B A D A N I A  O P E R A C Y J N E  I  D E C Y Z J E

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# ANALYSIS OF EFFECTS OF SOCIAL AND MANAGERIAL SKILLS TRAINING

The experiment was presented aiming at finding the effect of social skills trainings. Statistical methods used in the analysis of the results were discussed and a new approach was introduced to remove heteroscedasticity and solve the problem. The circumstances were shown in which social skills training is the most efficient.

## Introduction

Social skills training is a part of management development programs and its aim is to raise social competence (SC) and perceived self-efficacy (PSE) of both future and present managers and their total preparedness for leading others. Social competence can be expressed as possession of or ability to use skills as leading a team, performing feedback, managing conflicts etc., whereas self efficacy is defined as "the belief in one's capabilities to organize and execute the courses of actions required to manage prospective situations" (Bandura, 1986). Many studies reveal that PSE is an important contributor to performance accomplishments.

For practical and research reasons it is advisable to determine whether social skills training courses really produce desirable effects. We were interested in whether it was possible to prove changes in SC and PSE of participants of social skills training course. We made use of a research project in two groups of people. The experimental group comprised participants of social skills training while the control group was formed by those who attended a lecture (not training) course.

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Total scores on ad hoc created self-reporting scales of SC and PSE were examined responses. Each person was inquired twice, before and after taking a course. Two factors were investigated, group (lecture or training course) and occasion (before or after the course). This means that repeated measures were made on one of the two factors. The aim of the study was to compare the two groups by their effects across occasions, i.e., to compare the two profiles.

The paper contains some details about the research project itself and some discussion on statistical methods used in the analysis of the experimental results.

## 1. Scales used in the study

*Social competence*

A modified and reduced version of the questionnaire by Whetten and Cameron (1984) was used as an assessment tool of personal social competence. The questionnaire consisted of items identifying managerial skills that had been found to be important for success as a manager. The number of items in the modified version was reduced to 14 (with 1 item added to the original version and some items modified so that the set of items was better adjusted to the content of the examined social skills training program). Respondents were asked to answer on a 5-point scale. 120 students of the University of Economics in Prague constituted a sample for preliminary testing of the scale. The clarity, lack of ambiguity, scale cohesiveness (i.e. item-total correlations, where the total means the total score on the scale minus the relevant item score) and reliability of the scale were examined (item-item correlations are given in Figure 1, corrected item–total correlations in Figure 2). Factor analysis with one factor was used to check the homogeneity of the scale (Table 1) and all items with factor loadings less a 0,25 were consequently removed (DUV, EMP, SPO). In addition, the item INF was deleted to improve the content validity of the scale.

The final version of the scale consisted of 10 items (see below). Respondents were asked to mark on 5-point graphic scale, how much they thought each item applied to them (the closer she/he marked to a characteristic, the more it was typical of her/him). The individual total score (SCOM) was computed for each respondent by transforming a graphic scale to a number scale and calculating items nos. 1, 2, 3, 4, 8, 9, 10 as 5, 4, 3, 2, 1 in the direction from left to right and items with reverse-meaning (nos. 5, 6, 7) – as 5, 4, 3, 2, 1 in the direction from right to left.

The reliability was verified by computing Cronbach's alpha. Its value 0,68 is acceptable considering a small number of items. Item-total correlations were significant for all 10 items.

**Table 1**

| Items | | Factor loadings |
|---|---|---|
| *R** Have not good verbal skills. | *VERBD* | 0,665 |
| *R** Not able to express own opinions in a group of people. | *PRE* | 0,661 |
| Feel comfortable giving presentations or talks to the audience. | *REF* | 0,659 |
| Self-confident in social settings. | *SEBD* | 0,654 |
| Able to effectively manage activities of a small group. | *VEDT* | 0,540 |
| Assertive. | *ASER* | 0,415 |
| Able to effectively resolve conflicts to the satisfaction of both parties. | *KNF* | 0,332 |
| *R** Uncomfortable giving straightforward feedback to others. | *FEED* | 0,330 |
| Can absorb criticism without becoming defensive. | *KRIT* | 0,263 |
| Have little trouble being criticized. | *DEF* | 0,263 |
| Can generally find all needed information prior to making decisions. | *INF* | 0, 259 |
| Trusted by others. | *DUV* | 0,000 |
| Easy to identify with others feelings. | *EMP* | 0,000 |
| Prefer to work with others. | *SPO* | 0,000 |

*R** = reversed items

| | VEDT | ASER | KRIT | SEBD | PRE |
|---|---|---|---|---|---|
| VEDT | 1,0000 | | | | |
| ASER | ,1935 | 1,0000 | | | |
| KRIT | ,0931 | -,0809 | 1,0000 | | |
| SEBD | ,1876 | ,2140 | ,1315 | 1,0000 | |
| PRE | ,2478 | ,1374 | ,1835 | ,4071 | 1,0000 |
| VERBD | ,1766 | ,2058 | ,0074 | ,3490 | ,4652 |
| FEED | ,0498 | ,1226 | ,1530 | ,1286 | ,0987 |
| KNF | ,0757 | ,1928 | -,0071 | ,1452 | ,0988 |
| DEF | ,2021 | ,1147 | ,3957 | ,0891 | ,1081 |
| REF | ,4225 | ,1557 | ,0119 | ,3508 | ,3475 |

| | VERBD | FEED | KNF | DEF | REF |
|---|---|---|---|---|---|
| VERBD | 1,0000 | | | | |
| FEED | ,1954 | 1,0000 | | | |
| KNF | ,0721 | ,1108 | 1,0000 | | |
| DEF | ,0598 | ,0805 | ,1747 | 1,0000 | |
| REF | ,4733 | ,1210 | ,1159 | -,0448 | 1,0000 |

**Fig. 1.** Item–item correlation matrix

| | |
|---|---|
| VEDT | ,3777 |
| ASER | ,2693 |
| KRIT | ,1849 |
| SEBD | ,4589 |
| PRE | ,4815 |
| VERBD | ,4748 |
| FEED | ,2250 |
| KNF | ,2084 |
| DEF | ,2249 |
| REF | ,4403 |

**Fig. 2.** Corrected item – total correlations

*Self-efficacy*

The self-efficacy scale used in this study was prepared by the second author of this article on the basis of the methodological guidelines by Bandura (1995). It had four parts: assertiveness, presentation, active listening and teamwork skills. Respondents were asked to indicate how well – according to their own belief – they were able to manage specific situations in which they had to apply these four interpersonal skills. The items were scored on a 7-point scale (see the example in Appendix). The total score (SESCORE) for each respondent was computed as the sum of all item scores. An intelligibility of questions, lack of ambiguity, scale cohesiveness and reliability of all subscales were tested again on a sample of 92 students. After factor analysis all items with factor loadings less than 0,5 and those with heavier factor loadings for more than one factor were removed. The final scale consisted of 19 items. Item-total correlations were significant for all items except one. Cronbach's alpha for assertiveness subscale was 0,44 (this subscale had only 4 items) and it ranged from 0,71 to 0,90 for three other subscales.

We do not show all the items and other details because the research has not been finished yet.

## 2. Description of the experiment

The sample under study involved 68 individuals, namely students of the University of Economics. Those who took part in the social skills training course formed the experimental group, and those who attended only lecture course in applied social psychology formed the control group. The size of the two groups was 31 and 37, respectively. A compromise experimental group–control group design was used (the subjects were not assigned to groups at random). The groups were homogeneous from the

point of view of age, level of education and field of study. Each person was inquired twice, before and after accomplishing a course. Total scores on self-reporting scales of SC and PSE described above were examined responses. They were denoted SCOM and SESCORE, respectively. Two factors were investigated, GROUP (training or lecture course) and OCCASION (before or after the course). This means that repeated measures were made on one of the two factors. The aim of the study was to compare the two groups as regards their effect on the response variables.

## 3. Analysis

Although the scales used in the project are ordinal, the total scores are considered as continuous variables. Parametric procedures for analyzing data then require the assumption of the normal distribution. It is a common practice to use ANOVA or MANOVA to analyze repeated measures or within-subject design. Both methods assume equal covariance matrices in various groups defined by factor levels. When the assumption is violated, some other technique should be chosen, e.g., a multivariate rank test or two-stage linear mixed-effects model. Besides, it has been found to be worth considering the first differences of the original data. Taking differences sometimes results, at least approximately, in a very simple covariance pattern for the errors and facilitates interpretation of data. ANOVA or general linear model may then be used to model the differences.

***ANOVA and MANOVA***

The ANOVA model has a form

$$y_{ijk} = \mu + d_{i(j)} + \alpha_j + \tau_k + (\alpha\tau)_{jk} + e_{ijk}\,. \tag{1}$$

(1) is a mixed model with fixed group effects $\alpha_j$, $j = 1, 2$, occasion effects $\tau_k$, $k = 1, 2$, group-occasion interaction $(\alpha\tau)_{jk}$ and random effects of individuals $d_{i(j)}$, $i = 1, \ldots, n_j$. The constant $\mu$ represents the overall mean and $e_{ijk}$ are random errors. Usual $\Sigma$-restrictions for fixed effect parameters are considered and for the random variables the following assumptions are made

$$d_{i(j)} \sim N(0,\ \sigma_d^2) \quad e_{ijk} \sim N(0,\ \sigma^2) \quad \mathrm{cov}(d_{i(j)}, e_{i'j'k}) = 0 \quad \text{for all } i, i', j, j', k. \tag{2}$$

If we use matrix notation and denote by $\mathbf{y}_{i(j)}$ a $2 \times 1$ vector of appropriate total scores of the *i*-th individual in the *j*-th group, its covariance matrix is

$$\mathbf{V}_0 = \begin{bmatrix} \sigma_d^2 + \sigma^2 & \sigma_d^2 \\ \sigma_d^2 & \sigma_d^2 + \sigma^2 \end{bmatrix}. \tag{3}$$

This form of a covariance matrix is called compound symmetry and it is the sufficient condition for an application of univariate ANOVA. For test statistics to be constructed expected values of mean squares must be obtained. It is rather complicated when groups are of unequal size. It is convenient to reparameterize the model (1) for that purpose and to consider the cell means model

$$y_{ijk} = \mu_{jk} + d_{i(j)} + e_{ijk}. \tag{4}$$

We do not pursue the analysis any further and refer to Crowder, Hand (1990), where details can be found. Another way described therein is the synthesis by Hartley and Rao.

The interaction effect is substantial for appreciation of the efficacy of the social skills training course, so the compound hypothesis $H_0$: $\alpha\tau_{11} = \alpha\tau_{12} = \alpha\tau_{21} = \alpha\tau_{22} = 0$ is tested.

MANOVA model has a form

$$\mathbf{y}_{i(j)} = \boldsymbol{\mu}_j + \mathbf{e}_{ij}^*, \tag{5}$$

where $\boldsymbol{\mu}_j = (\mu_{j1}, \mu_{j2})^T$ denotes $\boldsymbol{\mu}$-profile in the $j$-th group, $\mu_{jk} = E(y_{ijk}) = \mu + \alpha_j + \tau_k + (\alpha\tau)_{jk}$, and $\mathbf{e}_{ij}^*$ is a vector of random errors such that $\mathbf{e}_{ij}^* \sim N(\mathbf{0}, \mathbf{V}_j)$. Then,

$$\mathbf{V}_j = \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{12} & \sigma_2^2 \end{bmatrix}. \tag{6}$$

Equality of covariance matrices in various groups is required but random error variances may differ on two occasions. Test of the hypothesis $H_0$: $\boldsymbol{\mu}_1 = \boldsymbol{\mu}_2$ corresponds to the test of the interaction in ANOVA. In the case of two groups nothing else can be profited from using the MANOVA, because transformations of Wilks' and the other three common statistics have the same distribution as $F$-statistic in ANOVA.

Before making inferences it should be checked whether or not the underlying distributional assumptions are valid for the data. Diagnostic plots of residuals may be used for that purpose. Another possibility of assessing the validity of these assumptions are Box's and Levene's tests that are commonly applied in connection with MANOVA.

*Multivariate rank test*

If the assumption of equal covariance matrices is violated, the multivariate rank test by Koch (1969) can be carried out. It is a generalization of the univariate Kruskall-Wallis test. In a multivariate two-sample problem the tested hypothesis is $H_0$: $\mathbf{m}_1 = \mathbf{m}_2$, where $\mathbf{m}_j$ is the vector of medians in the $j$-th group. A continuous but not necessarily normal distribution of $\mathbf{y}_{ij} = (y_{ij1}, ..., y_{ijm})$ is assumed. The validity of $H_0$: $\mathbf{m}_1 = \mathbf{m}_2$ is not much important in our problem. A hypothesis about contrasts, namely $\mathbf{C}^T\mathbf{m}_1 = \mathbf{C}^T\mathbf{m}_2$, should be tested. Because in our case of two repeated measures $\mathbf{C} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$ is taken into account, it is more helpful to use a parametric two-sample test.

*Two-stage linear mixed-effects model*

Another possibility is the two-stage mixed effects model extended to heteroscedasticity

$$\mathbf{y}_{i(j)} = \mathbf{X}_i\boldsymbol{\beta} + \mathbf{Z}_i\mathbf{u}_i + \mathbf{e}_i, \quad i = 1, \ldots, n, \quad n = n_1 + n_2, \quad j = 1, 2, \tag{7}$$

where $\mathbf{y}_{i(j)} = (y_{ij1}, y_{ij2})^T$ is the vector of two repeated measures on the $i$-th individual in the $j$-th group, $\boldsymbol{\beta} = (\mu, \alpha_1, \alpha_2, \tau_1, \tau_2, (\alpha\tau)_{11}, (\alpha\tau)_{21}, (\alpha\tau)_{12}, (\alpha\tau)_{22})^T$ is the 9 × 1 vector of fixed effects, $\mathbf{X}_i$ is the 2 × 9 design matrix for fixed effects $\boldsymbol{\beta}$, $\mathbf{u}_i$ is the $q$ × 1 vector of random effects, $q$ depends on the chosen model, $\mathbf{Z}_i$ is the 2 × $q$ design matrix for random effects and $\mathbf{e}_i$ is a 2 × 1 vector of random errors. It is assumed that $\mathbf{u}_i \sim N(\mathbf{0}, \mathbf{D})$, $\mathbf{e}_i \sim N(\mathbf{0}, \mathbf{R}_i)$. The random effects $\mathbf{u}_i$ and the random errors $\mathbf{e}_i$ are assumed to be independent for different individuals and to be independent of each other for the same individual. The matrices $\mathbf{D}$ and $\mathbf{R}_i$ are assumed to be positive-definite. There follows

$$\text{var}(\mathbf{y}_i) = \mathbf{V}_i = \mathbf{Z}_i\mathbf{D}\mathbf{Z}_i^T + \mathbf{R}_i. \tag{8}$$

This form enables us to model heteroscedasticity both across groups and occasions. Conditional $F$-tests of fixed effects are performed to test the hypotheses given above. More details can be found in Pinheiro, Bates (2000).

*Summary measures approach*

Taking first differences of repeated observations may simplify the analysis. Differences of a response variable are treated as a new response variable. In the case of two repeated measures the multivariate problem reduces to the univariate one. A comparison of group means by using the two-sample $t$-test is possible but the differences themselves do not probably suffice to describe the data completely. Baseline

measurements, i.e., measurements on the first occasion should be considered, too. Then, a general linear model, where baseline measurements are included as a covariate, is a suitable tool.

## Results

The values of *F*-statistics in ANOVA for two response variables with appropriate *P*-values are given in Table 2.

**Table 2**

| | SESCORE | | SCOM | |
|---|---|---|---|---|
| Source | *F* | *P*-value | *F* | *P*-value |
| Group | 0.384 | 0.537 | 1.034 | 0.313 |
| Occasion | 12.419 | 0.001 | 9.990 | 0.002 |
| Gr-Oc | 4.094 | 0.047 | 9.617 | 0.003 |

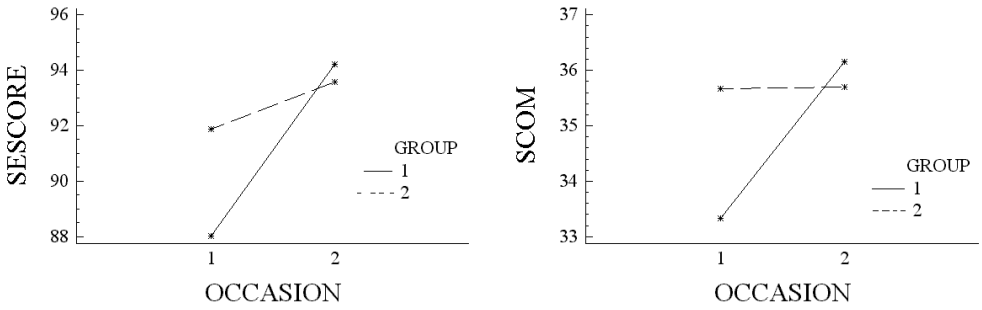


**Fig. 3.** Estimated marginal means for SESCORE and SCOM response variables

The interaction effect is crucial for appreciation of the efficacy of the social skills training course. *P*-values in the last row of Table 2 indicate that interaction is significant in the case of SESCORE as well as SCOM. As suggested by Figure 3, where solid lines correspond to the experimental group, the average change of total scores is much greater in the experimental group.

Results of the Box's test of equality of group covariance matrices and the Levene's test of equality of error variances are given in Tables 3 and 4, respectively.

**Table 3**

| SESCORE | | SCOM | |
|---|---|---|---|
| *F* | *P*-value | *F* | *P*-value |
| 1.988 | 0.113 | 4.236 | 0.005 |

**Table 4**

| | SESCORE | | SCOM | |
|---|---|---|---|---|
| Occasion | *F* | *P*-value | *F* | *P*-value |
| 1 | 1.037 | 0.312 | 0.019 | 0.890 |
| 2 | 1.940 | 0.168 | 4.267 | 0.043 |

Results of Box's test indicate violation of the assumptions in the case of SCOM. This means that covariance matrices in the experimental and control groups differ significantly. According to the Levene's test there is a significant difference between variances of the two groups on the second occasion (see Figure 4, too).

We also applied the two-stage linear mixed effects model (in S-PLUS program) extended to heteroscedasticity in the case of SCOM. Inferences from conditional *F*-tests are the same as in ANOVA and it would be a waste of space to describe the analysis in detail.

**Table 5**

| | | Levene's Test for Equality of Variances | | *t*-test for Equality of Means | |
|---|---|---|---|---|---|
| | | *F* | *P*-value | *T* | *P*-value |
| DSESCORE | Equal variances assumed | 0.182 | 0.671 | 2.023 | 0.047 |
| | Equal variances not assumed | | | 1.990 | 0.051 |
| DSCOM | Equal variances assumed | 7.793 | 0.007 | 3.101 | 0.003 |
| | Equal variances not assumed | | | 2.980 | 0.005 |

We computed differences of the two repeated measures for each of two responses SESCORE and SCOM, denoted DSESCORE and DSCOM. The effect of the training course should be approved by a significant difference between two means in the control group and the experimental one. The results of the usual two-sample *t*-tests are given in Table 5. The very small *P*-value for DSCOM indicates a significant effect of the factor group, i.e., the efficacy of the training course. As for SESCORE, the *P*-value near to 0,05 is less convincing.

Taking differences of total scores on two occasions carried no new results and heteroscedasticity was still present. To investigate the causes of heteroscedasticity the repeated total scores on each individual were displayed. We confine ourselves to SCOM, which is

interesting from the point of view of existing heteroscedasticity (Figure 4). As suggested by the figure, where solid lines correspond to individuals in the experimental group and the dotted ones to the control group, the total score increased mainly for those individuals in the experimental group who had lower scores on the first occasion.

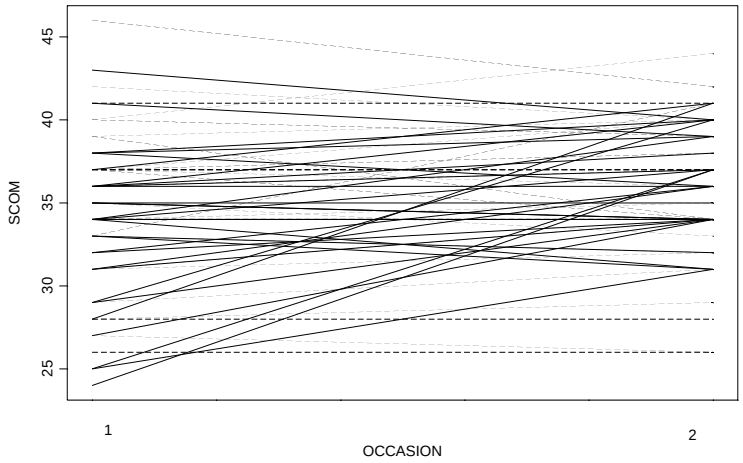


**Fig. 4.** Two repeated measures of SCOM on individuals of two groups

Now, baseline measurements on the first occasion were taken into account and a general linear model was applied. Differences of SCOM were the response variable and except the factor GROUP total scores on the first occasion SCOM1 were included as a covariate. As can be seen from Table 6, the effect of baseline measurements is highly significant and existence of the interaction suggests a different effect of baseline measurements in the two groups.

**Table 6**

| Coefficient | Estimate | *t*-value | *P*-value |
|---|---|---|---|
| GROUP | –10.2797 | –3.9999 | 0.0002 |
| SCOM 1 | –0.5123 | –6.9107 | 0.0000 |
| GROUP* SCOM 1 | 0.2747 | 3.7056 | 0.0004 |

To express this phenomenon less vaguely, a blocking factor was included in the model. The individuals in both the experimental and the control group were classified according to the levels of this blocking factor to three classes. To define the classes, data from the pilot sample of 120 students were used, and limits for the classes were determined by means of a normal distribution model. They correspond to the 0,33 and 0,66 quantiles of the normal distribution. In the first block there are individuals up to

the score of 30 (included), in the second block those with scores from 31 to 35 included and the third block is made up of those with more than 35 points. Again, a two-factor ANOVA was performed, with factors group and block and their interaction. Differences of SCOM (DSCOM) were a response variable (Table 7).

**Table 7**

| Source | *F*-value | *P*-value |
|---|---|---|
| Group | 22.06 | 0.0000 |
| Block | 13.85 | 0.0000 |
| Gr*Bl | 12.32 | 0.0000 |

According to the *P*-values, both main effects and interaction were highly significant. This time the Levene's test did not indicate departures from the assumption of homogeneity (*P*-value 0.186). Multiple comparisons could be realized but Figure 5 will do for interpretation. A remarkable mean change of SCOM in the first block in the experimental group can be seen.

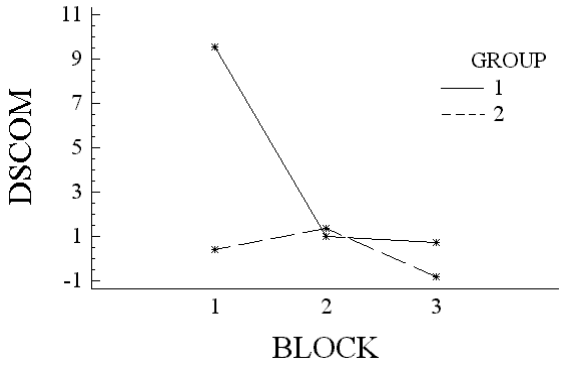


**Fig. 5**. Plot of group and block interaction

## Conclusions

The results of the analysis give evidence of an increase of SESCORE in the experimental group but only at 0,05 significance level. As for SCOM, the analysis confirmed the efficacy of the social skills training course especially for those, who were in the class with the lowest total score before accomplishing the course. The results indicate that social skills training is useful mainly for people who have had – for various reasons – limited opportunities to develop their social competence in their social environment.

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## Analiza efektów treningu umiejętności społecznych i kierowniczych

Trening umiejętności społecznych (*social skills*) jest częścią programów szkolenia kierownictwa. Jego celem jest podniesienie kwalifikacji społecznych (*social competence* SC) oraz postrzeganej osobistej skuteczności (*perceived self efficacy* PSE) kierowników, zarówno przyszłych, jak i obecnych, a także ich ogólnego przygotowania do przewodzenia innym. Wskazane jest, z powodów praktycznych i badawczych, określenie, czy treningi umiejętności społecznych faktycznie przynoszą takie rezultaty. Zastosowany został projekt badawczy z udziałem dwu grup osób. Grupa eksperymentalna składała się z uczestników treningów umiejętności społecznych, grupa kontrolna natomiast została uformowana z osób uczęszczających na zajęcia wykładowe (nietreningowe).

Jako wyniki pomiaru (*total scores*) przeanalizowano odpowiedzi badanych osób na utworzonych w tym celu skalach pomiaru cech SC i PSE. Pomiar u każdego badanego był dokonywany dwukrotnie – przed i po uczestnictwie w odpowiednich zajęciach. Zbadany został wpływ dwu czynników, rodzaju zajęć (wykłady lub treningi) oraz momentu badania (przed lub po zajęciach). Badania takie są zazwyczaj dokonywane za pomocą analizy wariancji (ANOVA) lub wielowymiarowej analizy wariancji (MANOVA). Ponieważ zgodnie z wynikami testów Boxa i Levene'a założenie o równych macierzach kowariancji w obu grupach nie zostało spełnione, dlatego konieczna była próba zastosowania odmiennych podejść. Wprowadzenie jako nowej zmiennej różnicy wyników między pomiarami w obu momentach badaniach oraz włączenie początkowych pomiarów jako zmiennej towarzyszącej (*covariate*) do ogólnego modelu liniowego pomogło usunąć heteroskedastyczność i rozwiązać problem.

W artykule przedstawiono pewne szczegóły dotyczące projektu badawczego oraz dyskusję na temat metod statystycznych zastosowanych w analizie wyników eksperymentu.

## Appendix: Illustrations of the scales used in the project

a) Social Competence Scale (SCOM)

*Rate yourself according to the following characteristics. The closer you mark to a characteristic, the more it is typical of you. Rate yourself as you are, not as you would like to be.*

| | | | |
|---|---|---|---|
| 1. | Able to effectively manage activities of a small group | …*…*…*…*… | Not able to effectively manage activities of a small group |
| 2. | Assertive | …*…*…*…*… | Not assertive |
| 3. | Have little trouble being criticized | …*…*…*…*… | Bothers me a lot to be criticized |
| 4. | Self-confident in social settings | …*…*…*…*… | Not self-confident in social settings |
| 5. | Not able to express own opinions in a group of people | …*…*…*…*… | Able to express own opinions in a group of people |
| 6. | Have not good verbal skills | …*…*…*…*… | Have good verbal skills |
| 7. | Uncomfortable giving straightforward feedback to others | …*…*…*…*… | No trouble giving straightforward feedback to others |
| 8. | Able to effectively resolve conflicts to the satisfaction of both parties | …*…*…*…*… | Have difficulty to effectively resolve conflicts to the satisfaction of both parties |
| 9. | Can absorb criticism without becoming defensive | …*…*…*…*… | Become very defensive when criticized |
| 10. | Feel comfortable giving presentations or talks to the audience | …*…*…*…*… | Having great difficulty giving presentations or talks to the audience |

b) Example from the self-efficacy scale used (than item from the team work subscale)

How much can you run a group discussion in a task situation ?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not well at all | | Not too well | | Pretty well | | Very well |