenting ideas, decision alternatives, advices for the team to read common learning and research materials, and also submitting the task, assigned to the member by the team. They can combine variety of tools for presenting information in various digital formats.

The other type of messages can be used for modelling communication within team, by suggesting organizational information, motivating, planning, discussing, voting activities, which jointly create communication culture, tone and trust in team.

The messages can be organized in thematic threads, assigned for specific topics and for solving intermediate tasks, leading to the project goal.

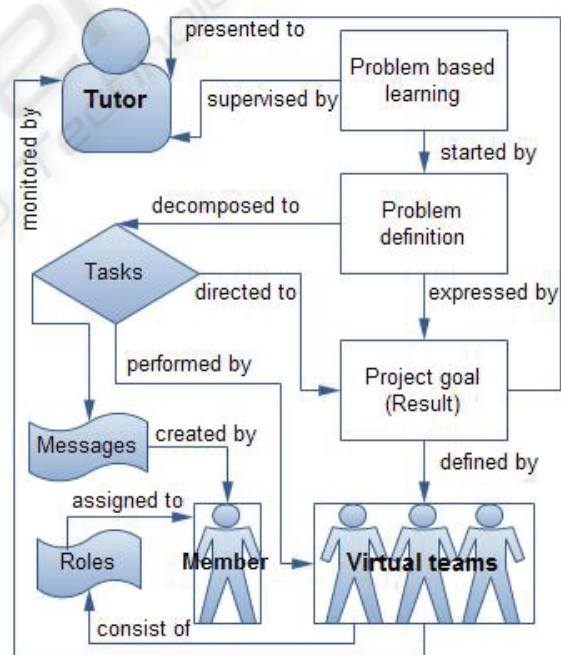


Figure 1: Entity-relationship diagram of learning in virtual teamwork.

The traditional methods of evaluation are basically oriented to grade the presented project result, taking into account the activeness of the individual learners and adjustments according to

self-evaluation of members within team. The activeness component in the virtual team learning environment can be mostly described as “productivity” of the learner, mainly expressed by the number of submitted messages. The assumption that high productivity leads to high effectiveness and good project result is not confirmed by any of the experimental analysis or results of the self-evaluation of the team members (Kriksciuniene, Sakalauskas, 2008, 2009). In Fig.1 the main entities which can be evaluated are: project goal (result), teams, members, tasks and messages.

The main problem of evaluation is that all the entities can be evaluated only after completion of the project, when the adequateness of the achieved result can be compared to the initial learning task. Until the final deadline of the project the learner and the tutor can not forecast the grade and the timely completion of the project. One of the goals of the design of the evaluation method is to apply quantitative and qualitative measures for evaluation and exploring their causal relationships leading to learning strategy fulfilment and enabling tracking of the progress. The balanced scorecard approach is applied for modelling dimensions and factors according to their direct and indirect influence to final goals of the project performance Table 1.

The suggested approach makes parallel to the balanced scorecard concept, presented by Kaplan and Norton (1996).

Highest hierarchical dimension reflects the traditional way to evaluate project, performed by the team-final result and timely completion.

Generally, the dimensions, expressing team performance and individual efforts tend to be evaluated either by subjective measures or by application easily observed indicators: duration of presence in the virtual learning environment or number of messages submitted to project forums. The list of observed factors can be extended as in Table 1. This scorecard can further be deployed to the group and to individual dimensions, so that each unit or person at the group knew his influence and performance toward strategy fulfilment by team.

In Table 1 the virtual teamwork is affected by the individual inputs, efforts, and role acting dimensions. This means that analysis of individual work can be understood as impulses, which either bring the team nearer to its project goal, or undermine it. The strength of factors of the individual dimensions can be tracked by analysis of messages. The dimension of messages bears factors which not only provide communication statistics about individuals and teams, but also helps to

analyse level of knowledge exchange, trust and intensity of communication, which is finally acknowledged by self-analysis of the team. Computational analysis and factors of measurement can allow to estimate the weight of the indicators, according to their influence to project work, partially automate the quantitative evaluation of work processes of the virtual team by collecting information, related to the derived indicators and to track the performance of each member of the learning team and evaluate their input to final result. The evaluation model, based on mining the results of experimental study, reflects cause-effect relationships, which could affect the outcome of the project work (Sakalauskas, Kriksciuniene, 2009).

Table 1: Project evaluation scorecard.

<i>Compounds of balanced scorecard</i>	
<i>Dimension</i>	<i>Factors</i>
Project goal (result) dimension	Time limit met Project goal achieved Project report submitted Presentation skills achieved Teamwork experience gained
Virtual team work dimension	Project problem defined Project result augmented Project quality calibrated Project milestones met Appropriate methods applied Project phases documented Project tasks shared in teams
Individual inputs dimension	Assigned tasks fulfilled Study materials understood Participation in team events Communication by using tools of virtual environment
Individual efforts dimension	Assignments admitted Study materials analysed Ideas generated and shared Task performance discussed Project processes organized Decision making and evaluation of alternatives
Individual role acting dimension	Role accepted and played Responsiveness to team tasks Team motivation Organizational efforts Leadership
Messages analysis dimension	Knowledge sharing intensity “Richness” of explanation Communication tools variety Culture of communication

The traditional way of evaluation the final outcome of the project by the final result and timely

completion does not provide possibility to equally spread the workload and to forecast the final grade. The individual evaluation measure is aimed to reveal the ability of the individual learner to act as a team member, show comprehension of the assigned tasks, and to be able to organize his individual work in alignment to teamwork processes.

Therefore in the Table 1 several areas of analysis of the project teamwork were tightly related: time management, assessing discussion quality both in team and individually, performing knowledge management, and making use of various virtual collaboration tools. The evaluation compounds include dimensions, tightly connected by causal relationships. They include evaluation of teamwork by its overall effectiveness, individual assessment and self-evaluation inside team as well. The important point of using these dimensions is aimed to derive individual indicators, which could be accumulated during the whole period of the project and expressed in quantitative manner. The accumulative individual evaluation can even serve to motivate learners to increase their performance during the project.

3 ASSESSMENT MODEL OF VIRTUAL TEAMWORK

One of the main challenges is not only to calculate statistics of communication processes, but to reveal knowledge sharing gaps, problems, potentials of individuals and team for achieving project goals. But it appeared that the performance-based statistics tools did not enable tutors to calculate the indicators for measuring how the individual learner prepares for the teamwork, what level of understanding of the teaching materials he has achieved, and how he can utilize his achieved level of knowledge by submitting ideas.

In order to take into account the balanced variables of the teamwork the compound grading model for individual performance evaluation is designed (Fig.2). The framework of evaluation combines variables included into the entity-relationship diagram (Fig.1) and project evaluation scorecard (Table 1). The base for individual evaluation is the team evaluation grade multiplied by individual performance coefficient (average=1). The individual grade is equal to the team grade if the individual evaluation and self-evaluation measures, consisting of corresponding factors, are equal to average within the team. If the individual learner outperforms the team average and individual added

value increases the project progress his individual grade will be higher, than that of the teamwork.

These evaluation compounds consist of grades, not only assigned by tutor, but also by estimating individual and team input variables and the results of internal self-assessment of the virtual team members (Table 2). In table 2, the suggested indicators for evaluation are presented. The teamwork grade is assigned by the tutor after submitting project report and making presentation of the project outcome. These indicators are naturally applied in any project setting. According to the project evaluation scorecard (Table 1), the project goal dimension is affected by the factors of the teamwork dimension. These factors imply, that the teams who have better values describing virtual teamwork dimension, get better grade. The suggested weights for the team evaluation grade are 60 % for project result and 40% for the teamwork (Fig.2).

The individual evaluation coefficient requires selecting and measuring variables which could describe individual inputs, efforts and role acting dimensions. The main factors, which could define individual progress in these dimensions, are enlisted in table 2. It is evident, that most of them can only be described subjectively by applying qualitative descriptions. In order to make the quantitative evaluations, the dimension of messages is applied. The factors are evaluated by assigning messages to categories by their content, length, role of the author, presence of ideas, and input to the final report. The lowest dimension of messages gives us two main advantages: they help to make numeric calculations of grade compounds and help to track performance during the project.

Self evaluation compounds can be selected by the tutor. The members can award each other by sharing 100 points along the three self-evaluation indicators (Table 2). The provided indicators

Table 2: Evaluation compounds of the virtual teamwork.

Evaluation compounds	Evaluation indicators
Team work grade	Project work (timely completion, report, presentation quality) Team work (communication materials, documents of project stages, the alignment of the defined goals to team tasks)
Individual evaluation	Inputs (messages with ideas, submitting tasks) Efforts (messages discussion and organization types, message length "richness", response time) Role acting
Self-evaluation	Role fulfillment Contribution to result Team player

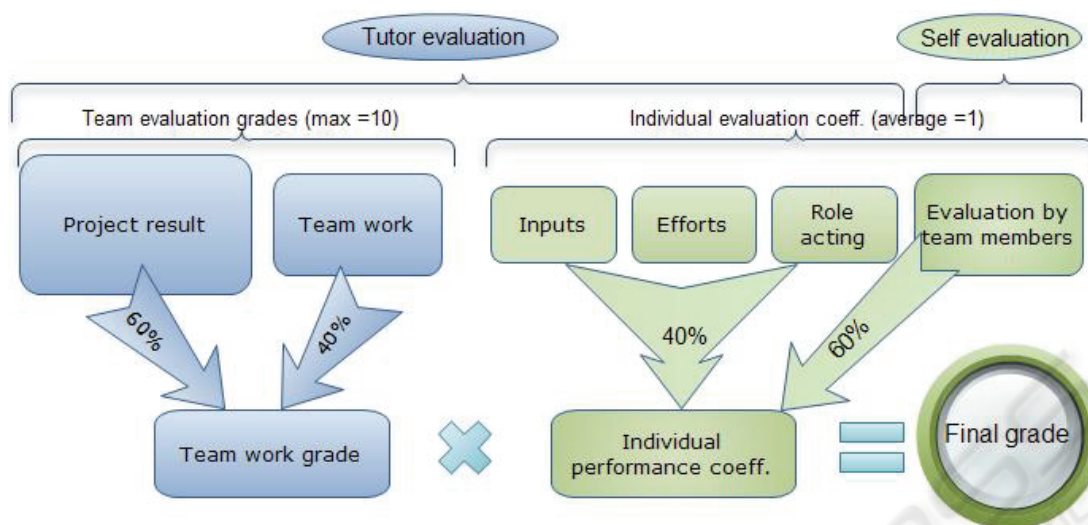


Figure 2: Framework of individual performance measurement.

had high cause-effect relationship to the individual indicators in the experimental analysis (Sakalauskas, Kriksciuniene, 2009).

The final measure for evaluation of individual efforts is calculated by multiplying team grade by the compound individual ratio (average=1). Therefore individual grade is higher or lower than the team result and can show, if the individual added value increase or decrease the project progress (Fig. 2).

In the experimental research the weights applied for individual evaluation, given by tutor and of the self evaluation variables were 40 and 60 percent respectively (Fig. 2). These values of weights were selected by taking into account the analysed relationships among the variables, but they can be further explored by applying quantitative methods as well. Application of the balanced approach revealed the possibilities for enhancement functionality of the virtual teamwork communication environment, as all the calculations of factors and indicators could be estimated half-manually and could be mainly done only upon its completion, after applying extensive procedures of data cleansing, normalizing, converting, and processing.

4 THE EXPERIMENTAL STUDY OF VIRTUAL TEAMWORK ASSESSMENT

The experimental research explored the four-compound model for evaluation process of individual learners within teamwork (Fig.2). The

international group of students solved the common task in the virtual environment during three weeks. They were grouped in 7 teams with heterogeneous nationalities, total 40 members, making project solution of information systems model. Participants were of 3 different specializations of studies: Business informatics (Dresden University of Technology), Business administration (St.Petersburg state University), Business information systems (Vilnius University).

During the project, there was no direct face-to-face meeting. All communication was done in the virtual environment. The team members were assigned roles of leader, researcher, critics or protocol writer. Student work was intensively observed and tutored by lecturers of the three universities.

The structure of the balanced scorecard model was applied for exploring interrelated dimensions, derived from the capabilities of the virtual environment for quantitative analysis and recommendations of participants of virtual projects (Table 1). The experimental study had to reveal, how the evaluation dimensions were interrelated and influenced individual evaluation. The compound grade according to the model of Fig. 2 and Table 2 was calculated and compared to the tutor's grade.

The project result dimension was calculated as average of grades (max =10), assigned by each tutor of the seven teams. The grades were put for project materials, prepared by the learners and submitted to the common wiki space, and for the quality of the final presentation. The data, recorded from virtual communication, included total number of 9392

messages, consisting of 1215 offline messages and 8177 chat messages from online team conferences.

The variables for team and individual evaluation were based on message analysis and derived indicators. The analysis showed which indicators were important to tutor, but undervalued by self-analysis and vice versa. The correlation analysis of the variables showed the strongest relationship between tutors' grade to the number of messages of organizational type and submitting individual tasks. Therefore, grade could not reveal the efforts of the learner in the sphere of offering ideas or helping to realize them inside the team. These characteristics were better noticed by the team members and expressed by self-evaluation characteristics. The selected weight for self-evaluation was set to 60%.

The experimental research of the variables, measured during the teamwork gave wider spread of marks between the 40 individual learners, than by applying conventional evaluation approach.

The project grade of the 7 teams varied from 6.536 to 9.786. The teamwork compound, which involved factors of the virtual team work dimension, was evaluated from 5.681 to 9.321. The individual evaluation coefficient, consisting of inputs, efforts and role acting components, weighted by 40% and self-evaluation component (weight 60%) varied among members from 0.514 to 1.444 (average=1). The final individual marks of team members varied from 0.292 to 1.33, and it allowed to conclude, that the evaluation of the individual members of the virtual team project by the suggested approach of balanced evaluation revealed more sensitively the efforts of the learners, than by sharing the project result for all team and adjusting it by individual grade, expressing active efforts of the learner.

The suggested evaluation method helped learners to understand both his individual impact to the team work and his acceptance by the team members and lead to deriving final grade with the clearly described quantitative measures of the four compounds.

5 SUMMARY

The suggested method is based on the balanced scorecard concept, applied for virtual teamwork evaluation along analysed dimensions of the teamwork. It allowed us to estimate performance indicators, not only by measuring efforts of teams or individuals by finding specific variables of virtual communication, but also by revealing their causal relationships to the final outcome of the virtual

project work. The balanced values are included to the compound grade for individual performance evaluation, which is designed by calculating the teamwork grade and multiplying it to individual performance coefficient.

These evaluation compounds consist of grades, not only assigned by tutor, but also by estimating individual and team input variables and the results of internal self-assessment of the virtual team members. The experimental data of the real virtual teamwork was applied for analysis of the quality of suggested method, aimed to ensure that the final grade of the project assessment reveals the individual progress of each learner related to team performance.

The four compound approaches helps to solve the difficult problem of forecasting of the project outcome, as the team grade is put only after completing whole project. As the individual indicators are accumulated starting from the beginning of the virtual project, they can encourage learner to spread efforts during all project period for getting both better individual and team grade. The suggested assessment procedure leads to deriving final grade with the clearly described quantitative measures. The virtual team members' can realize his impact to the team work and his effort acceptance by the team members.

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