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## **The image of a vocational school teacher in the eyes of students and its relationship with the effectiveness of education**

**Wizerunek nauczyciela szkoły zawodowej w oczach uczniów i jego związek z efektywnością kształcenia**

**Abstract:** The article discusses the competencies of vocational education teachers, as well as discusses the results of own research, which aimed to determine three types of teachers conceptualized by students – the most liked, the least liked, and the dream one.

The research used the interview method, where the research technique was an interview, and the research tool was an interview questionnaire. The students' statements were analyzed using the Python Natural Language Toolkit used for natural language processing. In this way, the most common words used by students in describing teachers were selected. As a result, the personal qualities and pedagogical competencies of mechatronic teachers that students approve and disapprove of, as well as those that they lack and which would make a difference to the effectiveness of education, were identified.

**Keywords:** vocational education, vocational teacher, effective teaching, Natural Language Processing, sentiment analysis, machine learning.

## **Introduction**

The expectations of teachers in Poland have significantly changed due to social and political transformations, as well as educational reform. Much bigger attention is now paid to their substantive preparation, knowledge about the latest news connected to their teaching field, and the willingness to self-develop. They should also be skilled in didactics, i.e. conducting lessons that are attractive and engaging for teenage learners, developing knowledge and acquiring new skills in order to construct meanings through personal and social experiences, as well as arranging learning environments in such a way that students know *how to learn*. Teachers are expected to have personal qualities allowing them to shape authentic interpersonal relations with the people in their care and introduce democratic and fair rules of classroom interactions. They are also required to trust their students' abilities to learn and to set high expectations of them, so as not to limit their possibilities to acquire knowledge. Every teacher should demonstrate various social, interpersonal and team skills, responsibility for the quality of their work, efficient methods of developing critical thinking and problem solving, as well as the willingness to help students become independent, self-regulatory beings.

## **The vocational school teacher in the light of selected literature**

Vast studies concerning vocational school teachers have been carried out in Poland (Nowacki & Nowak, 1974; Szlosek, 2014, 1988, 1987; Wiatrowski, 1993, 1989, 1987). The first classifications of such teachers were the result of the research conducted in 1970s. Tadeusz Nowacki (1974) proposed then a teacher classification that included the following criteria: the criterion of the organisational level of the educational institution, the criterion of division according to school subjects and the criterion of vocational training course.

In his study Franciszek Szlosek (1987) noticed a correlation between a teacher's educational and pedagogical background and the mastering of the vocational curriculum by the students. The research was based on observations of the teachers of theoretical vocational subjects during lessons in mechanical schools, as well as on the analysis of the material included in the questions and the answers of a test prepared by the same teachers. Teachers' professional qualifications influence the efficiency of their work, and, consequently, the efficiency of the school. Teachers of theoretical vocational subject, apart from educational background, should have appropriate ideological, moral and professional qualifications, and be generally prepared to understand the surrounding reality, participate in cultural life, as well as be able to develop their and their students' personality comprehensively.

Teachers of theoretical vocational subjects and teachers of practical vocational training should be a unified group and its representatives should have a master's degree.

Zygmunt Wiatrowski (1993) had a similar opinion on that note. He postulated creating a group of teachers of vocational subjects, or teachers of vocational training, and then divided them further into teachers who are predominantly prepared to teach either vocational theory or vocational practice, as they are not equally skilled in teaching both types of classes. He also designed the characteristics of qualifications of a vocational subjects teacher. According to him teachers should have professional preparation (moral and civic education), general preparation (knowledge, general skills allowing to function in a society), technical preparation (pertinent to the school subject they teach, including knowledge, skills, habits and professional abilities), and pedagogical preparation (guaranteeing appropriate and efficient activity). A teacher should be physically fit and have a neat appearance, as well as the following features and personality qualities: qualities that refer to an individual's approach to tasks (diligence, responsibility, ambition, etc.), qualities related to interpersonal relations in the workplace (discipline, companionship, honesty, etc.) and qualities related to working conditions (resistance to stress, pace, appropriate system of work, etc.) (Wiatrowski, 1993, p. 243). In Z. Wiatrowski's view teachers are also expected to be both demanding and understanding, strict and kind, as well as fair in their relations with students. Moreover, they are supposed to respect their own and their students' dignity, and strive for self-development and professional development, which will in turn influence the development of their teaching career.

In the economy based on knowledge and in the constantly changing society the skills that play a key role are problem-solving, (creative, computational and critical) thinking and the ability to cooperate and self-regulate. Teaching staff should constantly take action to self-develop, improve their knowledge concerning methods and grading tools, introduce new and innovative ways of teaching and learning, acquire key competences needed for self-development, employment, social inclusion, balanced lifestyle, acceptable life in peaceful societies and being an active citizen (European Commission, 2018). Therefore, there is a growing need to participate in extracurricular forms of vocational education, which are becoming more significant due to political, social and economic changes. The results of a study carried out by Ryszard Gerlach (1997) explicitly show the requirement of professional teaching staff that would have high subject and pedagogical qualifications in extracurricular education. Gerlach also

enumerates areas that need improvement, which would assure a better condition of vocational education.

### **Methods**

The aim of the study was to determine three types of teachers of mechatronic subjects (i.e.: the most popular teacher and the least popular teacher who teaches their profession, as well as the ideal, dream teacher who they would like to teach their profession) functioning in the opinion of students. The research problem was to define the teacher's image in the eyes of students and to determine its relationship with the effectiveness of education.

The intention of the authors was to check the personality and pedagogical competences of teachers preparing students for the profession of "mechatronics technician" in one of the Warsaw technical schools. Our intention was to learn the most frequently used concepts appearing in students' statements, which are used to create the image of the most or least liked and ideal teacher, as well as the aspects of teachers' work affecting the effectiveness of learning of the participants of the educational and didactic process, i.e. students.

Therefore, it is very important to answer the questions about the personal characteristics and pedagogical competences of a teacher teaching vocational subjects (which of them are highly valued and which are the least desired by the respondents). The following research questions were formulated in the own research:

What are the qualities of a teacher of vocational subjects teaching in a technical school educating in the profession of a mechatronics technician? What is the personality of the mechatronics teacher (most liked, least liked and ideal)? What pedagogical competences does a teacher of mechatronics subjects have? What are the differences between the most liked, least liked, and ideal mechatronics teacher?

The results of the research and their analysis will allow to obtain reliable data showing the recognition of the current expectations of students towards teachers of mechatronics subjects. They will make it possible to get to know the personal characteristics of teachers, their ability to use professional knowledge in direct contacts with students during classes, the level of teacher's methodological preparation, incl. the ability to explain the content of lessons, motivating students to learn, attractiveness of the classes.

The research used the interview method, where the technique was an interview and the research instrument was an interview questionnaire. The research sample was non-random, purposive and amounted to N=91. In one of the technical schools in Warsaw educating mechatronics technicians,

a written consent was obtained from the school's headmaster to conduct the research. Subsequently, students and parents of underage students were asked to give their written consent to participate in the research, which was voluntary and anonymous and it was possible at any time to decide to withdraw from the research without suffering any consequences. All students who consented to the study participated in the research. An additional criterion, however, was attending the second, third or fourth grade. The authors of the article assumed that they would obtain substantive statements from students of older grades. Out of all grades, ie four second grades, one third grade and one fourth grade, totaling 163 students, 91 students participated in the study. The study was carried out in the school year 2020/2021.

Mechatronics technician is the profession of the future, as it is a merge of mechanics, electronics and information technology, which are the most modern branches of the industry 4.0. Each student in this school is prepared to build and utilize different systems of industrial automatics, robotics, as well as intelligent service and production systems (*The Ordinance of Ministry of National Education of the Republic of Poland from May 16<sup>th</sup> 2019*).

The data obtained from the survey has been pre-processed. They were cleared of unnecessary words and meaningless statements. Then adjectives, including comparative and superlative adjectives, were selected from the set of words.

The speech tagging is the one of the more powerful aspects of the natural language processing module in Python Natural Language Toolkit. It is capable to label words in a sentence as nouns, adjectives, verbs...etc. But it can also label them by tense, and more. In this case selected words were labeled as: 'JJ' – adjectives (e.g. 'big'), 'JJR' – comparative adjectives (e.g. 'bigger'), and 'JJS' – superlative adjectives (e.g. 'biggest'). The Python code for the speech tagging is presented below.

```
import pandas as pd
import nltk
from wordcloud import WordCloud, STOPWORDS
import matplotlib.pyplot as plt
import numpy as np
from PIL import Image

# load data
processed_filename = "data_prepared.xlsx"
sheet_name = "Form Responses 1"

df = pd.read_excel(processed_filename, sheet_name=sheet_name)

header_most_liked = 'most_liked'
header_least_liked = 'least_liked'
header_ideal = 'header_ideal'

most_liked_list = df[header_most_liked].to_list()
least_liked_list = df[header_least_liked].to_list()
ideal_list = df[header_ideal].to_list()

def get_adjectives(phrases):
    adjective_tags = ["JJ", "JJR", "JJS"]

    words = []

    for e1 in phrases:
        adjs = filter(lambda w: w[1] in adjective_tags,
                      nltk.pos_tag(nltk.word_tokenize(e1)))
        for adj in adjs:
            words.append(adj[0].lower())

    return words
```

Code 1. Preliminary data processing

## Results and discussion

In this way, the most common words used to describe the worst, the best and the ideal teachers were identified. These words were analyzed for frequency in occurrence in the teacher descriptions prepared by students (see graphs in Figure 1, Figure 2, and Figure 3).

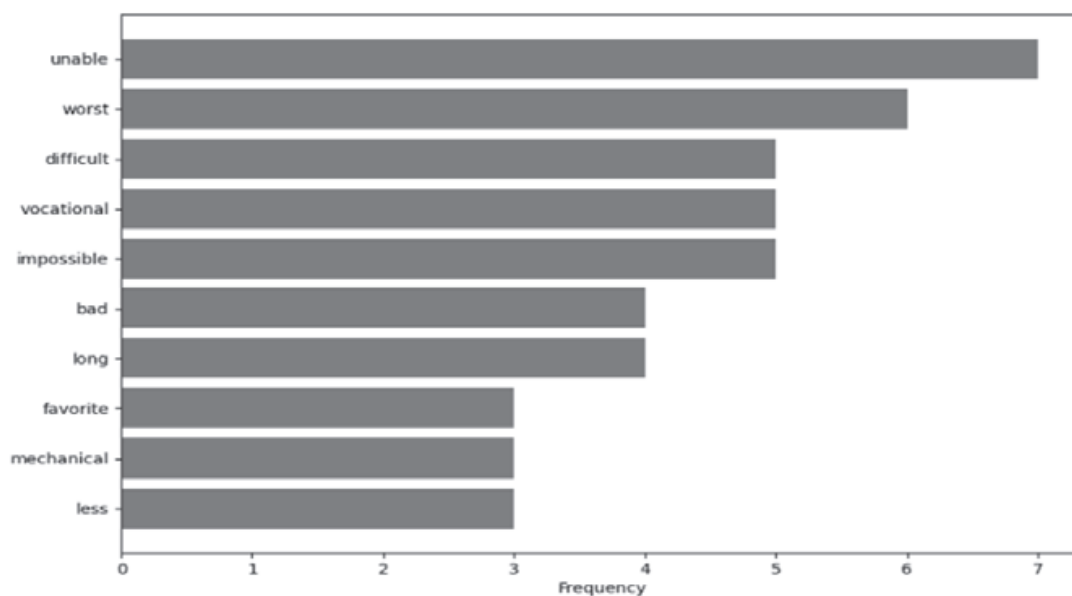


Figure 1. Ranking of words that describe the least-liked teacher

While describing their least favourite teacher, the students of technical secondary school used two expressions most frequently: *unable* (this word occurred 7 times in all of the students' utterances) and *worst* (noted 6 times in all of the utterances). The expressions *difficult*, *vocational* and *impossible* came third (they were noted 5 times in all of the students' utterances). The less frequently noted expressions were: *bad* and *long* (appeared 4 times in all of the students' utterances), as well as *favourite*, *mechanical* and *less* (three times in in all of the students' utterances). In the students' view the least popular teacher is unable to self-reflect, emphatically understand people in their care, implement appropriate leadership or creative ideas, develop own competences, act effectively through appropriate planning of pedagogical activities and controlling and assessing student's work, or use appropriate means to create conditions allowing for goal achievement. According to students, this kind of teacher discourages them from learning, even if they feel enthusiastic about the subject itself (the subject taught in later years). The students stress that they have chosen their education path consciously and the profession of mechatronics technician is their passion and favourite job. They don't want to be taught by a teacher who must be convinced (by them) to eliminate some elements not corresponding to their needs and expectations from the lesson, e.g. dictating some content from a textbook, or basing on examples from some other field while explaining phenomena and terms connected to mechatronics. They lose hope that the way the lessons are conducted can be modified. As a result, it's difficult for them to acquire professional knowledge and skills necessary to do their job. They are troubled by the fact that such a teacher doesn't inform them of the latest news in their

profession. The lessons are perceived as boring and endless and the students consider them a waste of their precious time.

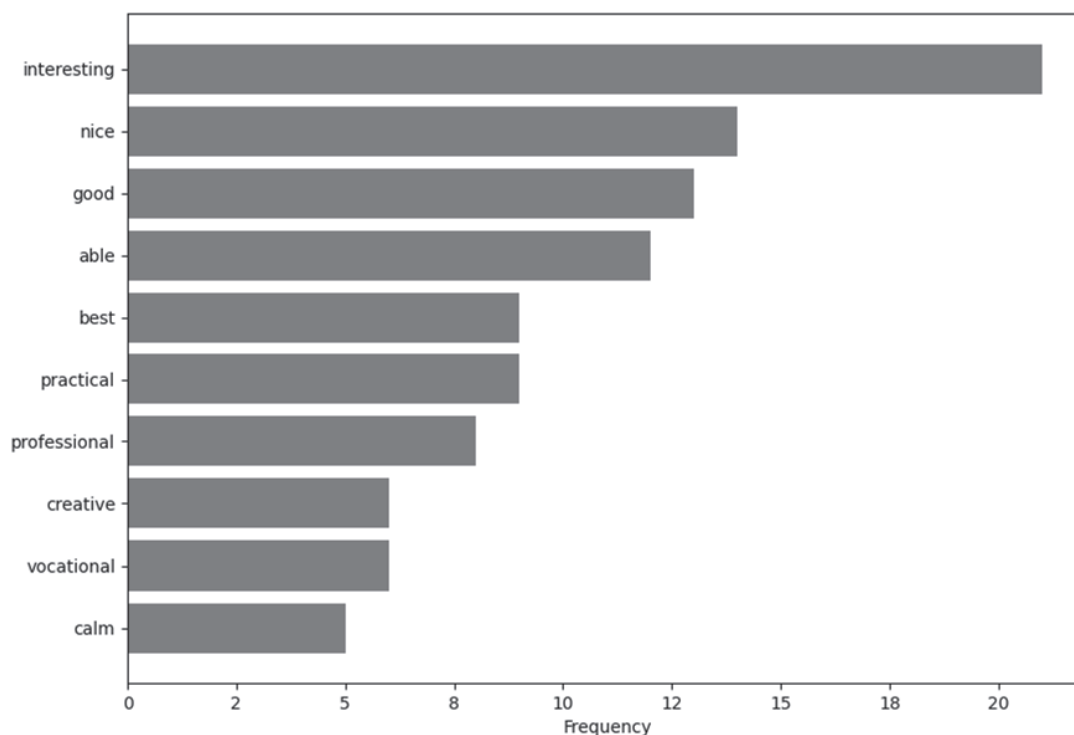


Figure 2. Ranking of words that describe the most-liked teacher

The dominant expression in written utterances concerning the most popular teacher of mechatronics subjects was *interesting* (this word appeared more than 20 times in all of the respondents' utterances). A little less frequent expressions were *nice* and *good* (they were used more than 12 times in all of the respondents' utterances), as well as *able* (it was used 12 times in all of the respondents' utterances). Other expressions frequently appearing in the students' opinions of this kind of teacher were: *best*, *practical*, *professional*, *creative* and *vocational* (they were used more than 5 times in all of the respondents' utterances), as well as *calm* (it was used 5 times in all of the respondents' utterances).

For the surveyed students the popular teacher shares the secrets of their profession in an attractive way and motivates them to act and become self-regulatory individuals. Such teachers are efficient in terms of planning, organising, supervising and assessing educational processes. Their behaviour aids active participation of students in the educational process and they care about students' versatile development. They are kind, friendly, patient and creative, as well as substantively prepared to teach the profession of mechatronics technician. Students appreciate full professionalism, knowledge in the mechatronics field, charisma, the choice of appropriate teaching methods



that guarantee the achievement of specific aims and the development of emotional bonds between teacher and students. According to students, the most popular teacher knows what and how to teach, can explain the most complicated professional topics, makes students aware of the usefulness and the application of theoretical knowledge in practice, and gives them the opportunity to practise such a practical usage.

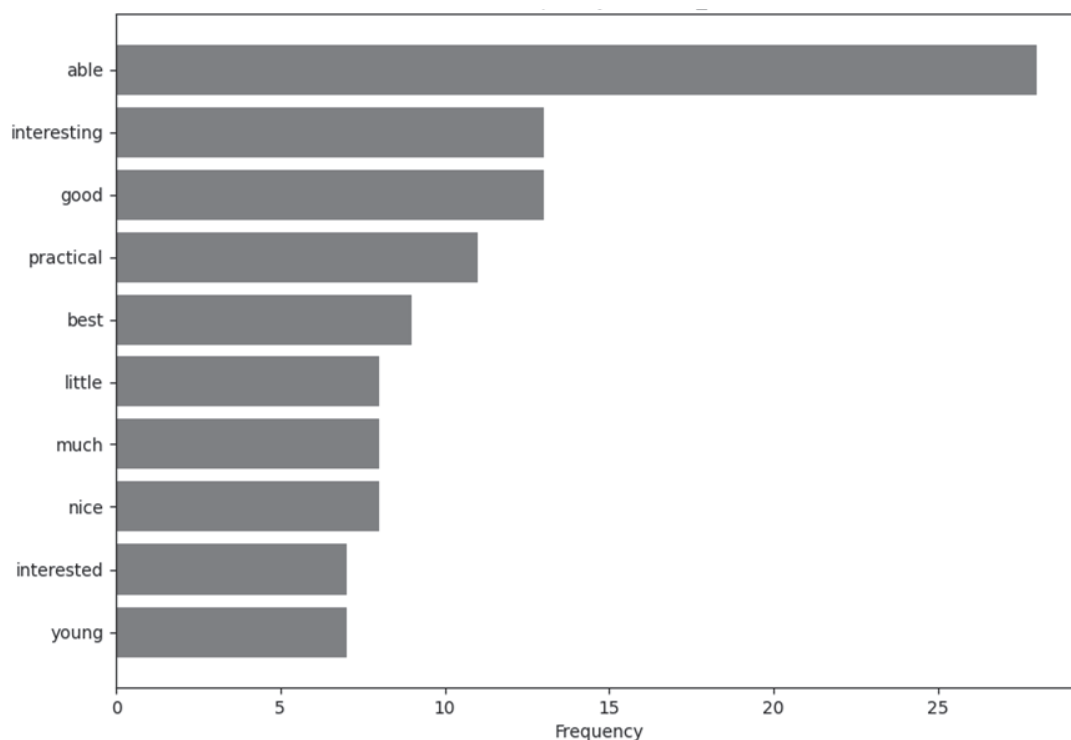


Figure 3. Ranking of words that describe the ideal teacher

In students' written surveys concerning an ideal teacher, who they would like to be taught mechatronics technician profession by, the expression that was used significantly more frequently than other ones was *able* (it occurred more than 25 times in all of the students' utterances). Other expressions used frequently to describe an ideal teacher included: *interesting*, *good*, *practical* (they occurred more than 10 times in all of the students' utterances), *best*, *little*, *much*, *nice*, *interested* and *young* (they occurred more than 5 times in all of the students' utterances).

The results of the study indicate explicitly that in an ideal teacher students value the ability to gain their favour by sharing the up-to-date knowledge and skills in the mechatronics field with them (both of which they will be able to apply later in their work). They also appreciate it when such a teacher prepares them for the life based on continuous increase of knowledge and its changeability, which, as a result, will allow them to complete changeable professional tasks in the future. The ideal teacher is good,

kind and can arouse interest in the subject. The age of such a teacher is also significant, as, according to the surveyed students, they prefer lessons with a young person. At the same time the expressions they use clearly indicate that they have an image of an ideal teacher and they can show differences between this image and the teachers that actually teach them (both the most and the least popular ones). The ideal teacher is described by the means of either superlative forms: *the best, the kindest, the most honest, the wisest* etc., or comparative forms to show how he or she should be different from the real vocational teachers, eg. *(s)he would assign less homework, (s)he would teach in a more pleasurable way than learning by heart, (s)he would command respect and maybe a little fear (so that every student behaves politely and tactfully), (s)he would be able to maintain order during the lesson; (s)he would have the knowledge concerning the subject they teach (mechatronics would be his/her hobby); (s)he would know what may interest a student... there are tens of such qualities and the best (the most popular) teachers I remember were surely not ideal, but they had a lot of these qualities in moderation.*

Then, the *Wordcloud in Python* library was used (Mueller, 2021) to generate maps of the most popular adjectives for each of the teacher categories.

A word cloud is useful to visualize uncoded text responses and questions with too many categories to conveniently show in a bar chart or a table. The area taken by each word or category is proportional to the number of respondents giving that answer (Kessler, 2021).

The library by Andreas Mueller can produce a number of different word-cloud visualizations and is based on the Python coding language.

Examples of 'word clouds' generated using the library described above are shown in Figure 4, Figure 5, and Figure 6 below.



Figure 4. The wordcloud describing the most-liked teacher





```
# sentiment labels
least_liked = 0
most_liked = 1
ideal = 2

for el in most_liked_list:
    data.append({"text": el, "sentiment": most_liked})

for el in least_liked_list:
    data.append({"text": el, "sentiment": least_liked})

for el in ideal_list:
    data.append({"text": el, "sentiment": ideal})

df = pd.DataFrame(data)
```

Code 2. Prediction model preparation

The Naive Bayes classifier implemented by the ‘scikit-learn’ library in Python was then used to prepare the machine learning models. The term frequency-inverse document frequency (TF-IDF) method was used (Salton, Fox, Wu, 1983; Salton & Buckley 1988; Wu, Luk, Wong, Kwok, 2008; Manning, Raghavan, Schutze, 2009; Robertson, 2004; Aizawa, 2003; Beel, Langer, Gipp, 2017; Seki, 2003) with parameters of 70% for training phrases and 30% for testing phrases.

The TF-IDF weight is a statistical measure used to evaluate how important a word is to a document in a collection or corpus. The importance increases proportionally to the number of times a word appears in the document but is offset by the frequency of the word in the corpus.

The TF-IDF weight is composed by two terms: the first computes the normalized Term Frequency (TF) – the number of times a word appears in a document, divided by the total number of words in that document; the second term is the Inverse Document Frequency (IDF), computed as the logarithm of the number of the documents in the corpus divided by the number of documents where the specific term appears (Seki, 2003).

The correctness of the results obtained using this method was 0.634. The source code for the Python calculations is presented below.

```
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import CountVectorizer
from nltk.tokenize import RegexpTokenizer
import matplotlib.pyplot as plt

from sklearn.naive_bayes import MultinomialNB
from sklearn import metrics

# tokenizer to remove unwanted elements from our data like symbols and numbers
token = RegexpTokenizer(r'[a-zA-Z0-9]+')
cv = CountVectorizer(lowercase=True,
                    stop_words='english',
                    ngram_range=(1, 1),
                    tokenizer=token.tokenize)
text_counts = cv.fit_transform(df['text'])

X_train, X_test, y_train, y_test = train_test_split(text_counts,
                                                    df['sentiment'],
                                                    test_size=0.3,
                                                    random_state=1)

clf = MultinomialNB().fit(X_train, y_train)
predicted = clf.predict(X_test)
print("MultinomialNB Accuracy:", metrics.accuracy_score(y_test, predicted))
```

Code 3. Machine Learning model preparation

Another analysis performed on the data was the term associations. It was then visualized using the Python Scattertext library. The Scattertext is a tool for finding distinguishing terms in corpora, and presenting them in an interactive, HTML scatter plot. Points corresponding to terms are selectively labeled.

In the example below the Scattertext is used to create visualize terms used to describe the least liked teacher and the ideal teacher. The unigrams are displayed as points in the scatter plot. Their x – and y – axes are the dense ranks of their usage to describe the least liked and the ideal teacher respectively.

The Python code is shown below, and the result plot is shown in Figure 7.

```
import scattertext as st
import en_core_web_sm
import pandas as pd

# load data
processed_filename = "data_prepared.xlsx"
sheet_name = "Form Responses 1"

df = pd.read_excel(processed_filename, sheet_name=sheet_name)

header_most_liked = 'most_liked'
header_least_liked = 'least_liked'
header_ideal = 'header_ideal'
most_liked_list = df[header_most_liked].to_list()
least_liked_list = df[header_least_liked].to_list()
ideal_list = df[header_ideal].to_list()

data = []

# sentiment labels
least_liked = 'least liked'
most_liked = 'most liked'
ideal = 'ideal'

for el in most_liked_list:
    data.append({"text": el, "sentiment": most_liked})
for el in least_liked_list:
    data.append({"text": el, "sentiment": least_liked})
for el in ideal_list:
    data.append({"text": el, "sentiment": ideal})

df = pd.DataFrame(data)
nlp = en_core_web_sm.load()
corpus = st.CorpusFromPandas(df,
                             category_col='sentiment',
                             text_col='text',
                             nlp=nlp).build().remove_terms(ENGLISH_STOP_WORDS,
                                                            ignore_absences=True)

html = st.produce_scattertext_explorer(corpus,
                                       category='ideal',
                                       category_name='Ideal',
                                       not_category_name='Least liked',
                                       width_in_pixels=500,
                                       height_in_pixels=600,
                                       metadata=df['text'])

open("5_Convention-Visualization.html", 'wb').write(html.encode('utf-8'))
```

Code 4. Visualizing term associations



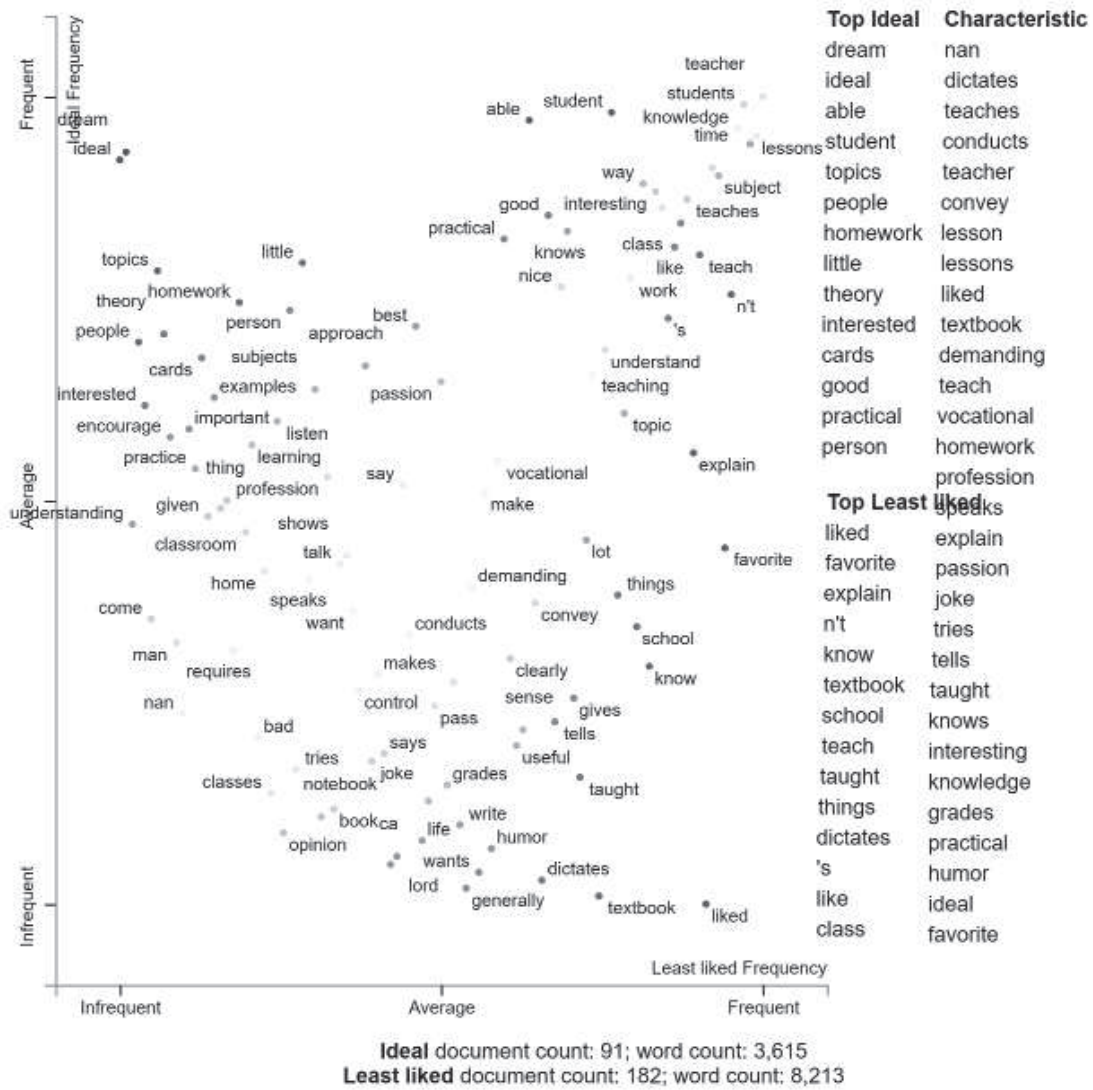


Figure 7. Convention visualization

The closer a word is to the upper-left corner, the more it describes the ideal teacher. The closer a word is to the lower-right corner, the more it describes the least-liked teacher. The words that are used both to describe the worst and ideal teacher are in the top right-hand corner. They are neutral and they refer to the educational process, e.g. *teacher*, *student*, *student's knowledge*, *lesson*. The most characteristic utterances concerning the description of the least popular teacher refer to a reproductive model of working with students and the necessity to memorize the content of a textbook that is dictated by the teacher. The ideal teacher, on the other hand, is a passionate person who can listen to students and react to what they say in an appropriate way, can teach the ability to assume responsibility for the decisions taken, aids crossing each student's own limits but in a way that is adapted to their abilities and is not forced, as well as gives them the feeling of perpetration.

## Conclusion

As a result of the study, the most popular terms used by students to describe the three types of teachers of mechatronics subjects were identified. Consequently, it was possible to define the personal qualities and pedagogical competence of vocational school teachers in the opinion of students, to determine the direction in which teachers of vocational subjects should move in order to be appreciated by their students and fully prepare them for life in a knowledge society, as well as to indicate which characteristics of teachers the students do not accept.

The question whether students will acquire general and professional competences on an appropriate level depends largely on the teacher and their approach to students, which results from their character and pedagogical abilities (Pardej, 2021).

General competences are counted among the basic effects of learning in general education, whereas professional competences are shaped to achieve more pragmatic aims, which are related to future professional work (Nowacki, 2004; Okoń, 2001). S. M. Kwiatkowski claims that the common core of general and professional competences, between which he notices a growing integration, should include „a preparation to life and creative work in a democratic country; moulding of broadly understood nationwide abilities (common for occupational groups) enabling job change; gaining and transforming technical abilities (according to technological changes); using interpersonal skills in the process of communication; searching, collecting, processing and protecting data; supporting attitudes that aid life-long learning” (Kwiatkowski, 2012, s. 41).

Needs, expectations and requirements of the participants of the educational process change along with the development of civilization. Young people who start vocational training are full of energy and willingness to discover the tricks of the trade. They are most willing to commune with teachers who have a positive attitude towards them, but are demanding and can discipline the class at the same time. The question whether they will continue to be passionate about the profession is largely dependent on both the teacher of theoretical vocational subjects and the teacher of practical vocational subjects. Each teacher eligible to teach should constantly self-develop and improve their qualifications in order to teach students more efficiently. Students expect their teachers to treat them as valuable participants of the educational process. They also appreciate the effort of teachers and they are willing to tell about the ones who made a positive impact on their professional lives, prepared them to do their job well, to act unconventionally and

to be open to the new in their profession. Organising classes in a way that facilitates learning will definitely make both teachers and students look back with a smile to the time spent together.

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