Exploring the Connection Between Personality Dimensions and Learning Strategies in Mathematics

Aurelija KASPARAVIČIŪTĖ, Svetlana DANILENKO,
Rūta SIMANAVIČIENĖ

Vilnius Gediminas Technical University, Sauletekio ave. 11, LT-10223 Vilnius, Lithuania

aurelija.kasparaviciute@vilniustech.lt,
svetlana.danilenko@vilniustech.lt,
ruta.simanaviciene@vilniustech.lt

ORCID 0000-0001-8261-314X, ORCID 0000-0001-8731-2522,
ORCID 0000-0002-1614-9470

Abstract. Personality traits are indicative of consistent patterns in thoughts, emotions, and behaviours, and they consequently impact students' academic performance. Numerous scientific investigations have explored the determinants of student learning success, with some emphasizing the significance of considering both student personality traits and generational cohorts. This study seeks to examine the associations between the Big Five personality dimensions and the learning strategies employed in mathematics lectures. A random sample of first- and second-year informatics engineering science students from Vilnius Gediminas Technical University (VILNIUS TECH) was selected for this research. Data were gathered through an anonymous survey utilizing a questionnaire developed by the authors. Non-parametric statistical tests were employed to analyse the data. The findings revealed that the sample predominantly consisted of students exhibiting the personality dimensions of agreeableness and conscientiousness. Furthermore, students' selection of learning strategies was generally independent of their personality dimensions. Nonetheless, the study underscored students' preferences for diverse learning strategies, irrespective of their personality traits.

Keywords: Big Five personality dimensions, academic success, mathematics learning strategies, Generation Z.

Introduction

Hendrastomo and Januarti (2023) characterize education as a dynamic concept, asserting that "In the world of education, there is nothing static; the curriculum is ever-evolving, knowledge continually expands, and the participants, both teachers and students, are in a constant state of transformation. <…> Education engenders culture and order, akin to a domestication process. It is also a process of cultivating various human potentials, including academic, relational, talent, physical, and artistic abilities." In contemporary times, education must adapt to address the needs of the new generation, as its role is to enhance, develop behavior, thinking, and action, and to motivate adaptation to the evolving times (Hendrastomo and Januarti, 2023). Numerous studies in educational

research have concentrated on developing more effective teaching and learning strategies (Biwer et al., 2020; Kumari et al., 2023; Munna and Kalam, 2021; Cacula 2024; Pliuskuvienė et al., 2024). Teaching methods encompass a variety of strategies and techniques employed by educators to engage students and improve learning outcomes. Sugano and Mamolo (2021) identify several teaching methodologies, including combination learning, cooperative learning, inquiry-based learning, individualized instruction, manipulative and multiple representations, multicultural education, problem-based learning, project-based learning, and technology-based instruction. In this study, learning strategies are defined as sets of tools (e.g., textbooks, lecture videos, interactive knowledge tests, etc.) and activities (e.g., individual or group consultations, group work, lecture work, homework, etc.) that constitute the learning process, from which the learner makes selections. Similarly, Juste and López (2010) describe learning strategies as approaches that incorporate various steps or sequences of actions that learners choose to enhance their learning experience, address challenges, and meet academic requirements (Juste and López, 2010). Bligh and Cameron (2000) argue that traditional teaching and learning (e.g. teacher-centric, classroom-based, focused on lectures and textbooks methods; teacher has full control over the learning environment, decides the teaching methodology; student learn through repetition and memorization, there is little or no scope for critical thinking) methods are ineffective due to their reliance on economic evaluation and their tendency to foster passive learning. Similarly, Kumari (2023) and colleagues assert in their research paper that "the traditional method of teaching and learning has been in existence for centuries, with little changes over time. However, this approach is no longer effective in the twenty-first century." Consequently, Kumari et al. (2023) aimed to ensure that educational topics are taught in a manner tailored to the needs of individual learners.

Significant attention has been directed towards scientific papers that explore more effective teaching methods and learning strategies, with the goal of identifying the challenges faced in educating Generation Z (Gen Z) and enhancing teaching-learning strategies (Cilliers, 2022). Currently, university students born between 1997 and 2012 are identified as Gen Z. Hendrastomo and Januarti (2023) concluded that Gen Z is distinguished by its unique characteristics. This generation is characterised by a complex interplay of universal values and self-centeredness, which influences their communication behaviour and unique approach to the environment. Furthermore, feedback on achieved results and the integration of the latest technologies in daily activities are crucial for Gen Z (Dolot, 2018). Gen Z students are more self-confident, technologically adept, and focused on personal development (Hernandez-De-Menendez et al., 2008). In the 21st century, there has been considerable discourse on generational differences, with significant emphasis on developing teaching strategies for Gen Z students to address the challenges encountered in educating this cohort (Cilliers, 2022).

Extensive research has demonstrated that a student's academic success is linked to their personality traits. To enhance the accessibility and sustainability of higher education, the relationship between individualized teaching methods and students' academic performance should be examined (Abe, 2020). Lyons et al. (2017) investigated the Flipped Classroom method and observed that student personality traits are a primary factor in academic success. The Flipped classroom method reverses traditional teaching by engaging students to learn new content outside of class and using class time only for active learning, discussions, problem-solving, and collaborative projects with teacher guidance.

Durak (2023) posits that personality traits significantly influence students' academic outcomes. Feher and Vernon (2021) examined five major personality dimensions that can categorize a wide range of personality traits. These dimensions, known as the Big Five, include Extraversion, Neuroticism, Agreeableness, Conscientiousness, and Openness to experience. Accordingly, it can be concluded that considering the personality dimensions of Gen Z may enhance the effectiveness of the study process.

This study aims to investigate whether different learning strategies employed in VilniusTech University mathematics lectures are equally effective for Gen Z students with varying personality dimensions.

1. Related works

As Kumari et al. (2023) observe, learning outcomes in the twenty-first century are frequently evaluated through quantitative indicators such as graduation rates. While such metrics have financial and institutional relevance, they do not necessarily align with broader educational objectives or students' career aspirations. Traditional teaching and learning approaches have been shown to be increasingly ineffective in contemporary educational contexts, as they often fail to prioritise critical thinking, undervalue the development of practical skills, and inadequately respond to the evolving demands of the labour market. To enhance educational effectiveness, there is a growing consensus that instruction must be increasingly individualised and oriented towards the development of competencies essential for the modern era (Kumari et al., 2023). Within higher education, Voskoglou (2019) highlights that traditional teaching methods; particularly in mathematics remain prevalent, sometimes supplemented by challenging questions and mathematical discourse aimed at fostering conceptual understanding and critical analysis. Through a classroom based experimental comparison of traditional and alternative instructional approaches at the university level, Voskoglou (2019) demonstrates the potential value of such pedagogical innovations, while also emphasising the need for further empirical research before definitive conclusions can be drawn. Complementing this pedagogical perspective, Anthony (2000) identifies students' intrinsic motivation as a primary determinant of success in mathematics learning, while Afshar et al. (2019) demonstrate that both lecturers and institutional leadership play a significant role in shaping student motivation in higher education contexts.

An expanding body of research further indicates that individual differences; particularly personality traits are critical predictors of academic success (Durak, 2023; Opoku et al., 2023). Collectively, these findings suggest that improving the effectiveness of mathematics education requires not only refined teaching strategies but also a deeper understanding of learners themselves. Consequently, identifying which learning approaches are most effective necessitates a fundamental question: "who are contemporary university students, and what challenges do they face?".

As noted earlier, the majority of today's university students belong to Gen Z, typically defined as individuals born between 1997 and 2012 (Marin and White, 2023). Hendrastomo and Januarti (2023) argue that educators' efforts to understand the defining characteristics of Gen Z are among the most important factors contributing to effective learning. Gen Z students are described as pragmatic, self-aware, and inclined towards individualised learning; they recognise education as a personal investment, have grown up

within a globalised and rapidly changing society, and often display confidence, competitiveness, curiosity, independence, and a preference for autonomy (Hendrastomo and Januarti, 2023). Lopez and Abadiano (2023) propose a technological, motivational, learning framework to better align instructional practices with the learning preferences of Gen Z. This framework emphasises e-learning, interactive pedagogy, career and financial literacy, interpersonal relationships, healthy competition, multimodal instruction, and the application and contextualisation of concepts. Gen Z students tend to engage more deeply with interactive digital environments and place greater value on applied understanding than on rote memorisation. Given the elevated levels of stress experienced by this cohort, openness to discussions around mental health and social equity is also particularly salient. Moreover, education and career advancement are highly prioritised, underscoring the importance of financial literacy and career guidance (Twenge, 2017). Despite their immersion in digital environments, evidence suggests that Gen Z students often lack the skills required to use digital technologies effectively for learning purposes and may prefer individualised tasks over collaborative work (Marin and White, 2023). Research further indicates that incorporating real-world problems; particularly those arising from social contexts alongside practical tasks that promote reasoning and problem-solving can significantly enhance achievement in mathematics. Lecturers who account for the preferences and characteristics of Gen Z are therefore better positioned to design learning experiences that resonate with students and foster deeper conceptual understanding.

In parallel, substantial research has established strong associations between personality traits and academic performance (Durak, 2023; Çağataylı and Çelebi, 2022; Vedel and Poropat, 2017). Personality traits are commonly defined as relatively stable patterns of thought, emotion, and behaviour that distinguish individuals and can be used to explain and predict outcomes such as academic achievement (Anglim and O'Connor, 2019). While there is ongoing debate regarding the most appropriate psychological framework for categorising personality, the Five Factor Model (FFM), or Big Five model, remains the most widely adopted approach (Feher and Vernon, 2021). Originally proposed by Goldberg (1981, 1990) and further validated by McCrae and Costa (1987), the Big Five model encompasses neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. These dimensions capture emotional stability, sociability, intellectual curiosity, interpersonal orientation, and goal directed behaviour, respectively (McCredie and Kurtz, 2020). Research consistently demonstrates that conscientiousness is a particularly strong predictor of academic achievement, including in mathematics, as it is associated with effective study habits, persistence, and motivation (Muhid et al., 2021). Conversely, elevated levels of anxiety linked to neuroticism can impair the cognitive resources required for mathematical problem-solving, thereby limiting academic success (Koner and Mazumder, 2024).

Recent studies further suggest that predicting academic success solely on the basis of prior grades or entrance examination scores is insufficient (Çağataylı and Çelebi, 2022). Instead, incorporating personality dimensions provides a more nuanced understanding of learning outcomes. Wakefield and Tyler (2023), for example, demonstrate that increased interactivity in theoretical lectures significantly enhances student performance compared with passive learning formats such as recorded videos.

In summary, existing research highlights a substantive relationship among personality traits, instructional design, and student learning outcomes. While considerable progress has been made in identifying effective pedagogical strategies, further investigation is

required to deepen understanding of how individual differences interact with teaching practices. Addressing these factors remains central to improving both the quality and success of higher education.

2. Methodology

This article analyses which learning strategies are more acceptable to Gen Z students based on Big Five personality dimensions (agreeableness, conscientiousness, neuroticism, extraversion and openness). In this study the following learning strategies are included: material provided by the lecturer (e.g. textbooks, lecture videos, interactive knowledge tests, etc.); organizational structure of the lecture (e.g. student are constantly involved in the discussion, on issues related to the course, solving tasks in student groups with the possibility to consult with the lecture, etc.); organizational structure of the study process (e.g. to know in advance assessment system, list of all topics, strictly follow dates of assessments, class attendance, etc.); communication style of the lecturer (e.g. lecturer is charismatic, agreeable, restrained, etc.); student personal learning process (e.g. wants to gain study knowledge, to be one of the best, can set down his own goals, loves to work in groups, etc.), that make up the learning process.

In order to assess the effectiveness of the learning process applied in mathematics lectures, a qualitative study was conducted. This study focused on the relationship between learning tools, activities and student personality dimensions. Initially, a questionnaire (see, WEB, a, Questionnaire) was developed for the first and second-year students of Informatics Engineering at VilniusTech who are enrolled in mathematics courses. The questionnaire was performed at the end of the studies and presented to students in their national language, i.e. Lithuanian. It consists of eight parts, each containing between 10 and 25 questions:

I.   A questionnaire developed to assess the five personality dimensions (Bunevičius, 2005).
II.   The use of materials presented in the MOODLE environment.
III. The benefits of organisational forms during lectures.
IV.   The influence of course organisational structure on the learning process.
V.   The impact of the lecturer's communication style.
VI.   Factors that may influence personal students' learning process.
VII. Students' ability to plan time and organise their work.
VIII. Demographic indicators.

The first part of the questionnaire consists of 25 questions and is designed to identify personality dimensions (see Part I in WEB, a, Questionnaire). The approach for evaluating personality dimensions is grounded in the framework established by Goldberg (1999). According to this methodology, Bunevičius (2005) developed a questionnaire that uses 25 pairs of adjectives. In each pair of adjectives, the respondents must indicate how strongly one of the adjectives applies to them on a scale from 1 to 7. In Table 1, the labels of the adjectives describing each personality dimension are indicated. We want to remark, that abbreviations of traits are listed in questionnaire (see Part I in WEB, a, Questionnaire).

Table 1. Assessment of the Big Five personality dimensions (Bunevičius, 2005)

Personality dimension	Notation
Extraversion	A, F, K, P, U. Reversed: A, K, U
Conscientiousness	D, I, N, S, X. Reversed: D, N, X
Agreeableness	E, J, O, T, Y. Reversed: J, T
Neuroticism	B, G, L, Q, V. Reversed: G, V
Openness	C, H, M, R, W. Reversed: C, M, W

Each personality dimension in Table 1 is evaluated separately by adding up the scores of the responses of different combinations of pairs of traits. For each personality dimension, the total arithmetic sum of the answers of the corresponding pairs of traits is added separately, except for those marked "Reversed", which are evaluated inversely: "7" corresponds to "1"; "6" - "2"; "5" - "3"; "1" - "7"; "2" - "6"; "3" - "5"; rating "4" is not changed. The dominant personality dimension is the one with the highest arithmetic sum of points.

To determine the factors that impact learning mathematics and how they are linked to students' personality dimensions, six parts of questions starting from Part II, were formulated in the questionnaire (see Parts II-VII in WEB, a, Questionnaire). These questions were developed by the authors based on a review of the scientific literature (Anthony, 2000; Baruth and Cohen, 2023; Çağataylı and Çelebi, 2022; Durak, 2023; Jensen, 2015; Komarraju and Karau, 2005; Opoku et al., 2023; Rajapakshe, 2017; Voskoglou, 2019) as well as the authors' personal teaching experiences. Additionally, the questions from the eighth part of the questionnaire are intended to determine the demographic characteristics of the sample. In more detail, Part II contains questions related to the use of material provided by the lecturer in the MOODLE environment (see Part II in WEB, a Questionnaire, or Table 2). These questions are assigned to assess how often students use the lecturers' prepared course learning tools. Part III (see Part III in WEB, a Questionnaire, or Table 3) consists of questions related to the lecture's organisational structure. These questions are designed to evaluate students' choices of lecture structure, taking into account their own level of information absorption. Part IV (see Part IV in WEB, a Questionnaire, or Table 4) addresses the influence of course organisational structure on the learning process. These questions are assigned to determine how students evaluate the influence of the organisational study process, taking into account students' own learning process. Part V (see Part V in WEB, a Questionnaire, or Table 5) is intended for questions connected to the impact of the lecturer's communication style. These questions are designed to determine how students evaluate the relationship between the lecturer's communication style and the quality of student education. Part VI (see Part VI in WEB, a Questionnaire, or Table 6) contains questions referring to factors that may influence students' personal study learning process. Part VII (see Part VII in WEB, a Questionnaire, or Table 7) involves questions related to students' ability to plan time and organise their own work. Part VIII (see Part VIII in WEB, a Questionnaire) is composed of questions related to demographic indicators, such as gender, age, place of secondary education, study program, etc.

Let us remark that in this paper, the activities and tools selected by the lecturer are considered effective if they are acceptable to the majority of students. The effectiveness of learning strategies is associated with a higher frequency.

The majority of variables analysed in this study are qualitative and measured on an ordinal scale. To assess statistically significant differences between variables, non-parametric tests were applied: for dependent samples, the Friedman test and the Wilcoxon Signed Ranks Test were used; for independent samples, the Kruskal-Wallis test and the Mann-Whitney U Test were employed. For qualitative variables, the dependence between categorical variables was examined using the Chi-Square Test. Differences were considered statistically significant when the p-value (p) < 0.05. The research data were analysed using IBM SPSS Statistics, version 26.

## 3. Case study

The described methodology was used for a specific case analysis. The population of the study consisted of 108 students from the 1st and 2nd semesters of the Informatics Engineering study programs at VILNIUS TECH university, who studied mathematics courses in their first year. The aim is to identify the factors that impact learning mathematics courses and how they are linked to students' personality dimensions. In the future, this study will be expanded by including students from different study programs.

Based on the research data (see Part VIII in WEB, a, Questionnaire) it can be observed that more male students choose to study informatics engineering. In this study, male students made up 73.63% of the respondents. The majority of the research sample consisted of Software Engineering students (54.44%), followed by Multimedia Design students (27.78%), Information Systems students (13.33%), and Information Technology program students (4.44%). In addition, the majority of respondents (97.83%) studied in a state-funded place, and most of them (70.65%) studied in the desired program. According to VILNIUS TECH university's Admissions and Information Center, most of our students belong to Gen Z (born from 1995 until 2003).

According to the survey results, the vast majority of students participating in the study belonged to the agreeableness (39.13%) and conscientiousness (36.96%) dimensions (see Figure 1). Some respondents were assigned to several dimensions (14.81%). Thus, due to statistical analysis requirements, the further study examined only the data of agreeable, conscious and extroverted students.

 Further analysis was performed on data obtained from Parts II-VII (see Parts II-VII, in WEB, a, Questionnaire). Firstly, the aim is to assess whether statistically significant differences between personality dimensions exist or not, considering student preferences for different learning strategies. Secondly, if a significant difference between personality dimensions exists for a given question, it is examined between which personality dimensions and what assessments students made on that question. In addition, box plot diagrams were used to determine which learning strategies students (regardless of personality dimension) prefer.
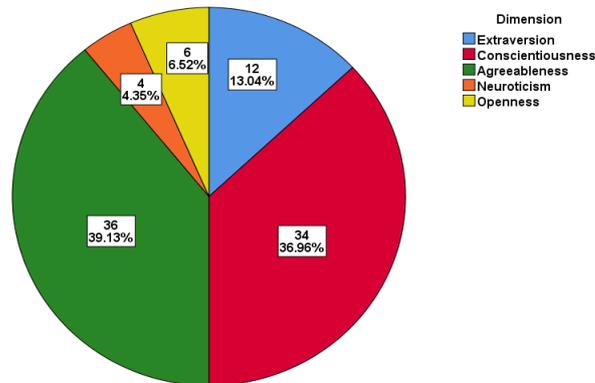
Figure 1. Distribution of students according to personality dimensions

Firstly, the analysis aimed to determine how often students use the material provided by the teacher in the MOODLE environment, depending on its form. To assess whether student preferences for different forms of course materials (see Part II, Question I, in WEB, a, Questionnaire) depend on the student personality dimension, the Kruskal-Wallis test was applied. The study showed that the choice of students in groups of different personality dimensions did not statistically significantly differ. It was concluded by the results of the Kruskal-Wallis test, since for all cases $p > 0.05$ (Table 2). Thus, it means that the choices of course material forms for students with different personality dimensions are similar.

Table 2. Statistical significance difference between personality dimensions' groups, considering students' preferences for different forms of course materials.

Rate how often you use the material provided by the teacher in the MOODLE environment, taking into account its form (0 - I do not use it at all. From 1 - I hardly use it, to 7 - I use it very often)	p, df =2
Lecture material (outlines or slides) (q.2.I.1)	0.990
Lecture videos (q.2.I.2)	0.439
Additional lecture material (q.2.I.3)	0.920
Literature (not scientific papers) (q.2.I.4)	0.745
Scientific literature (q.2.I.5)	0.910
Self-control questionnaire with answers (q.2.I.6)	0.566
Self-control MOODLE tests (q.2.I.7)	0.871
Additional exercises without answers (q.2.I.8)	0.948
Program codes of considered exercises (q.2.I.9)	0.326

In addition, to assess which form of course material students prefer and which form they consider ineffective, the boxplot was created (Figure 2). Here, the analysis was performed among all students, without taking into account their personality dimensions. The study results showed that students prioritise outlines or slides, self-control questionnaires with answers and self-control MOODLE tests (with a median of 6). The lowest scores (with a median of 1) were given to scientific literature and additional literature, such as textbooks (not scientific articles). The Wilcoxon Signed Ranks Test indicated that the choice of mentioned forms of course material (q.2.I.1, q.2.I.4, q.2.I.5, q.2.I.6, q.2.I.7) statistically significantly differ from other forms of course material as $p < 0.05$
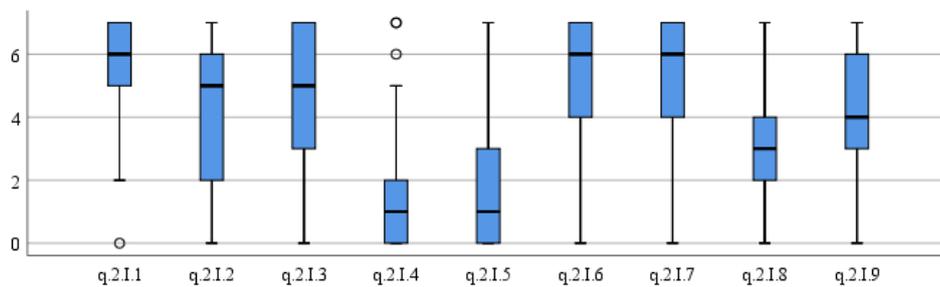
Figure 2. Boxplot diagrams of students' preferences for different forms of course materials presented in the Moodle environment (see Table 2)

Furthermore, Part II (Questions II and III) of the Questionnaire was also aimed at revealing student preferences for the length of lecture videos and the size of lecture materials (slides, textbooks). The study results showed that the majority (67.6%) of students prefer short lecture videos over a long recording of the entire lecture. The Chi-Square Test result (p = 0.519, df = 2) indicate that the preference for the length of video recordings does not depend on the student personality dimension. Also, students prioritised comprehensively presented lecture material over a concise summary of the lecture (54.5%). This preference does not depend on the student personality dimension, as confirmed by the Chi-Square Test (p = 0.452, df=2).

In Part III, Question I (see Part III, Question I, in WEB, a, Questionnaire), students had to rate the usefulness of the organisational structure of the lecture, taking into account their own level of information absorption. The p-values of all Kruskal-Wallis tests, except for "Solving tasks in student groups with the possibility to consult with the lecturer (q.3.I.5)", exceeded 0.05 (see Table 3). Thus, students with different personality dimensions rate organisational structures in the lecture similarly, except q.3.I.5.

Table 3. Statistical significance difference between personality dimensions' groups, considering student preferences for different organisational structures of the lecture

Rate the usefulness of organising lecture structure, taking into account your own level of information absorption (from 1 – completely useless, to 7 - very useful):	p, df =2
Independent solving of the self-control questionnaire with answers (q.3.I.1)	0.620
Lecturer provides detailed solutions to the tasks. Student follows the lecture without active participation (q.3.I.2)	0.654
Lecturer presents material in detail, the student is constantly involved in the discussion, on issues related to the course (q.3.I.3)	0.994
Lecturer presents problematic questions and, together with the students, searches for answers to the questions of the topic being analysed (q.3.I.4)	0.760
Solving tasks in student groups with the possibility to consult lecturer (q.3.I.5)	0.046
Students solve tasks at the blackboard (q.3.I.6)	0.350
Student presents a new topic proposed by the teacher, which he analysed independently at home (q.3.I.7)	0.063

To evaluate which organisational structures of the lecture students prefer (without taking into account their personality dimensions), the boxplot diagram was assessed (see Figure 3). The results of the study showed that students rated "Independent solving of self-control questionnaire with answers (q.3.I.1)" with higher scores (with a median of 6). The lowest scores (with a median of 2) were given for "Student presents a new topic proposed by the teacher, which he analysed independent at home (q.3.I.7)".
The Wilcoxon Signed Ranks Test indicated that the mentioned organisational structures of the lecture (q.3.I.1, q.3.I.7) statistically significantly differed from other structures examined in this study ($p < 0.05$).
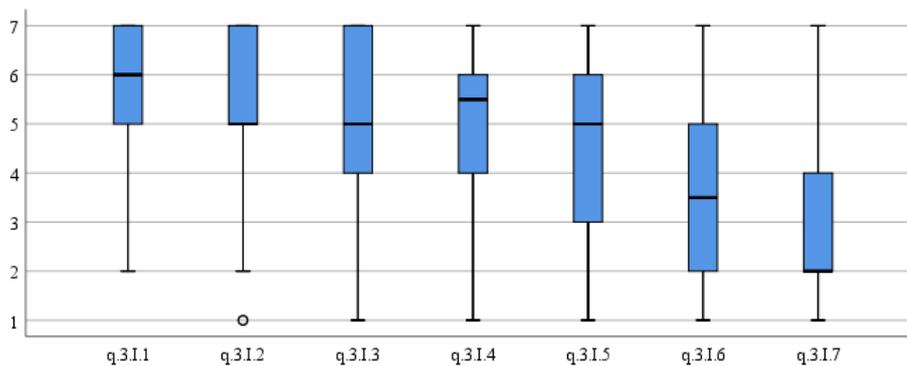
Figure 3. Boxplot diagrams of student preferences for different organisational structures of the lecture (see Table 3)

Let's recall that the p-value of the Kruskal-Wallis test for "Solving tasks in student groups with the possibility to consult with the lecturer (q.3.I.5)" is $0.046 < 0.05$. For q.3.I.5, Mann-Whitney Test results showed that only choices of agreeable and conscientious students statistically significantly differ, as $p = 0.023 < 0.05$. Furthermore, according to the boxplot (see Figure 4), agreeable students are more likely to choose to perform tasks in student groups during the lecture with the opportunity to consult with the lecturer than conscientious students.
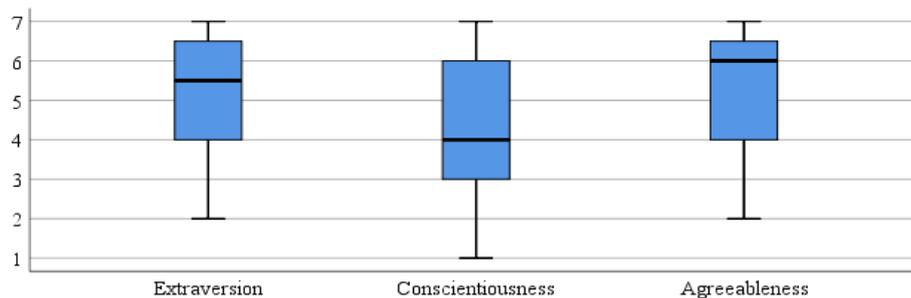
Figure 4. Boxplot diagrams of student preferences for q.3.I.5 (see Table 3)

Additionally, in this part of the study (see Part III, Question II, in WEB, a, Questionnaire), students were also asked which form of lecture, in their opinion, is most helpful in mastering the topic under consideration. Students could choose one of four options: (1) when the lecturer relies on his/her own personal experience; (2) when he/she relies only on textbook material and scientific literature facts; (3) when he/she combines textbook content with examples from personal experience; (4) when the form of presentation is not significant for the student. Student answers to additional questions allowed us to determine that for the majority (91.9%) of them, it is most beneficial when the lecturer combines textbook material with examples from their personal experience.

To analyse the responses to the questions about how students evaluate the impact of the organizational study process on their own learning process (see Part IV, Question I in WEB, a, Questionnaire), it was found that the evaluations did not statistically significantly differ (student preferences are similar) considering personality dimensions, as indicated by the results of the Kruskal-Wallis test (see Table 4), since for all cases $p > 0.05$.

Table 4. Statistical significance difference between personality dimensions' groups, considering the influence of the organisational study process

Rate the influence of the organisational study process, taking into account your own learning process (from 1 - not at all important to 7 - very important):	p, df =2
At the beginning of the semester to know exact assessments days (q.4.I.1)	0.496
Review of the study course card (q.4.I.2)	0.933
To get the list of all topics of the study course in advance (q.4.I.3)	0.069
Know the assessment course in advance (q.4.I.4)	0.072
Know in advance what kind of literature will be needed for studying (q.4.I.5)	0.265
Strictly follow dates of assessments (q.4.I.6)	0.275
Strictly follow content of the course (q.4.I.7)	0.554
Strict marking of class attendance (q.4.I.8)	0.686

Furthermore, to evaluate which item of the organisational study process students prefer and which they believe negatively affects their learning process, medians were assessed (see Figure 5). Here, analysis was performed without taking into account their personality dimensions. The study results showed that students rated the opportunity to know exactly all assessment dates at the beginning of the semester (q.4.I.1) and the assessment system in advance with higher scores (q.4.I.4) (with a median of 7). The lowest score was given to the strict marking of class attendance (q.4.I.8) (with a median of 2). After conducting the Wilcoxon Signed Ranks test, it was determined that q.4.I.1, q.4.I.4, q.4.I.8 differ statistically significantly from other items examined in this study (as $p < 0.05$).
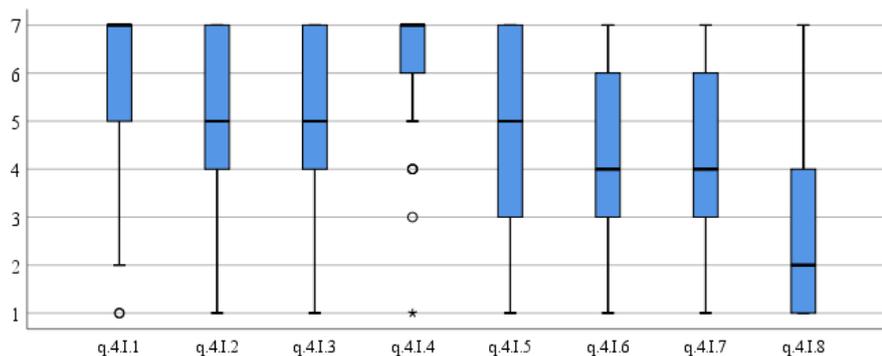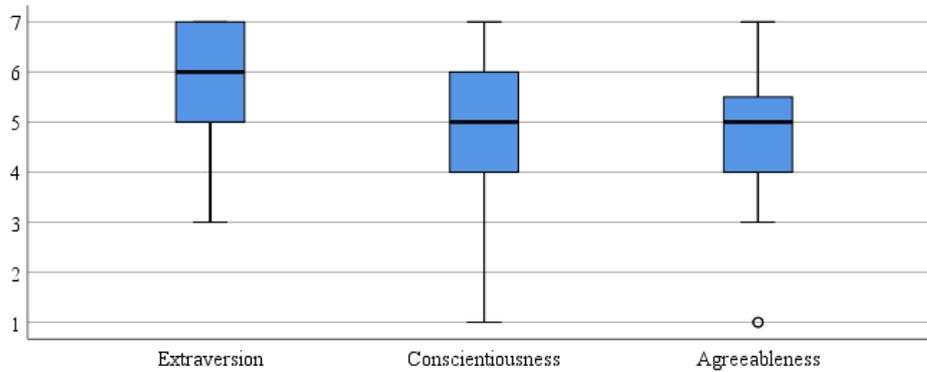

Figure 5. Boxplot diagrams of student preferences for different items of organizational study process (see Table 4)

The next question that was analysed is intended to understand how students evaluate the impact of the lecturer's communication style on their own learning quality (see Part V, Question I in WEB, a, Questionnaire). It was found that p-values of all Kruskal-Wallis tests, except "Lecturer who encourages reflection on students' personal progress (q.5.I.12)", exceeded 0.05 (see Table 5). Accordingly, students with different personality dimensions rated the lecturer's communication styles similarly, except for q.5.I.12.

Table 5. Statistical significance difference between personality dimensions' groups, considering student preferences for the lecturer's communication style

Rate how the lecturer's communication style affects the quality of your education (1 – strong negative influence, 2 – medium negative influence, 3 – small negative influence, 4 – no influence, 5 – small positive influence, 6 – medium positive influence, 7 – strong positive influence)	p, df =2
Lecturer is charismatic (q.5.I.1)	0.487
Lecturer is agreeable (q.5.I.2)	0.147
Lecturer strictly follows the rules and demands from the students (q.5.I.3)	0.723
Lecturer is restrained (q.5.I.4)	0.736
Lecturer emphasizes his status (q.5.I.5)	0.405
Lecturer is flexible (q.5.I.6)	0.939
Lecturer is supportive and willing to help (q.5.I.7)	0.551
Lecturer does not tolerate academic (q.5.I.8)	0.235
Lecturer is forgiving and gives everyone a personal opportunity, at least to receive positive evaluations (q.5.I.9)	0.455
Lecturer supports the students' initiative (q.5.I.10)	0.624
Lecturer encourages students to take responsibility (q.5.I.11)	0.774
Lecturer who encourages reflection on students' personal progress (q.5.I.12)	0.035

Furthermore, the Mann-Whitney Test results showed that the evaluations of students belonging to the extraversion personality dimension statistically significantly differ from those of other personality dimensions when assessing q.5.I.12 ($p = 0.035 < 0.05$). In addition, Mann-Whitney Test results showed that only choices of extravert and agreeable, also extravert and conscientious students significantly differed, as in both cases, $p = 0.016 < 0.05$. According to the boxplot, students who have extraversion personality dimension were more inclined than those of other personality dimensions to choose the lecturer's encouragement for students to reflect on their personal progress (see Figure 6).

Figure 6. Boxplot diagrams of student preferences for q.5.I.12 (see Table 5)
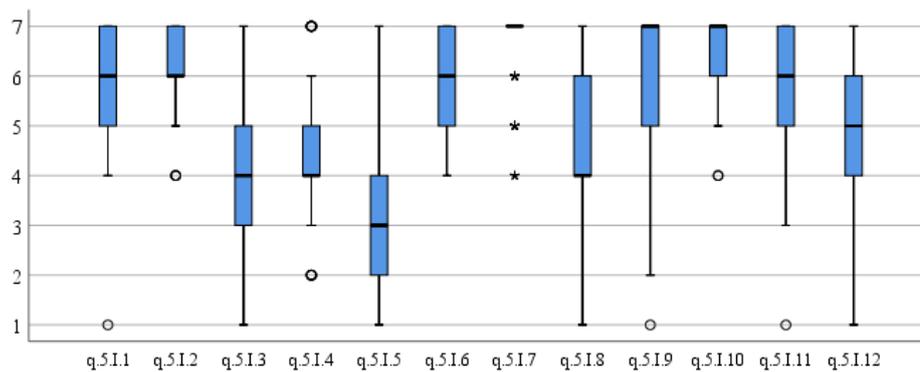
Figure 7. Boxplot diagrams of students' preferences for different lecturer's communication style (see Table 5)

As in other parts, the medians of students' preferences were considered without taking into account their personality dimensions. The results of Boxplot diagrams (see Figure 7) showed that students rated "Lecturer is forgiving and gives everyone a personal opportunity, at least to receive positive evaluations (q.5.I.9)" and "Lecturer supports the students' initiative (q.5.I.10)" with the highest scores (with a median of 7). The lowest scores (with a median of 2) were given for "Lecturer emphasises his status (q.5.I.5)". The Wilcoxon Signed Ranks Test indicated that q.5.I.5 statistically significantly differ from other items with the lowest scores, as $p = 0.000 < 0.05$. Also, q.5.I.9 statistically significantly differ from almost all items examined in this study (as $p < 0.05$), except for q.5.I.1, q.5.I.2, q.5.I.6, as, accordingly, $p = 0.783$, $p = 0.131$, $p = 0.625$. In addition, q.5.I.10 statistically significantly differs from almost all items examined in this study (as $p < 0.05$), except for q.5.I.2, for which $p = 0.239$.

In order to examine the factors that may influence student personal learning process, 14 questions were created (see Part VI, Question I in WEB, a, Questionnaire). After conducting the Kruskal-Wallis test (see Table 6), it was found that only two questions had different student responses depending on personality dimension. Students' opinions varied regarding "To be one of the best students in the study process (q.6.I.5)" ($p = 0.029 < 0.05$) and "The opportunity to study together with someone (q.6.I.11)" ($p = 0.002 < 0.05$).

Table 6. Statistical significance difference between personality dimensions' groups, considering student preferences for different factors that influence their own learning process

Rate how important the listed factors are for your personal learning process (from 1 – not at all important, to 7 – very important):	p, df =2
To gain good study knowledge (q.6.I.1)	0.169
My study results would not disappoint my relatives (q.6.I.2)	0.571
My study results would not disappoint the lecturers (q.6.I.3)	0.789
Do not let yourself down in the learning process (q.6.I.4)	0.638
To be one of the best students in the learning process (q.6.I.5)	0.029
To have enough ability to study (q.6.I.6)	0.242
Be confident, not afraid of difficulties (q.6.I.7)	0.417
Reflect on my learning, what helps me and hinders my learning (q.6.I.8)	0.895
Ability to set your own learning goals (q.6.I.9)	0.744
Study based on the study goals set by the lecturer (q.6.I.10)	0.303
The opportunity to study together with someone (q.6.I.11)	0.002
The opportunity to express my opinion to the group I study with (q.6.I.12)	0.196
When it's hard to study, I try to remember what I want to achieve (q.6.I.13)	0.434
Perception of how gained knowledge can be applied in professional activities (q.6.I.14)	0.665

Moreover, analysing the responses to the questions "How important is it for you to be one of the best students in the learning process?" and "How important is it for you to have the opportunity to learn with someone?" it was found that the responses of students belonging to the dimensions of extraversion and agreeableness, as well as students belonging to personality dimensions of extraversion and conscientiousness, statistically significantly differ. The statistical significance is confirmed by the results of the Mann-Whitney Test, indicating that students belonging to the extraversion personality dimension are significantly more inclined to learn with someone ($p < 0.05$). For students belonging to conscientiousness or agreeableness personality dimensions, it is more important to be one of the best students in the learning process ($p < 0.05$) (see Figure 8).
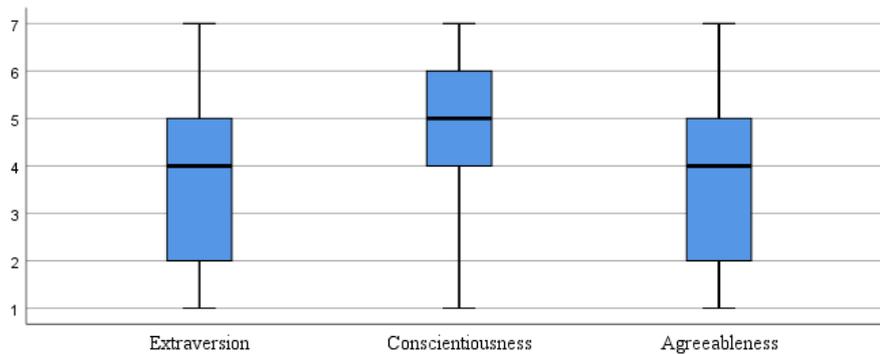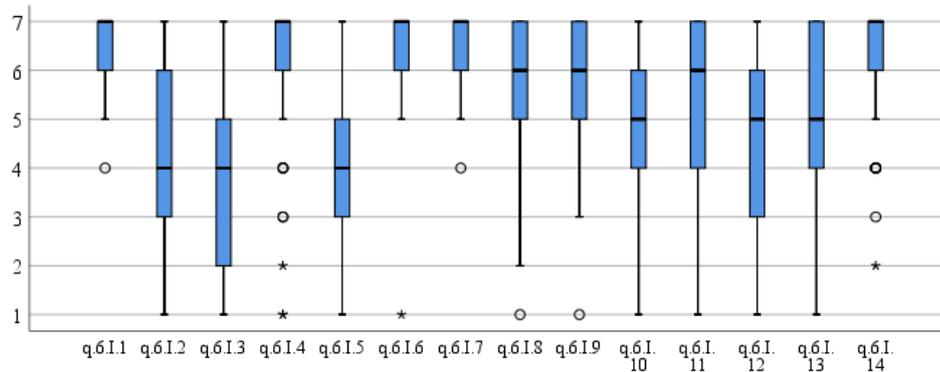
(a)   Boxplot diagrams of student preferences for q.6.I.5
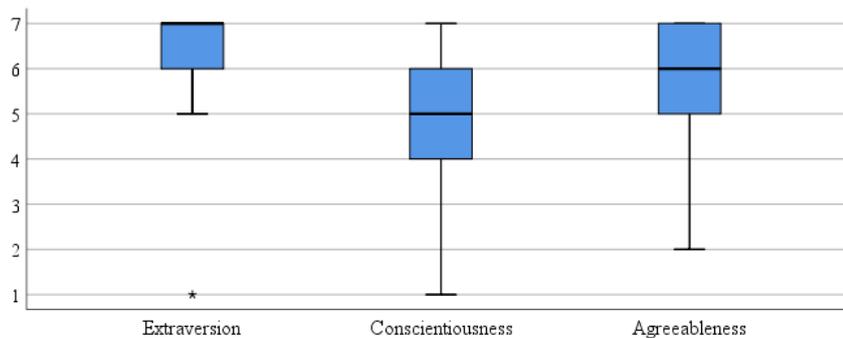
(b)   Boxplot diagrams of student preferences for q.6.I.11

Figure 8. Boxplot diagrams of student preferences for q.6.I.5 and q.6.I.11 (see Table 6)

In addition, from the Boxplot diagrams (see Figure 9), follows that students rated q.6.I.1, q.6.I.4, q.6.I.6, q.6.I.7, q.6.I.14 with the highest scores (with a median of 7). The lowest scores (with a median of 4) were given for q.6.I.2, q.6.I.3, and q.6.I.5. The Wilcoxon Signed Ranks Test indicated that q.6.I.1, q.6.I.4, q.6.I.6, q.6.I.7, q.6.I.14 statistically significantly differ from other examined in this study ($p < 0.05$). Mentioned items are not statistically significantly different from each other.   Besides, q.6.I.3 statistically significantly differ from all other items examined in this study. q.6.I.2 is not statistically significantly different only from q.6.I.5, q.6.I.10, q.6.I.12, and q.6.I.5 is not statistically significantly different only from q.6.I.2, q.6.I.12.
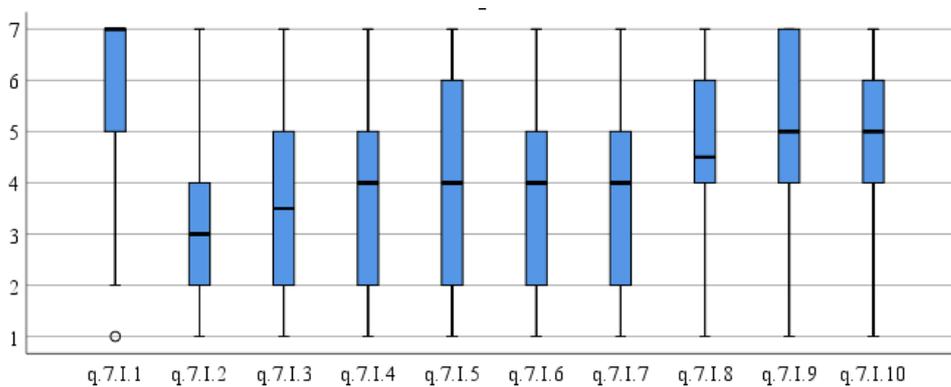
Figure 9. Boxplot diagrams of student preferences for different factors that influence their own learning process (see Table 6)

Concerning analysis for students' ability to plan time and organise their work, 10 questions were asked (see Part VII, Question I in WEB, a, Questionnaire). After analysing the response data using the Kruskal–Wallis test, it was found that, considering personality dimensions of students, the responses did not statistically significantly differ ($p > 0.05$) (Table 7). Thus, responses of students with different personality dimensions are similar.

Table 7. Statistical significance difference between personality dimensions' groups, considering student preferences for their abilities to plan time and organize their work

Rate how often it occurs during own learning process (0 - never occurs, from 1 - very rarely, to 7 - very often)	p, df =2
When I have a lot of work to do, I think about which work is most important and try to focus on it (q.7.I.1)	0.913
I never find time to study (q.7.I.2)	0.559
If I don't understand something, I skip it (q.7.I.3)	0.593
As soon as I sit down to study something, all kinds of distractions appear (q.7.I.4)	0.152
I create a time schedule to remember, organise and plan activities (q.7.I.5)	0.476
I stick to the schedule of tasks I have made (q.7.I.6)	0.219
I waste a lot of time trying to find information I have somewhere (q.7.I.7)	0.111
When I see that someone is not doing well in their studies, I offer to help (q.7.I.8)	0.302
When I encounter problems while studying, I usually ask for help from my fellow students or the teacher (q.7.I.9)	0.423
I know how to choose the material I need from a large number of information sources (q.7.I.10)	0.720

Additionally, from the Boxplot diagrams, it can be observed that students tend to pay more attention to planning tasks according to their importance and priorities. This conclusion can be drawn by observing medians (Figure 10) of the responses to question q.7.I.1. The lowest scores students give to the question "I never find time to study (q.7.I.2) (with a median of 3). The Wilcoxon Signed Ranks Test indicated that q.7.I.1 statistically significantly differs from other items examined in this study (p = 0.000 < 0.05). Also, q.7.I.2 statistically significantly differs from almost all other items examined in this study, except for q.7.I.3, q.7.I.5, q.7.I.6, as accordingly p = 0.259, p = 0.108, p = 0.120.

Figure 10. Boxplot diagrams of student preferences for their abilities to plan time and organise their work (see Table 7)

4. Conclusions

A study conducted with informatics engineering students first showed that the organisational structure, the forms of materials, the lecture-related tools, and the lecturer's communication style affect these students' learning. These students are representatives of Gen Z, for whom the quality of studies and an understanding of how the acquired knowledge is applied in professional activities are important.

According to the analysis, the majority of respondents (97.83%) studied in a state-funded place, and most of them (70.65%) studied in their dream program. Thus, the majority of students at the beginning of studies are motivated to learn, and the lecturer becomes responsible for organising a learning strategy, in order to ensure the needs of most students.

There is an ongoing debate regarding the most appropriate psychological framework for categorising personality. However, the most common model in the literature is the Big Five model. In this model, each personality is considered to be associated with five main dimensions: neuroticism, extraversion, openness to experience, agreeableness and conscientiousness.

In the current study only the personality dimensions of agreeableness, conscientiousness, and extraversion possessed a sufficient sample size for further data

analysis. Study results showed that for conscientious or agreeable students, being among the top students in the academic process is significantly essential. Also, analyses of scientific literature reveal that conscientiousness and openness were the most significant predictors of academic performance. Corresponding to the considered research papers, the connection between learning success and personality dimensions may vary slightly across different academic fields. Thus, this study is planned to be repeated in other study programs where mathematics courses are taught.

Regarding the study results, there is no statistically significant difference between personality dimensions and student preferences for most learning strategies. However, factors related to their working within student groups, becoming one of the best students in the learning process, and their expectation of encouragement for reflection on their own personal progress had a statistically significant difference with their personality dimensions.

The study's results indicated that students prefer to learn using short videos and lecture slides rather than course textbooks, scientific articles, or long lecture videos. Besides, students prioritise outlines or slides, self-control questionnaires with answers and self-control MOODLE tests. For the majority (91.9%) of students, it is most beneficial when the lecturer combines textbook material with examples from their personal experience.

Furthermore, the study results showed that it is essential for students to be fully aware of all due dates and the assessment system at the start of the semester. For students who exhibit the extraversion personality dimension, receiving feedback from a teacher regarding their academic progress is more crucial than for others. These students tend to study with friends or in groups. Also, as mentioned earlier, for conscientious or agreeable students, being among the top students in the academic process is significantly important. Additionally, it was observed that students tend to pay more attention to planning tasks according to their importance and priorities.

The study is planned to be replicated, involving more student groups from different study programs, since in the current study, only the personality dimensions of agreeableness, conscientiousness, and extraversion possessed a sufficient sample size for further data analysis. Also, the study is planned to be conducted among different faculties that have the same mathematics courses. Taking into account the offer of new learning methods, it is planned to conduct the study by including newly applicable methods in the questionnaire.

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