Mathematical Model of Criterion Assessment

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Abstract— **Mathematical model of criterion assessment of learning outcomes developed to study subject validity of assessment.**

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I. Introduction

Independent assessment of learning outcomes usually is performing in testing form. If the assessment is aimed at rating of assessed persons predictive validity is a general index of assessment quality [1]. In criterion assessment it is important to be sure that assessment satisfies needs of subject validity [2].

In both cases validity proving demands some kind of additional assessment.

Rating assessment is being applied to selection procedures as a rule. Therefore predictive validity may be assessed by successes of selected persons. At universities admission it is being evaluated as a correlation between assessment score and university learning outcomes [1].

Evaluation of subject validity demands really some external additional assessment.

We suggest mathematical model of knowledge assessment. This model helps to discover scope of such external assessment and to develop techniques for such evaluation.

Let denote $\boldsymbol{K}$ – field of knowledge to be assessed. We consider $\boldsymbol{K}$ as a set of elementary tasks and questions concerning knowledge area. We identify knowledge area with $\boldsymbol{K}$. We suppose also that all elements of $\boldsymbol{K}$ are equivalent to items for assessment (for example test items).

Let $\boldsymbol{A}$ be statistical population, i.e. a set of all persons who may be assessed at knowledge area $\boldsymbol{K}$.

For each $q \in \boldsymbol{K}$ $a(q)$ means vector of scores having been gotten by all members of statistical population. $a(q)$ may be considered as some random variable. For two elements q_1 and $q_2 \in \boldsymbol{K}$ $r(a(q_1),a(q_2))$ is correlation of two variables $a(q_1)$ and $a(q_2)$. Finally we can metrize $\boldsymbol{K}$ applying metric

$$\rho(q_1, q_2)=sqrt(1-r(a(q_1),a(q_2)^2)). \qquad (1)$$

It is easy to show that ρ satisfies metric axioms.

Test T in this model is some finite subset of $\boldsymbol{K}$.

So problem of developing test with subject validity becomes equivalent to finding finite ε – covering T of $\boldsymbol{K}$, where $\varepsilon > 0$ determines degree of test validity.

The model may be applied to evaluate test validity in two ways.

Firstly after passing the test T persons passed it (or some subset of them) have to pass another control test T_1. If distance between T and T_1 measured by (1) is less or equal ε, ε – degree of validity is considered as approved with statistical reliability depending of set T_1.

Second approach may be more technologically attractive. Test T consists of two parts T_1 and T_2. Second part plays a role of control test and the first is the assessment test. This approach is well known for testing researchers [2].

Test T_1 should be carefully designed to ensure subject validity. Test T_2 may be formed in random way.

References

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[2] L.Crocker and J.Algina, Introduction to Classical and Modern Test Theory. Holt, Rinehart and Winston, 1986. – 527 p.