A New Approach to an Achievement Motivation System for the Choice of an Engineering High School and Field of Study

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Abstract:

Achievement motivation is an important prerequisite for students' engagement, overcoming study difficulties and, ultimately, successful completion of their studies. The aim of this study is to find out the current level of performance motivation of the population of students of engineering high schools, to compare its level with the standard for high school population and to find out whether there is a relationship between its level and choice. Two questionnaires were used in the research. The first was the School Achievement Motivation Questionnaire for Pupils. The theory of achievement motivation is then based on the concept of independence of the need for successful performance and the need to avoid failure. The resulting orientation of a person in a performance situation then depends on the predominance of one or the other tendency. The second questionnaire was focused on finding personal data, questions of school choice, satisfaction with school choice and other. The research was carried out at the beginning of 2020 and the sample consisted of over 900 students. Main results of the study: First, in the component of performance motivation NACH (need to achieve) the performance motivation of the group is statistically different from the group norm. In the NAF (the need to avoid failure) component, the results are statistically identical. Second, schools do not differ in the results for the NACH component, but differ in the NAF component. Third, in both components, the value of performance motivation for beginners and for final years in both components is significantly different from other years. Fourth, the student's statement on the choice of study at an engineering school as a primary choice is not related to the values of NACH and NAF. Fifth, the level of student's achievement motivation in both components is related to the student's idea of studying.

Keywords: *Engineering High School Education, School Achievement Motivation, Need for Successful Performance, Need to Avoid Failure, Choice of School, Concept of Study*

1 Introduction

1.1 Theoretical concept

Students' achievement motivation is an important prerequisite for their engagement, overcoming study difficulties and, ultimately, successful completion of their studies. The motivation to achieve goals not only leads individuals to pursue work they perceive to be valuable, it also prompts them to compete with others [2]. This drive may come from an internal or external source. Achievement motivation is intrinsic when it is sparked by an interest or enjoyment in the task itself. It is organic to the person, not a product of external pressure. Achievement motivation can be instead extrinsic when it comes from outside the person. Common sources of extrinsic motivation among students are rewards like good marks, or praise from parents and teachers. [9]

Hustinx et al. [5] summarize the views of older authors (McClelland et al. [7]; Heckhausen [3]; and others) in the thesis: "Individuals with a high achievement motivation set standards of excellence, show clear affect in connection with evaluation of their performance, and display a high level of aspiration in terms of achievement goals" (p. 561). Hustinx et al found out by research, that achievement motivation shows a certain degree of stability, but this stability decreased to rather low values when intervals between measurements increased up to four years. Alternatively, it is possible that achievement motivation, even though it may have some characteristics of a stable trait, is a characteristic that partially depends on, and is activated by, situational factors." (p. 576)

According to research Steinmayr and Spinath [18] motivation constructs nearly explained as much unique variance in general school performance as intelligence. The achievement motivation can be treated as an important psychological predictor of graduates' future success or failure and according to McClelland and other authors it should be intentionally trained. [6]

Theories of achievement motivation have significantly evolved over the last several decades, and research grounded in these theories influences and informs teaching practices, parent involvement activities in schools, and educational interventions targeted at students, administrators, teachers, and parents. [8]

Since the 1950s, performance motivation has been in the focus of pedagogical and psychological research, which usually examines it as an independent phenomenon of the school population. For high engineering school students, motivation is also a prerequisite for obtaining professional qualifications for the professions that are usually defined by national qualifications frameworks.

1.2. Current Research on Achievement motivation of secondary school students

In all PISA countries and economies except Belgium and Switzerland, disadvantaged students have lower levels of achievement motivation than advantaged students. On average across OECD countries, immigrant students reported higher achievement motivation than non-immigrant students. Achievement motivation is positively related to performance at school and to life satisfaction. On average across OECD countries, students in the top quarter of the index of achievement motivation score 37 points higher in science and reported 0.7 point higher life satisfaction (on a scale from 0 to 10) than students in the bottom quarter of the index. [9]

Tamilselvi and Devi [19] found out in a smaller sample of 100 Indian higher secondary school students, that the achievement motivation of higher secondary school students from the selected government schools in Coimbatore District is found to be associated with the type of family they come from, whereas, their gender, subject group, locality of the school they study are not associated with their achievement motivation. Achievement motivation of the students is not associated with the level of education, occupation and annual income of their parents. Also, Pawar [11] ascertained, that male and female secondary school students were found to have same level of academic achievement motivation. The expected result was, that urban secondary school students have high level of academic achievement motivation than rural students.

For a similarly large sample of college students Shekhar and Devi [15] detected significant difference between the achievement motivation of male and female college students and between the achievement motivations among science and arts stream students. Whereas females have higher achievement motivation compared to males and science stream students have significantly higher achievement motivation (AM) compared to arts stream students. Sarangi [14] also confirms, that boys have marginally better AM than girls. In terms of the theoretical concept of AM his other results are interesting: „In case of relationship between Achievement Motivation and Academic Achievement, it is observed from the study there is no significant relationship between AM and AA (*Acadademic Achievement*) in case of tribal students and boys students. On the other hand, there is significant relationship between AM and AA in case of non-tribal students, girl-students, rural and urban students. Hence the study revealed that the achievement motivation enhances the academic achievement of the students (p. 144).

Pavlas [10] determined the level of performance motivation in a sample of 116 students from two different secondary schools, one of which was a sports grammar school and the other industrial high school, using a standardized questionnaire LMI (Leistungsmotivationsinventar), which in its current form is suitable only for counseling or research (Sedláková and Knapová [17]). He used the obtained values for a total of 17 dimensions of performance motivation (each of which is saturated with 10 items) to determine possible differences between technically oriented students and between humanities-oriented students. He found that there were statistically significant differences between these schools in the dimension of pride of performance and orientation to status in favor of students of the Sport grammar school. A statistically significant difference was found in the dimension of willingness to learn in favor of students of the Secondary Industrial School. There are no statistically significant differences in any dimension among the women of these schools. There are statistically significant differences between these schools in the willingness to learn dimension in favor of men in industrial school. Men of industrial school have a higher score of performance motivation compared to women of both types of schools in the dimension of "difficulty preference". Overall, he states that high school students are motivated on average in the overall score of performance motivation.

Poledňová, Stránská and Neidobová [13] examined the performance motivation of high school students in relation to their social position in the class. Differences between achievement motivation scores of students with different social positionsin the class (as given by the combination of influence and popularity) proved non-significant.

Bakadorova, Hoferichter and Raufelder [1] proved by comparative research, that students from both Montréal and Moscow compare their levels of achievement to the performance of their peers, which motivates them to perform better.

In six countries, Pavelková, Hrabal and Hrabal [12] found that the fear of failure to a certain extent acts as a positive motivating factor, while in a strong form it paralyzes individuals and weakens performance.

Smith and Karaman [16] notes that many studies examining performance motivation, as a predictor of performance, work with relatively small groups and provide mixed results. Therefore, they develop and validate a broad and unique achievement motivation measure consisting of 36 items assessing concept Contextual Achievement Motivation in multiple settings (School, Work, Family, and Community).

Although some studies have dealt with the performance motivation of high school students, no survey of the level of performance motivation was recorded in the population of students of secondary technical schools.

2. Own Research on Achievement Motivation of High School Students

2.1 Aim, Research Questions and Hypotheses of Study

The aim of this study is to find out the current level of performance motivation of the population of students of secondary technical schools in the Moravian-Silesian Region of Czech Republic, to compare its level with the standard for general secondary school population and to find out whether there is a relationship

between its level and choice.

The study finds answers to the following research questions:

1. Does the level of performance motivation of the research population in both components differ from the norm for the secondary school population?

2. Does the level of performance motivation of the individual schools constituting the research set differ in their two components?

3. Does the level of performance motivation in both components change with gradual years of study?

4. Is there a relationship between the performance motivation in both their components and the student's declaration of choice as a primary choice in engineering school?

5. Is there a relationship between the performance motivation in both their components and the student's declaration of conformity of the current study with the idea of it before entering school?

Hypotheses were formulated on the research questions:

H1: The level of performance motivation of the research sample in both their components is the same as the norm for the secondary school population.

H2: The level of performance motivation in both their components does not differ between the individual schools in the research set.

H3: The level of performance motivation in both of its components is higher at the beginning and end of studies compared to the other years.

H4: There is no correlation between the performance motivation in both their components and the student's declaration on the choice of study as a primary choice.

H5: The level of performance motivation in both their components and the student's declaration of conformity of the current study are related to the concept.

2.2. Methods

Two questionnaires were used in the research. The first was the School Performance Motivation Questionnaire for Pupils [4], which builds on Atkinson's approach. In his model, Atkinson unites the findings of performance motivation research and anxiety research. The theory of performance motivation is then based on the concept of independence of the need for successful performance and the need to avoid failure. The need for successful performance and the need to avoid failure are the basis of performance orientation, further consisting of the degree of attractiveness of the performance activity to individuals and the subjective probability of the expected outcome. The resulting orientation of a person in a performance situation then depends on the predominance of one or the other tendency. The second questionnaire compiled by the authors of the study was focused on finding personal data about students, questions of school choice, satisfaction with school choice and other didactic variables. The research was carried out at the beginning of 2020 and the research sample consisted of over 900 students of secondary technical schools in the Moravian-Silesian Region of the Czech Republic.

2.3. Results

The questionnaire includes 12 questions. Questions 1-6 saturate the NACH indicator (*need to achieve, need for successful performance*). Questions 7-12 saturate the NAF indicator *(the need to avoid failure, or the fear of failure)*.

Both NSP and NAF indicators are determined for each respondent as the sum of the point score for each of these indicators. The point score is called the *raw score*.

The contribution of the questionnaire item of each sub-question is the following rule to the interval scale: answer a - maximum (almost always / always / a lot, etc.) (5 points), b (4 points), c (3 points), d (2 points), e – minimal (not at all / almost never / never, etc.) (1 point).

Each respondent therefore has its own raw score value for NACH and NAF.

The NACH standard for all secondary school pupils is determined on the basis of the arithmetic average of the graw scores of all partial NACHs calculated for all respondents. Its value is 19.41.

The NAF standard for all secondary school pupils is determined on the basis of the arithmetic average of the graw scores of all partial NAFs calculated for all respondents. Its value is 18.03.

The average values of the total raw scores of NACH and NAF at individual secondary schools with a mechanical programms. (Tab. 1) are shown in Fig. 1. For reasons of data protection, these schools will be marked with the name of the city in which they are located.

The average values of the total raw scores of NACH and NAF for individual year of study (Tab. 2) are shown in Fig. 2.

Tab. 1. Total raw scores of NACH and NAF indicators for respondents by individual institutions

Mechanical high school students in the city	NACH	NAF
Frýdek–Místek	20,50	18,49
Opava I.	19,59	17,95
Opava II.	19,21	18,90
Krnov	19,00	17,54
Ostrava	18,98	17,56

Tab. 2. Total raw scores of the NACH and NAF indicators for respondents for individual year of study

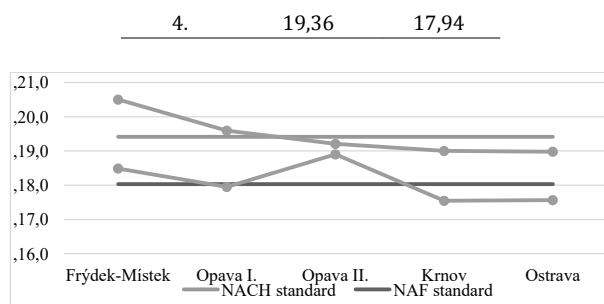| Year	NACH	NAF
1.	19,79	17,59
2.	18,97	18,42
3.	19,35	18,27

Fig. 1. Total raw scores of NACH and NAF indicators by individual institutions in comparison with NACH and NAF standards
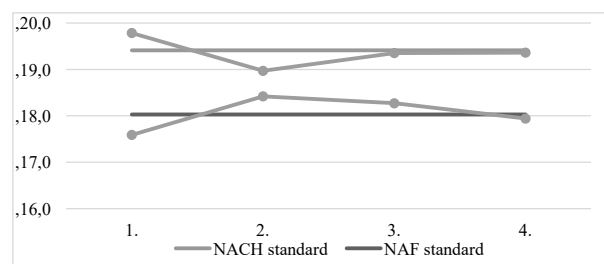

Fig. 2. Total raw scores of the NACH and NAF indicators for individual years of study in comparison with the NACH and NAF standards

The hypotheses had to be divided into part a and part b to consider the partial indicators of NACH or NAF. The hypotheses were tested using IBM Statistics version 26 software support.

Hypothesis 1*aH.* Null hypothesis about the mean value of the parameter: 1aH0: The level of performance motivation in the NACH component is statistically significantly identical to the mean value of 19.41 of the standard for the secondary school population.

Alternative hypothesis about the mean value of the parameter: 1aH1: The level of performance motivation in the NACH component is not statistically significantly identical with the mean value of 19.41 of the standard for the secondary school population.

From the p-value, determined by the mean value test, **p = 0,0010303** ** ($p < 0,05$ *, $p < 0,01$ **, $p < 0,001$ ***), it follows that at the significance level $\alpha = 0,01$, the null hypothesis is rejected in favor of the alternative hypothesis. Therefore, it is true that the level of performance motivation in the NACH component **is not statistically significantly identical** with the mean value of 19.41 of the standard for the secondary school population.

Hypothesis 1*bH.* Null hypothesis about the mean value of the parameter: 1bH0: The level of performance motivation in the NAF component is statistically significantly identical to the mean value of 18.03 of the standard for the secondary school population.

Alternative hypothesis about the mean value of the parameter: 1bH1: The level of performance motivation in the NAF component is not statistically significantly identical to the mean value of 18.03 of the standard for the secondary school population.

From the p-value, determined by the mean value test, p = 0.54736 (p> 0.05), it follows that at the level of significance $\alpha = 0.05$, the null hypothesis is not rejected. Therefore, the level of performance motivation in the NAF component **is statistically significantly identical** to the mean value of 18.03 of the standard for the secondary school population.

Hypothesis 2*aH.* Null hypothesis: 2aH0: The level of performance motivation in the NACH component is statistically significantly the same within schools.

Alternative hypothesis: 2aH1: The level of performance motivation in the NACH component is statistically significantly different within schools.

From the p-value, determined by the non-parametric Kruskal-Wallis test, p = 0.003488 ** ($p < 0.05$ *, $p < 0.01$ **, $p < 0.001$ ***), it follows that at the significance level $\alpha = 0,01$ the null hypothesis is rejected in favor of the alternative hypothesis. Therefore, the level of performance motivation in the NACH component **is statistically significantly different** within schools.

Hypothesis 2*bH.* Null hypothesis: 2bH0: The level of performance motivation in the NAF component is statistically significantly the same within schools.

Alternative hypothesis: 2bH1: The level of performance motivation in the NAF component is statistically significantly different within schools.

From the p-value, determined by the non-parametric Kruskal-Wallis test, p = 0.08841 (p> 0.05), it follows that at the significance level $\alpha = 0.05$, the null hypothesis is not rejected. Therefore, it is true that the level of performance motivation in the NAF component **is statistically significantly the same** within schools.

Hypothesis 3*aH.* Null hypothesis: 3aH0: The level of performance motivation in the component of NACH is statistically significantly identical at the beginning and at the end of the study compared to other years of study.

Alternative hypothesis: 3aH1: The level of performance motivation in the NACH component is statistically significantly higher at the beginning and at the end of the study compared to other years of study.

From the p-value, determined by the one-sided non-parametric Mann-Whitney test, p = 0.04264 * ($p < 0.05$ *, $p < 0.01$ **, $p < 0.001$ ***), it follows that at the significance level $\alpha = 0,05$ the null hypothesis is rejected in favor of the alternative hypothesis. Therefore, it is true that the level of performance motivation in the NACH component **is statistically significantly higher** at the beginning and at the end of the study compared to other years of study.

Hypothesis 3*bH.* Null hypothesis: 3bH0: The level of performance motivation in the NAF component is statistically significantly identical at the beginning and at the end of the study compared to other years of study.

Alternative hypothesis: 3bH1: The level of performance motivation in the NAF component is statisti-

cally significantly higher at the beginning and at the end of the study compared to other years of study.

The p-value, determined by the one-sided non-parametric Mann-Whitney test, p = 6.72 × 10-4 *** (p <0.05 *, p <0.01 **, p <0.001 ***), shows that at the significance level α = 0.001, the null hypothesis is rejected in favor of the alternative hypothesis. Therefore, it is true that the level of performance motivation in the NAF component is statistically significantly higher at the beginning and at the end of the study compared to other years of study.

Hypothesis 4aH. Null hypothesis: 4aH0: There is no statistically significant relationship between performance motivation in the NACH component and the student's statement on the choice of study at an engineering school as a primary choice.

Alternative hypothesis: 4aH1: There is a statistically significant relationship between performance motivation in the NACH component and the student's statement on the choice of study at an engineering school as a primary choice.

From the p-value, determined by the non-parametric Mann-Whitney test, p = 0.91791 (p> 0.05), it follows that at the significance level α = 0.05 the null hypothesis is not rejected. Therefore, it is true that **there is no statistically significant relationship** between performance motivation in the NACH component and the student's statement on the choice of study at an engineering school as a primary choice.

Hypothesis 4bH. Null hypothesis: 4bH0: There is no statistically significant relationship between performance motivation in the NAF component and the student's statement on the choice of study at an engineering as a primary choice.

Alternative hypothesis: 4bH1: There is a statistically significant relationship between performance motivation in the NAF component and the student's statement on the choice of study at an engineering school as a primary choice.

From the p-value, determined by the non-parametric Mann-Whitney test, p = 0.03917 * (p <0.05 *, p <0.01 **, p <0.001 ***), it follows that at the significance level α = 0, 05 the null hypothesis is rejected in favor of the alternative hypothesis. Therefore, there **is a statistically significant relationship** between performance motivation in the NAF component and the student's statement on the choice of study at an engineering school as a primary choice.

Hypothesis 5aH. Null hypothesis: 5aH0: There is no statistically significant relationship between performance motivation in the NACH component and the student's statement on the coincidence of current study and the idea.

Alternative hypothesis: 5aH1: There is a statistically significant relationship between performance motivation in the component of NACH and the student's statement on the coincidence of the current study and the idea.

From the p-value, determined by the non-parametric Mann-Whitney test, p = 2,157 × 10-15 *** (p <0,05 *, p <0,01 **, p <0,001 ***), it follows that at the level of significance α = 0.001, the null hypothesis is rejected in favor of the alternative hypothesis. Therefore, it is true that **there is a statistically significant relationship** between performance motivation in the NACH component and the student's statement on the coincidence of the current study and the idea.

Hypothesis 5bH. Null hypothesis: 5bH0: There is no statistically significant relationship between performance motivation in the NAF component and the student's statement on the coincidence of current study and the idea.

Alternative hypothesis: 5bH1: There is a statistically significant relationship between performance motivation in the NAF component and the student's statement on the coincidence of current study and the idea.

From the p-value, determined by the non-parametric Mann-Whitney test, p = 5.846 × 10-7 *** (p <0.05 *, p <0.01 **, p <0.001 ***), it follows that at the level of significance α = 0.001, the null hypothesis is rejected in favor of the alternative hypothesis. Therefore, it is true that **there is a statistically significant relationship** between performance motivation in the NAF component and the student's statement on the coincidence of current study and the idea.

3. Discussion

The results of our research cannot be compared with the results of other researchers, as the individual studies worked with other evaluation tools. However, they can be compared with a standardized standard for the relevant population. In this view, it is a fundamental finding that in the component of performance motivation – NACH (*need to achieve, need for successful performance*) the performance motivation of the sample is statistically different from the group norm. In the NAF indicator component (*the need to avoid failure, or the fear of failure*) the results are statistically identical. In two out of five examined schools, the school values in both components are always higher than the group standard and in three schools lower.

Schools do not differ in the results for the NACH component, but differ in the NAF component. In both components, the value of performance motivation for beginners and for final years is significantly different from other years. The effect of "novelty" and desired study is probably manifested in the first year in the highest value of performance motivation in the NACH component and the lowest value of NAF among all four years. In the second year of study, on the other hand, the lowest value of NACH and the highest of NAF turns out. With the following years, NACH rises slightly and NAF decreases. This finding probably explains the students' interest in successfully completing their studies and entering practice with the acquired qualification or continuing their university studies.

It has not been confirmed that the student's statement on the choice of study at an engineering school as a primary choice is related to the values of NACH and NAF. This could be explained by the lack of prefer-

ence for secondary technical studies or by the standard quality of basic education, which allows a wider choice of fields of secondary education for graduates of basic education. On the other hand, if this link were to be confirmed, it would mean that teachers would pay increased attention to pupils for whom secondary mechanical school was another professional choice and are not intrinsically motivated to adequate school performance.

It was confirmed that there is a statistically significant relationship between performance motivation in the NACH performance motivation component and also in the NAF component with the student's declaration of the coinciding of the current study with the idea of it. This would testify in favor of the system of professional orientation of youth, resp. also in favor of the care of parents for the professional choice of children, which provide those interested in studying at secondary schools with information about the field and its study, which are then confirmed by the pupils' educational practice.

4. Conclusion

Engineering production in developed countries has a great perspective in the era of Industry 4.0 and faces a shortage of skilled labor. The work of secondary school teachers with the results of their students' performance motivation measurement could positively influence not only the updating and modification of the curriculum, but also the methods used in the theoretical and practical component of their vocational training. It is very important to lead pupils and students to find a positive form of adaptation to the social environment, to strengthen motivation that is related to the diverse focus of human activity, such as technical study. It is possible to develop pupils' motivation for technical studies by updating (awakening) their needs (cognitive, performance, social). Pupils' cognitive needs can be developed by problem tasks in the field of technical everyday reality. It is appropriate to support project teaching, in which there is enough space for problem-based teaching, manual competition, programmed learning, creative tasks, research activities (technical experiments), brainstorming discussions and sharing examples of good technically oriented everyday practice.

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