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PEER REVIEWED ARTICLE

Does academia disfavor contextual and extraverted students?

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ABSTRACT

In a study conducted at the Norwegian University of Life Sciences (NMBU), 288 students volunteered to answer an electronic questionnaire constructed to classify their personality type (16 categories), their work habits and preferences, operational values and preferred direction (leadership). In addition, examination grades from nine undergraduate subjects, some mathematical and some non-mathematical, were obtained for the same students. Statistical analyses revealed a clear connection between grades and certain personality characteristics. This should by no means be interpreted as differences in skills, but rather as an indication of biased teaching style and pedagogical structure in the university. The results across all the nine subjects show that the traditional teaching structure in universities with lectures in large auditoriums with limited dialogue, a rigid and structured curriculum, textbook reading and paper-and-pencil tests, clearly disfavours students who can be characterized as extraverted and contextual/relational, and to some extent also those who are intuitive and feeling. Among these students, we typically find those who are altruistic, creative and out-of-the box thinkers. It is suggestive that academia, probably to a large extent, fails to bring such resourceful people to positions where their talents can really make a difference, for instance in research.

Keywords

personality, myers-briggs, big five, exam performance, pedagogics, biased teaching style.


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SAMMENDRAG

I en studie utført ved Norges Miljø- og Biovitenskapelige Universitet (NMBU) fylte 288 studenter frivillig ut et elektronisk spørreskjema for å kartlegge deres personlighetstype (16 typer), deres arbeidsvaner og -preferanser, operative verdier og foretrukket ledelse. I tillegg ble det gitt tilgang til eksamenskarakterer for ni lavere grads kurs, noen matematiske og noen ikke-matematiske, for de samme studentene. Statistiske analyser viste en klar sammenheng mellom eksamenskarakterer og noen av personlighetsvariablene. Dette bør ikke tolkes dithen at det skyldes forskjeller i evner, men heller som en indikasjon på at undervisningsstilen og den pedagogiske strukturen favoriserer enkelte framfor andre. Resultatene viser på tvers av fagene at den tradisjonelle undervisningsformen med forelesninger i store auditorier med lite dialog, et fast og strukturert pensum, lærebokstudier og tekstoppgaver klart er i disfavør av studenter som kan karakteriseres som ekstroverte og kontekstuelle/ relasjonsorienterte, og til en viss grad også de som er intuitive og «feeling». Blant disse studentene finner vi typisk de som kan sies å være altruistiske, kreative og som «tenker utenfor boksen». Det er tankevekkende at akademia antagelig i stor grad mislykkes med å bringe slike ressurssterke personer fram til posisjoner, for eksempel innen forskning, hvor de virkelig kan gjøre en forskjell.

Nøkkelord

personlighet, Myers-Briggs, big five, eksamensresultat, pedagogikk, favoriserende undervisningsform.

INTRODUCTION

In the fall of 2014, approximately 1,400 students at the Norwegian University of Life Sciences (NMBU) were given the opportunity to do an online questionnaire developed by Brovold & Valeur (see Brovold, 2014). The questionnaire was developed as a tool for screening personality type and preferences with regard to work, work (study) habits, operational values and preferred direction (both self- and instructional direction). The personality test is a multi-factor model, which includes the factors similar to the Myers-Briggs four-factor model (Myers & Myers, 1980), in the manner that the test persons are categorized into 16 main types; but also underlying continuous scores along five personality variables are obtained in the same manner as another frequently used personality test, the Big Five (five-factor model) (Goldberg, 1981). In total, 288 students completed the questionnaire.

In addition, exam grade information was obtained for the same tested students in nine subjects, some purely mathematical and some non-mathematical subjects. The subjects were all at an undergraduate level at the university with typically a large number of students (50–300).

The purpose of this study was: (1) to get an overview of the distribution of personality types among the students at NMBU, (2) to analyze exam grading data as a function of personality information, and (3) to reflect upon the results so as to give pedagogical recommendations on how to reach groups of students who are potentially disfavored by the way courses are taught today. Our focus regarding the latter points was mainly the mathematical courses, since the problem of how to deal with math anxiety is of increasing interest, as well as the problem of procrastination in study subjects demanding a steady progress or even an accumulation of the curriculum.

Before this study was conducted, some hypotheses were formulated on the basis of previous findings in literature. Both Myers and Myers (1980) and Lawrence (1993) give insight into how information about personality type can be taken into account in education, and in an extensive study, Brovold (2014) shows relations between personality type and preferences with regard to work (study) habits, operational values and how persons would like to receive direction (guidance) and whether they prefer self-direction or help with study sequencing/structure. Based on these references, we anticipated the following findings:

- 1 Due to the abstraction level of mathematical subjects, students with logical-rational and intuitive type personalities should score best on exams at university level mathematics courses.
- 2 The teaching structure in mathematics at universities, with typically large class lectures, well-structured curriculum, textbook reading and paper-and-pencil exams, should favor students characterized as introvert, logic/rational, and what Brovold (2014) refers to as digital/instrumental and sequential order thinkers. Students who are extraverts, the feeling (value/rational) types and contextual/relational thinkers should statistically be disfavored by the rigid course structure with lack of autonomy, lack of personal relevance, and also by the lack of dialogue process with the teacher.

METHODS AND DATA

Personality test and data

In order to obtain the personality type and preference data, a questionnaire containing in total 300 multiple-choice questions was used. A sub-section of these questions measures personality along five continuous traits, also known as the Big Five (Goldberg, 1981): Conscientiousness (J/P), extraversion (E/I) agreeableness (F/T), openness (N/S), and neuroticism. The extremes of the first four mentioned traits correspond to the type preference dichotomies developed by Briggs Myers (1980) from the theory of Carl Jung (1921) in this order: the Judgement (J) vs Perception (P) preference, the Extraversion (E) vs Introversion (I) preference, the Feeling (F) vs Thinking (T) preference, and the iNtuitive (N) vs Sensing (S) preference. In this study we will use the con-

tinuous measures of the Big Five in the statistical analyses, but use the Briggs Myers dichotomies extensively in the discussion of the results. The J/P preference corresponds to the Digital (D) vs Contextual (C) notation used by Brovold (2014). Since the D/C interpretation of the conscientiousness trait fits better in the pedagogic discussion of this paper, we will use the D/C dichotomy throughout. A person who has the different types may briefly be described as follows:

D (Digital): Prefers to have worked out plans, builds up understanding by first understanding the parts (bottom-up thinking), and usually good at getting things done in due time.

C (Contextual): Likes to be flexible with regard to how and when to reach a preset goal, often procrastinating as an effect of the need for more background information in respect to finding a relation or a big picture which gives the parts a meaningful context (top-down thinking).

E (Extravert): Mainly interested in the outer world of things, often acts before/while thinking, and likes to communicate and interact with others and to work in groups.

I (Introvert): Mainly interested in the inner world of concepts and ideas, thinks before acting, and likes to work individually.

F (Feeling): Tends to make decisions based on their values rather than pure logic, is often empathetic, and strives to create a warm, personal and friendly environment.

T (Thinking): Tends to make decisions based on pure logic and theories rather than values, and may seem impersonal.

S (Sensing): Makes perception mainly through the senses, and is fact oriented and down-to-earth (often classified as a bottom-up attention).

N (iNtuitive): Tends to perceive the world indirectly through the unconscious, associations and “reading between the lines” (often classified as a top-down attention).

In addition to the type dichotomies and the neuroticism trait, a number of preferences regarding work habits, work interests and areas of motivation, emotions, operational values and preferred (self-) direction were measured in addition to sub-facets of the Big Five model (McCrae & Costa, 2003). Brovold (2014) found a clear connection between the personality types and these preferences, and this will be a valuable asset to the type information in order to understand why certain students score higher than others on different exams. Both the personality traits and the preferences are therefore used as explanatory variables in the statistical analyses described below.

Subjects and exam scores

Exam grades were transferred to numerical values as follows: A=6, B=5, C=4, D=3, E=2, F/drop-out=1. Hence, for all results presented in the following, a positive numerical effect of any predictor variable corresponds to an expected better grade on exams. The subjects are all lectured in a traditional way with common lectures in an auditorium, followed up by exercise groups (where student interaction is optional) and a written exam. The subjects are presented in Table 1. The subjects vary in the level of abstraction as measured in mathematical content. The level of mathematical difficulty is more or less decreasing from the top to the bottom of the table. The calculus subjects are the most demanding theoretically, whereas MATH100 and STAT100 are taught with more emphasis on automating methods, understanding and interpretation. The two economics courses and general chemistry use simple mathematics as a tool for computation, while no mathematics is used in the two latter subjects. The grade data are used as response variables in the statistical analyses presented here.

TABLE 1: List of subjects included in the study with the corresponding number of students who completed the personality test and for whom exam grade information is available.

Subject code	Subject	Number tested
MATH112	Calculus 2	56
MATH111	Calculus 1	75
MATH100	Introductory Mathematics	198
STAT100	Statistics	180
ECN110	Introduction to Microeconomics	80
BUS100	Cost Accounting, Fundamentals	67
KJM100	General Chemistry	116
AOS230	The Psychology of Organization and Leadership	23
PHI100	Examen Philosophicum	192

Statistical analysis

The data were analyzed using subject specific univariate analysis, where the differences in mean grade within type dichotomies were tested by standard two-sample *t*-tests. For instance, tests were performed to check for a significant difference between Digital (sequential/detailed) or D students and Contextual (relational/holistic) or C students in all subjects. Two-sample tests were also conducted for testing combinations of traits, such as the difference between students with code DI (Digital and Introvert) and all other students. A bootstrap test (Efron, 1982) was also conducted to compare the fail/drop-out rates for the D/C dichotomy.

The univariate analyses may give subject-specific conclusions, but they are also vulnerable to low sample numbers for some subjects. Further, it may be difficult to make global conclusions based on a series of univariate tests. Since the effect of personality type and work preferences is likely to influence exam scores similarly for many subjects, a multivariate regression analysis was conducted. A Partial Least Squares regression (PLSR) model was used (Martens & Næs, 1989) with a multiple response matrix (Y) comprised by the (partly incomplete) exam scores, and a predictor matrix (X) containing the (continuous) personality traits and preference data. In total, there were 50 predictor variables and 9 response variables. The complexity of the PLSR-model and the significance of the predictor variables was determined by means of leave-one-out cross-validation and jackknife-testing (see e.g. Efron, 1982). The jackknife test provides p -values indicating the significance level of each predictor variable for the prediction of grade in each subject. In order to summarize the most important variables, we extracted those predictors which were significant at 5 % test level for at least 3 of the 9 subjects.

In order to illustrate the multivariate results, a so-called correlation loadings plot was constructed, which represents a “2D-window” into the 50-dimensional space spanned by the predictor variables. The window shows the main covariance patterns between X and Y which are found in the data, and the plot provides important information patterns “at a glance”.

RESULTS

Descriptive statistics

All 16 personality types arising from combining all four dichotomies D/C, E/I, F/T and S/N were represented among the students completing the test, and the distribution of these is given in Table 2.

TABLE 2: Counts for the 16 personality types among the 288 students completing the test. The order of the latter two letters varies in order to express the dominant (fourth letter) and the secondary (third letter) process, as discussed by Lowen (1982).

CENF = 12	CIFN = 6	DEFN = 3	DINF = 5
CENT = 4	CIFS = 8	DEFS = 20	DINT = 8
CESF = 9	CITN = 13	DETN = 6	DISF = 38
CEST = 21	CITS = 13	DETS = 39	DIST = 81

Univariate analyses (two-sample t-tests)

The exam data gave an estimated positive effect of having the following types for ALL subjects (in parentheses are those subjects which are significant at test level 5%): D: (MATH100, STAT100, ECN110, PHI100), I: (STAT100), IS: (STAT100), whereas for the next types the estimated effect was negative for ALL subjects: C: (MATH100, STAT100, ECN110, PHI100), E: (STAT100),

CE: (STAT100, ECN110), CF: (MATH100, STAT100, ECN110, BUS100, PHI100), CN: (STAT100, PHI100), EF: (MATH100, STAT100, BUS100, PHI100). No types were found significant for MATH112, MATH111 and AOS230.

MULTIVARIATE ANALYSIS BY PARTIAL LEAST SQUARES REGRESSION

Figure 1 shows the correlation loadings plot from the PLS-regression with the subject grade data as a multivariate response and the personality test data as predictors (the jackknife test for testing significance was performed for one PLS-component, which was found to give minimum cross-validated prediction error)

REFLECTIONS

Discussion of results

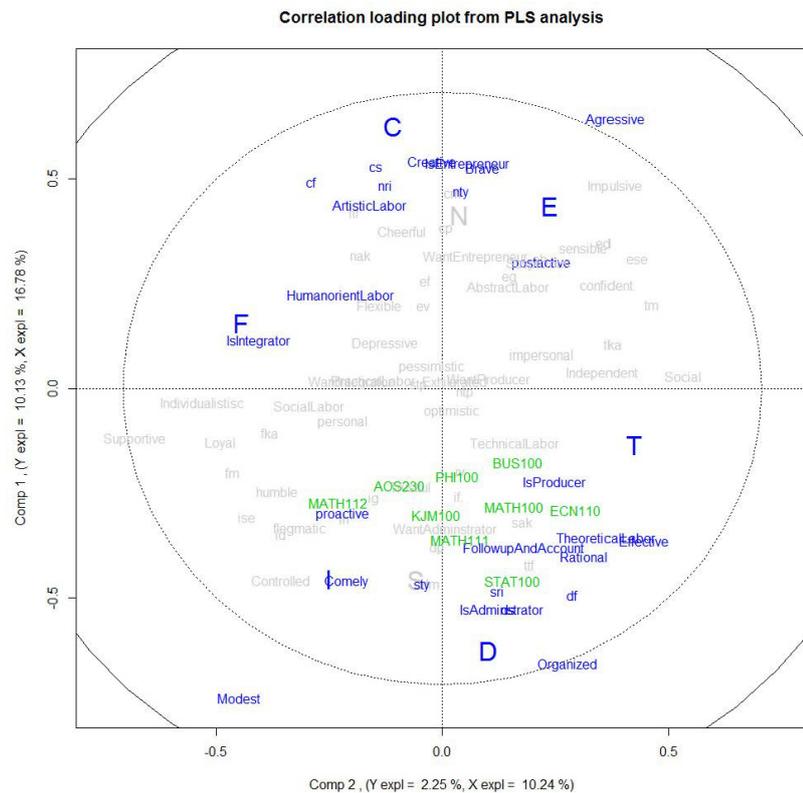
Table 2 shows clearly that certain personality types dominate among the tested students (DIST, DETS and DISF), and the total number of digital students is higher than the number of contextual ones. Probably this reflects a true bias towards digital types at STEM-oriented studies at NMBU, but the bias may be smaller in the population since contextual students seem to have a different motivation or “discipline” to start or complete a long questionnaire than the digital students. There is a higher proportion of A-students in the sample than in the population as a whole, whereas the distribution of the other grades is more or less similar to the population frequencies. It is difficult to say how this bias affects the results, but if we assume that those contextual and extravert students who did finish the test are among the more disciplined kind, then the differences between CE students and DI students would in general be even larger.

The main patterns of covariance between grades and the personality variables may be read out of Figure 1. Variables located close together in the plot are positively associated with each other, whereas variables at opposite sides in the plot show negative association. The fact that all nine subjects lie together in the lower part of the plot indicates that the effect of personality and preferences on exam scores is very similar for all subjects. This means that we cannot detect clear differences from these data between mathematical and non-mathematical subjects in this respect, and that there are certain types that score best in general. In the lower half of Figure 1, we also see that the variables D, I and T are significant, and this should be interpreted as follows: The digital, introverted thinkers score significantly higher on exams than the opposite type, the contextual, extraverted feelers (CEF). This should by no means be interpreted as the former group being more skilled or smarter than the latter, but rather that the subjects are taught in a manner that favors the DI(S)T-students. This finding confirms the results from the univariate *t*-tests, but the multivariate test

shows more clearly that this is a general trend for all the nine subjects under study, mathematical and non-mathematical. The finding is in line with the two hypotheses postulated in the introduction, but it is somewhat surprising that the non-mathematical subjects show very much the same tendency.

So which other characteristics are typical and significant for the students answering best to the pedagogical structure? We see that these students consider themselves as systematic, disciplined, organized, proactive (avoid risks, be prepared), effective, rational, modest and comely, they are attracted to theoretical labor and follow-up and account positions, and they view themselves as producers and administrators. Finally, the facets *df* (disciplined, having a plan, rigid), *ds* (steady worker, avoiding stress and multi-tasking), *sty* (loyal, predictable) and *sri* (practical, finisher, finding easiest way) were significant. It is clear that this is a group of people who thrive under a well-sequenced pedagogic structure with lectures with an accumulating profile and an expectation of individual homework between lectures. They work steadily toward the exam without procrastinating, and for a subject like STAT100, a steady pace is crucial for obtaining good results. The students who appear to be disfavored by the academic structure are the CE(N)F-type students located in the upper part of Figure 1. These are the creative and contextual, extraverted, altruistic and creative students. They consider themselves as brave, aggressive (or persevering/tough), postactive (venture, careless, improvising), are attracted to artistic and more often to human-related work, and they consider themselves as entrepreneurs and also integrators, especially when they have a dominant F in their personality code. For these, the facets *cf* (impulsive, unpredictable), *cs* (procrastinating, multi-tasking), *nri* (creative, find new paths), and *nty* (dissenter, avoiding repetition) were significant. If we also mention at this point that the contextual students have a significantly higher rate of fail/drop-out than the digital students (*p*-value 0.036), it becomes apparent that academia fails to reach this group of students, and fails to bring them to positions where their talents could make a difference, for instance in research. Of course, there are exceptions, but they are most likely fewer than they should be.

All subjects studied here were at an undergraduate level, where reproducing material presented at lectures in the exams typically gives good grades. It is therefore anticipated that a similar study for master's level courses would give another picture in which creativity, different ways of pedagogic involvement and entrepreneurship is more focused and honored.



Figur 1: In this figure, the subjects (Y-loadings) are colored green, whereas the personality test variables are grey or blue (variables being significant at 5% level for at least three subjects are colored blue).

Pedagogic considerations

In order to hold on to the creative, the altruistic and the contextual students and to bring them to the forefront in academia, it is obvious that a change in, or perhaps better, a supplemental way of teaching should be offered to these students. Apparently, we already have the “DIST-university”; maybe it is time also to create the CNF/T-university? This group of students needs to grasp the big picture first, where the digits get their meaning from their web of relation, and less from the instrumental correct sequential order of digits. Contextual students need structure to help them keep a steady pace, but in order to be motivated they should, if possible, be included in making the structure to minimize the experience of loss of freedom. If the curriculum allows it, affording a certain flexibility with regard to the path to take towards the goal and letting the students feel that they make the path as they go, would increase the probability of having a motivated group of students. Furthermore, to practice more a kind of “backward teaching” starting with the answer or goal, and letting the students find the methods or how, would trigger their curiosity. A “flipped classroom” style with video-lectures as homework, would probably also be to the benefit of these students, since it would open up for more discussion-based teaching in class, possibilities for working in groups (great for EF-students) and working on (potentially self-defined) projects (for CNF/T students). The lecturers may then put

less effort into giving lectures, and more into the dialogue with the students. The dialogue-based teaching has also another benefit, since it will likely reduce the distance between the lecturer and each student, a distance which in classical mathematics lectures is known to enhance math-anxiety among many students, especially the Feeling type of students, as discussed in Brovold (2014). Basically, it boils down to creating a friendly, but sometimes more critical, relevant and motivating context for good learning, although this is a very different way of teaching than professors at universities (typically DINTs ...) are used to giving. These days, many question where universities will be in the near future. Modern technology, the Internet, video lectures and Massive Open Online Courses (MOOCs) may seem a threat to the existence of many universities, but in the light of this study, this development should, perhaps, also be considered as a threat to the CNF/T students. MOOCs are in their nature designed for digital and introverted people, who enjoy the solitude at home in front of the computer. So, if we turn this around, one can perhaps conclude that if online learning has come to stay, academia is perhaps more free to turn to a formerly neglected groups of students? A general conclusion or guiding principle for mathematical education applicable to every student may be: Use interaction, find the differentiation and do the adaption. One size doesn't fit them all!

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