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Trait Emotional Intelligence and Multiple Intelligences as Predictors of Academic Success in Serbian and Greek IT Students

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Abstract: Even though research on predicting the academic achievement of IT students is not scarce, the inclusion of trait emotional intelligence and multiple intelligences as predictive factors is somewhat novel. The research examined associations between identified profiles of trait emotional intelligence and multiple intelligences, and academic success in the sample of 288 IT students, 208 from Serbia and 80 from Greece. The results show that trait emotional intelligence and multiple intelligences profile both proved to be important predictors of academic success. Another predictor of IT students' academic success was related to their prior schooling success. The results indicate that fostering a student-centered learning model through tertiary education, with special emphasis on students' personal dispositions and traits, could be crucial for their academic success, especially in the multidisciplinary field of information technology.

Keywords: academic success; IT; trait emotional intelligence; multiple intelligences.

Introduction

The academic success of university IT students has been monitored and studied for a long time, but with the trend of increasing prices of education and new demands of the labor market, it is becoming one of the key indicators for both school stakeholders and the economy in general. An aggregate of academic achievement of IT students required for a successful future professional career can be reflected into subsets of specific skills, knowledge, and competencies in specific areas, such are digital literacy, communication, collaboration, digital content creation, safety, and problem-solving (Vuorikari, Kluzer and Punie, 2022) in which they should excel. The general attitude of researchers is that the individual characteristics (qualities) of students are an obvious predictor of their success. When we think of individual characteristics, we primarily think of their intelligence (Mayer, 2020). However, the results of many studies show that general intelligence alone does not exceed 25% of the variance of success (Bergold and Steinmayr, 2018), so other personal dispositions should also be taken into account. Student intelligence combined with other personal dispositions can be observed as general ability which combined with previous achievement researchers identified as the most consistent predictor of success (Richardson, Abraham and Bond, 2012; Stankov and Lee, 2014).

Which IT student characteristics predict higher academic achievement and thus increase the probability of a long-term successful career in the IT industry? To explore possible answers to this question, the research focused on examining the role of trait emotional intelligence and multiple intelligences profile as possible precursors of academic success. Besides traditional statics analysis methods, educational data mining was used in the form of a artificial neural network for predicting academic success. This approach can provide clues on previously unknown trends that relate to student characteristics, behavior, and academic performance (Mahajan and Saini, 2020). Identifying the relevance of the beforementioned personality characteristics to academic achievement is important as it can inform the skills, knowledge, and methods on which teachers and curriculum creators should focus while designing and implementing the process of education.

The rest of the paper is organized as follows. The next section presents previous research on

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academic success prediction using trait emotional intelligence and the theory of multiple intelligences. The research methodology is described in the following section. Results are then presented and discussed, followed by concluding remarks.

Related work

Academic performance is heavily influenced by biological and psychological traits independent of standard notions of cognitive ability (Nye et al., 2012). Trait emotional intelligence concept concerns individual belief about own emotions (Petrides and Mavroveli, 2018), but it is not a synonym with emotional intelligence and should not be observed as a cognitive ability, competency, or skill (Siegling, Saklofske and Petrides, 2015). Sanchez-Ruiz, Mavroveli and Poullis (2013) reported that personality characteristics and trait emotional intelligence were better predictors of university students' academic performance than fluid intelligence. Emotional experience is defined by the emotional intelligence model and by its nature is a subjective one (Matthews, Zeidner and Roberts, 2008), thus not amenable to valid measurement via self-assessment tools. The research on trait emotional intelligence significantly expanded in the past decade, including new assessment procedures by developing several questionnaires, their localization, and psychometric evaluation (Dåderman and Kajonius, 2022; Herrera Torres, Buitrago Bonilla and Cepero Espinosa, 2017; Jolić-Marjanović and Altaras-Dimitrijević, 2014; Pérez-Díaz and Petrides, 2021; Stamatopoulou, Galanis and Prezerakos, 2016). These self-assessment questionnaires may also be used as a diagnostic tool for identifying personality disorders as scores negatively correlate to most disorders (Cuesta-Zamora, González-Martí and García-López, 2018; Sinclair and Feigenbaum, 2012). There are four subdimensions (factors) of trait emotional intelligence: Well-Being, Self-Control, Emotionality, and Sociability (Petrides, 2009). Trait emotional intelligence construct shows rigidity when compared to other higher-order personality traits (Big Five) (McAdams, 1992; Soto and Jackson, 2013), revealing that about 40% of the variance can be directly attributed to genetic factors and secondarily correlated to non-shared environmental factors (Vernon et al., 2008). Self-motivation is often observed as a lower-order trait, but its high levels directly lead to forming purposeful and achievement-oriented individuals which in terms positively reflect on superior academic success (Tepper, Duffy and Shaw, 2001). Students with a higher level of self-control tend to avoid temptation-related external stimuli and are better at pursuing established goals (Fujita, 2011). Researchers often point to the negative correlation between neuroticism and academic performance as its higher level leads to negative emotions in a stressful situation, such as evaluation (Martínez-Monteagudo et al., 2019). Taneja et al. (2020) emphasized that higher levels of trait emotional intelligence positively influenced student academic performance as their interaction with peers and greater social interaction enable adaptive social functioning. Several recent studies reported modest correlations on the samples of high-school and university students (Parker et al., 2004; Perera and DiGiacomo, 2015) which aroused interest for further investigation and consequently nominated the construct to be included in this research. Based on these considerations, even though the trait emotional intelligence model was not constructed as a cognitive ability, it is expected to positively correlate with the academic success of IT students.

The theory of multiple intelligences (Gardner, 1993) models a unique set of various personal characteristics, eight in total (Gardner, 2000): musical/rhythmic, body/kinesthetic, logical/mathematical, visual/spatial, verbal/linguistic, interpersonal, intrapersonal, and naturalist. Even though it was not initially intended for educational application, a group of practitioners embraced the model and started adapting their teaching practice to meet the perceived student individual capabilities and provide them with useful and relevant information to gain more efficient learning. Multiple intelligences profile can also be used for indirect assessment of various other students' personal characteristics (Aleksić and Ivanović, 2017; Sajjadi and De Troyer, 2022). The assessment procedure should be a part of the educational process (Almeida et al., 2010) so that each intelligence type serves as a framework for cognitive and/or emotional transfer (Bellarmen, 2021). However, even though over three decades have passed since introducing the theory, there still is no valid practical alternative to self-assessment questionnaires. The fact that multiple intelligence types all interact with one another to some degree, presents a challenge to profile validation. Nevertheless, this interference also signifies that multiple intelligences may impede one another so that the model performs to its full potential. Each intelligence possesses clear and distinct cognitive-neural correlates (Shearer, 2020). Various researchers explored the impact of multiple intelligences theory on academic performance (Aguayo, Ruano and Vallejo, 2021; Liliawati, Zulfikar and Kamal, 2018; Soleimani et al., 2012; Šafranj and Zivlak, 2018). Yaghoob and Hossein (2016) observed the positive correlation between verbal and visual intelligence with academic performance and reported on the relationship between higher verbal, logical-mathematical, and intrapersonal intelligence and academic success. The number of studies that focused on higher education academic success was particularly limited, which

further adds to the importance of this research.

Materials and Methods

The research problem is how IT students' trait emotional intelligence and multiple intelligences profile are related to academic success. The aim of the research is to examine the presumption that the academic success of IT students can be predicted based on the assessed levels of trait emotional intelligence factors and multiple intelligences profile. The results may inform whether trait emotional intelligence and multiple intelligences profile assessment should be included as factors when designing curriculum and delivering educational content to IT students.

Two research goals were defined:

1. Examination of the significance of trait emotional intelligence factors predicting the academic success of IT students.

2. Examination of the significance of multiple intelligences profile predicting the academic success of IT students.

In accordance with the defined aim and goals, two research hypotheses were formulated and are further explained.

H1: The identified trait emotional intelligence factors are the predictors of IT students' academic success.

Rationale: The expectation is based on referent research (Laborde, Dosseville and Scelles, 2010) that concluded the existence of a relationship between trait emotional intelligence scores and academic performance.

H2: The identified multiple intelligences profile is the predictor of IT students' academic success.

Rationale: The expectation is based on referent research (Gardner, 2000; Soleimani et al., 2012; Yaghoob and Hossein, 2016) that concluded the existence of a relationship between multiple intelligences profile and academic performance.

The first part of the questionnaire was used to gather the basic sociodemographic information. The following independent research variables were defined: Gender, Type of settlement, English proficiency level, Type of secondary school graduated, and Secondary education GPA. Following the hypotheses, five trait emotional intelligence factors (including global trait) were assessed in the second part of the questionnaire via the TEIQue-SF psychometric instrument in the form of a 30-item seven-point Likert type scale (Dåderman and Kajonius, 2022; Jolić-Marjanović and Altaras-Dimitrijević, 2014). The third part of the questionnaire was the assessment of student multiple intelligences profile via IPVIS instrument (Aleksić, & Ivanović, 2016) in the form of 119-item six-point Likert type scale. All the activities listed above were time-restricted.

The research was realized in 2022 at the Faculty of Technical Sciences in Čačak, University of Kragujevac (Serbia) and the School of Informatics, Aristotle University of Thessaloniki (Greece). A total of 288 IT students 19 to 31 years of age participated in the research, out of which N = 208 (72.2 %) were from Serbia, and N = 80 (27.8 %) were from Greece. The selection was made with the goal of representing various geographic, economic, and socio-cultural environments. Students completed the three-part questionnaire anonymously and voluntarily at the school facilities in about 60 minutes.

Following the theoretical-empirical nature of the research, and with the goal of exploring defined hypotheses, the participants were examined by the descriptive-analytical non-experimental method, based on which the distribution of properties was established and the relationships among variables were analyzed. The statistical data analysis was performed using IBM SPSS Statistics v22 and IBM SPSS Modeler v18 software packages. The following methods were used: descriptive statistics (frequency, percentage, arithmetic mean, standard deviation, minimum, maximum, skewness, kurtosis), Shapiro-Wilk test, correlation analysis, χ^2 test, Independent samples t-test, Cronbach's alpha internal consistency coefficient, Kaiser-Meyer-Olkin (KMO) measure of sample adequacy, Bartlett's test, exploratory factor analysis, analysis of variance (ANOVA), Tukey HSD test, Kruskal-Wallis H test, regression analysis, and educational data mining.

Results

The valid sample of N = 288 students consisted of N = 143 (49.6 %) male and N = 65 (22.6 %) female IT students from Serbia, and N = 64 (22.2 %) male and N = 16 (5.6 %) female IT students from Greece. The average age of the participants was 21.1 years (SD = 1.28). In total, N = 173 (60.1 %)

students were living in urban areas (57.2 % in Serbia and 67.5 % in Greece) and N = 115 (39.9 %) were living in rural areas (42.8 % in Serbia and 32.5 % in Greece). When asked about the perceived English proficiency level, N = 69 (24.0 %) reported advanced, N = 115 (39.9 %) reported upper intermediate, N = 83 (28.8 %) reported intermediate, N = 20 (6.9 %) reported elementary, and N = 1 (0.3 %) reported beginner. An independent samples t-test was conducted to examine whether there was a significant difference between IT students in relation to their English proficiency level. The test revealed a significant difference between students $t(286) = -4.37$; $p < .001$. Students from Greece reported significantly higher English proficiency level ($M = 4.16$, $SD = .834$) than students from Serbia ($M = 3.66$, $SD = .880$) on a scale from 1 to 5.

The average secondary education GPA was 3.39 ($SD = .753$). An independent samples t-test revealed no significant difference for the average secondary education GPA between IT students in Serbia and Greece. Most of the students graduated their secondary education in the field of IT, computer science or electrotechnics (N = 118; 41.0 %) (GPA = 3.44), N = 98 (34.0 %) graduated gymnasium (GPA = 3.37), N = 31 (10.8 %) graduated economy or law (GPA = 3.39), N = 13 (4.5 %) graduated in mechanical engineering, traffic or construction (GPA = 3.23), and N = 28 (9.7 %) graduated some other vocational school that was not listed in the questionnaire. An independent samples t-test was conducted to examine whether there was a significant gender difference between IT students concerning their secondary education GPA. The test revealed a statistically significant difference between students $t(173.8) = -2.12$, $p = .035$. Females ($M = 3.53$, $SD = .654$) achieved significantly higher secondary education GPA than males ($M = 3.34$, $SD = .783$). There was no significant effect on secondary education GPA for type of living environment. A Pearson correlation coefficient was computed to assess the relationship between English proficiency level and secondary education GPA. There was no significant association between the two variables, $r(286) = .18$, $p = .079$.

Trait emotional intelligence factors

The inter-item correlation matrix for each of the five TEIQue-SF factors (including global trait emotional intelligence) shows the existence of statistically significant correlations that confirmed the validity of TEIQue-SF. The average inter-item correlation for each trait emotional intelligence was as follows: well-being (.354), self-control (.207), emotionality (.186), and sociability (.087). The existence of a positive statistically significant correlations between individual traits and global trait emotional intelligence in the range (.602÷.840) confirmed the construct validity (Clark, & Watson, 1995) of TEIQue-SF. The internal consistencies for the scores in this study are presented in Table 1.

Table 1
Trait emotional intelligence rating

Trait emotional intelligence	Items	α	Male		Female		Serbian students		Greek students	
			M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Well-being	6	.757	65.9	17.3	70.9	16.9	71.1	17.7	57.2	11.3
Self-control	6	.610	57.6	14.8	54.9	18.3	59.0	16.6	51.1	12.1
Emotionality	8	.639	58.4	18.4	65.4	18.3	67.6	15.2	41.6	12.7
Sociability	6	.525	55.4	13.6	55.5	14.2	57.7	13.7	49.5	12.0
Global	30	.834	59.6	12.7	62.5	12.9	64.6	11.6	49.3	8.3

An independent samples t-test was conducted to examine whether there was a significant gender difference between IT students in relation to their trait emotional intelligence. The test revealed a significant gender difference between students in well-being trait $t(286) = -2.23$; $p = .026$ and emotionality trait $t(286) = -2.87$; $p = .004$. Female students achieved significantly higher scores in well-being trait ($M = 70.9$, $SD = 16.9$) than male students ($M = 65.9$, $SD = 17.3$). Female students also achieved significantly higher scores in emotionality trait ($M = 65.4$, $SD = 18.3$) than male students ($M = 58.4$, $SD = 18.4$). The t-test revealed no significant difference in self-control $t(122.8) = 1.17$, $p = .244$, sociability $t(286) = -.021$, $p = .984$, nor global trait emotional intelligence $t(286) = -1.77$, $p = .079$.

An independent samples t-test was also conducted to examine whether there was a significant difference between IT students in relation to their country of origin. The test revealed a significant

difference between students in well-being trait t(222.7) = 7.89; p < .001, self-control trait t(195.3) = 4.47; p < .001, emotionality trait t(269.6) = 14.7; p < .001, sociability trait t(162.1) = 5.00; p < .001, and global trait emotional intelligence t(199.8) = 12.5; p < .001. Students from Serbia achieved significantly higher scores than students from Greece in all trait emotional intelligence factors: well-being (M = 71.1, SD = 17.7) to (M = 57.2, SD = 11.3), self-control (M = 59.0, SD = 16.6) to (M = 51.1, SD = 12.1), emotionality (M = 67.6, SD = 15.2) to (M = 41.6, SD = 12.7), sociability (M = 57.7, SD = 13.7) to (M = 49.5, SD = 12.0), and global (M = 64.6, SD = 11.6) to (M = 49.3, SD = 8.28).

The t-test revealed no significant difference for type of living environment between IT students in relation to their trait emotional intelligence.

A Pearson correlation coefficient was computed to assess the relationship between English proficiency level and trait emotional intelligence scores. There were very weak negative correlations between the English proficiency level and well-being trait score [r(286) = -.178; p = .002], emotionality trait score [r(286) = -.174; p = .003], and global trait emotional intelligence score [r(286) = -.139; p = .019]. Increases in the proficiency level of English were correlated with decreases in well-being trait, emotionality trait, and global trait emotional intelligence scores.

There were statistically significant differences between groups when the effect of type of secondary education school on trait emotional intelligence was compared, as determined by Kruskal-Wallis H test for well-being [$\chi^2(4) = 10.6$, p = .032] with two highest mean rank scores of 188.8 for economy or law and 144.4 for mechanical engineering, traffic or construction high schools, emotionality [$\chi^2(4) = 19.1$, p = .001] with two highest mean rank scores of 186.8 for economy or law and 153.0 for IT, computer science or electrotechnics high schools, and global trait emotional intelligence [$\chi^2(4) = 15.9$, p = .003] with two highest mean rank scores of 194.5 for economy or law and 171.0 for mechanical engineering, traffic or construction high schools.

A Pearson correlation coefficient was computed to assess the relationship between secondary education GPA and trait emotional intelligence scores. There was no significant correlation between variables.

Multiple intelligences profile

IPVIS was found to be of excellent overall reliability (119 items; α=.952). The inter-item correlation matrix for each of the eight factors shows the existence of statistically significant correlations that confirmed the validity of IPVIS. The average inter-item correlation for each of the multiple intelligences was as follows: musical/rhythmic (.313), bodily/kinesthetic (.224), logical/mathematical (.277), visual/spatial (.280), verbal/linguistic (.284), interpersonal (.166), intrapersonal (.303), and naturalist (.313). The existence of positive statistically significant average inter-item correlations in the range between .146 and .629 confirmed the internal consistency of IPVIS scales (Clark and Watson, 1995). The internal consistencies for the scores in this study are presented in Table 2.

Table 2

Multiple intelligences profile score

Multiple intelligence	Items	α	Male		Female		Serbian students		Greek students	
			M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Musical/rhythmic	14	.869	52.2	19.8	51.0	16.2	49.7	18.5	57.7	18.5
Bodily/kinesthetic	13	.792	56.8	18.4	56.0	18.3	55.5	18.3	59.3	18.2
Logical/mathematical	17	.865	61.1	17.2	63.9	17.9	61.7	17.6	62.3	16.9
Visual/spatial	15	.853	54.1	18.6	56.9	16.9	55.2	17.9	54.2	18.9
Verbal/linguistic	20	.883	55.4	16.5	57.9	16.9	56.7	17.0	54.6	15.7
Interpersonal	18	.765	62.5	12.8	65.4	11.7	63.9	12.6	61.8	12.4
Intrapersonal	9	.786	72.1	16.1	71.3	15.5	74.6	14.9	64.7	16.3
Naturalist	13	.850	60.9	20.3	66.1	17.8	66.1	19.0	52.5	18.0

An independent samples t-test were conducted to examine whether there was a significant gender difference between IT students in relation to their multiple intelligences profile scores. The t-test revealed a significant difference in naturalist intelligence, t(286) = -2.01, p = .045. Female students achieved significantly higher scores in naturalist intelligence (M = 66.1, SD = 17.8) than male students (M = 60.9, SD = 20.3).

An independent samples t-test were also conducted to examine whether there was a significant difference between IT students from Serbia and Greece in relation to their multiple intelligences profile scores. The t-test revealed a significant difference in musical/rhythmic [t(286) = -3.29, p = .001], intrapersonal [t(286) = 4.92, p < .001], and naturalist intelligence [t(286) = 5.49, p < .001]. While students from Greece achieved significantly higher scores in musical/rhythmic intelligence (M = 57.7, SD = 18.5) than students from Serbia (M = 49.7, SD = 18.5), Serbian students exceeded their colleagues from Greece in intrapersonal intelligence scores, (M = 74.6, SD = 14.9) and (M = 64.7, SD = 16.3), respectively, and naturalist intelligence scores, (M = 66.1, SD = 19.0) and (M = 52.5, SD = 18.0), respectively.

When we examined whether there was a significant difference for type of living environment between IT students in relation to their multiple intelligences profile, the t-test revealed a significant difference only in naturalist intelligence, t(286) = -4.06, p < .001. Students living in rural areas (M = 68.0, SD = 18.9) achieved significantly higher scores in naturalist intelligence than students living in urban areas (M = 58.6, SD = 19.4).

A Pearson correlation coefficient was computed to assess the relationship between English proficiency level and multiple intelligences profile. There was very weak positive correlation between the English proficiency level and musical/rhythmic intelligence (r(286) = .167; p=.005). Increases in the proficiency level of English were correlated with increases in musical/rhythmic intelligence score.

A one-way between-subjects ANOVA was conducted to compare the effect of the type of secondary school student graduated on multiple intelligences profile. There was a significant effect of type of secondary school student graduated on musical/rhythmic and naturalist intelligence at the p < .05 level, [F(4,283) = 2.64, p = .034, η2 = .036] and [F(4,283) = 2.72, p = .030, η2 = .037], respectively. Post hoc comparisons using the Tukey HSD test indicated that the level of musical/rhythmic intelligence was significantly higher in IT students who graduated gymnasium compared to students who graduated secondary education in the field of economy or law (p = .042), likewise for naturalist intelligence (p = .040).

A Pearson correlation coefficient was computed to assess the relationship between secondary education GPA and multiple intelligences profile. There was very weak positive correlation between secondary education GPA and logical/mathematical intelligence r(286) = .135, p = .022. Increases in secondary education GPA were correlated with increases in logical/mathematical intelligence.

A Pearson correlation coefficient was computed to assess the relationship between trait emotional intelligence and multiple intelligences profile and the result are presented in Table 3.

Table 3

Correlations between trait emotional intelligence factors and multiple intelligences profile

	Trait emotional intelligence				
Multiple intelligences	Well-being	Self-control	Emotionality	Sociability	Global
Musical/rhythmic	.009	-.013	-.071	.021	-.046
Bodily/kinesthetic	.280**	.209**	.129*	.236**	.262**
Logical/mathematical	.188**	.194**	.178**	.299**	.283**
Visual/spatial	.331**	.303**	.227**	.219**	.358**
Verbal/linguistic	.296**	.296**	.266**	.457**	.414**
Interpersonal	.435**	.285**	.312**	.364**	.455**
Intrapersonal	.451**	.318**	.342**	.262**	.484**
Naturalist	.314**	.202**	.384**	.278**	.416**

* $p < .05$; ** $p < .01$

Weak and moderate positive correlations were identified between trait emotional intelligence factors and multiple intelligences except for musical/rhythmic intelligence.

Predicting academic success

Students' tertiary education GPA mean value was 7.72 (SD = .931). The t-test revealed no significant difference in gender between IT students concerning their tertiary education GPA t(286) = -.120, p = .905.

An independent samples t-test was conducted to examine whether there was a significant difference between IT students from Serbia and Greece in relation to their tertiary education GPA. The test revealed a significant difference between students t(286) = 4.63, p < .001. Students from Serbia

achieved significantly higher GPA than students from Greece, (M = 7.87, SD =.897) and (M = 7.32, SD = .907), respectively.

There was no significant effect on tertiary GPA for the type of living environment, t(286) = .201, p = .841.

A Pearson correlation coefficient was computed to assess the relationship between English proficiency level and tertiary education GPA. There was no significant correlation between the two variables, r(286) = .073, p = .218.

A one-way between-subjects ANOVA was conducted to compare the effect of the type of secondary school student graduated on tertiary education GPA. There were no statistically significant differences between groups when the effect of type of secondary school was compared on tertiary education GPA [F(4,283) = 2.08, p = .084].

A Pearson correlation coefficient was computed to assess the relationship between secondary education GPA and tertiary education GPA. There was a significant weak positive correlation between the two variables, r(286) = .360, p < .001. Increases in secondary education GPA were correlated with increases in tertiary education GPA.

A Pearson correlation coefficient was computed to assess the relationship between trait emotional intelligence and tertiary education GPA. There were very weak positive correlations between tertiary education GPA and emotionality trait [r(286) = .142; p = .016], sociability trait [r(286) = .126; p = .033], and global trait emotional intelligence factors [r(286) = .142; p = .016]. Increases in the emotionality, sociability or global trait emotional intelligence scores were correlated with increases in tertiary education GPA.

A Pearson correlation coefficient was also computed to assess the relationship between tertiary education GPA and multiple intelligences profile. There were weak positive correlations between tertiary education GPA and logical/mathematical [r(286) = .221, p < .001], intrapersonal [r(286) = .178, p = .002], and naturalist intelligence [r(286) = .140, p = .017]. Increases in logical/mathematical, intrapersonal or naturalist intelligence were correlated with increases in tertiary education GPA.

Educational data mining was used by performing predictive neural network analysis. A multiplayer perception (i.e., MLP) class of artificial neural network was used to build the model and test its accuracy. The data was randomly assigned to training (70%), testing (20%) and validation (10%) subsets. All covariates were normalized before the training. The scaled conjugate gradient method was used for the batch training of the artificial neural network. In order to obtain more accurate prediction, an ensemble was created using boosting. The experimental model presented in Figure 1 was capable of calculating predictor importance for tertiary education GPA based on the 19 input parameters (factors).

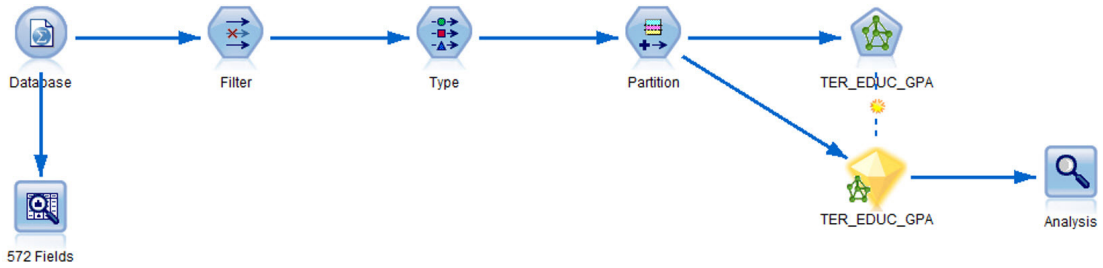

Figure 1. The experimental environment of the predictive neural network model.

MLP class of artificial neural network identified N = 288 valid cases for processing, out of which N = 198 (68.7 %) was used for training, N = 44 (15.3 %) was used for testing, and N = 46 (16.0 %) was used for validation, resulting in 96.9 % model accuracy. Architecture selection chose 3 nodes for the hidden layer. The neural network model identified 17 predictors with significant effects. The resulting accuracy in the model summary was satisfactory 96.8 %. The relative importance of the predictors in the model is visualized in Figure 2.

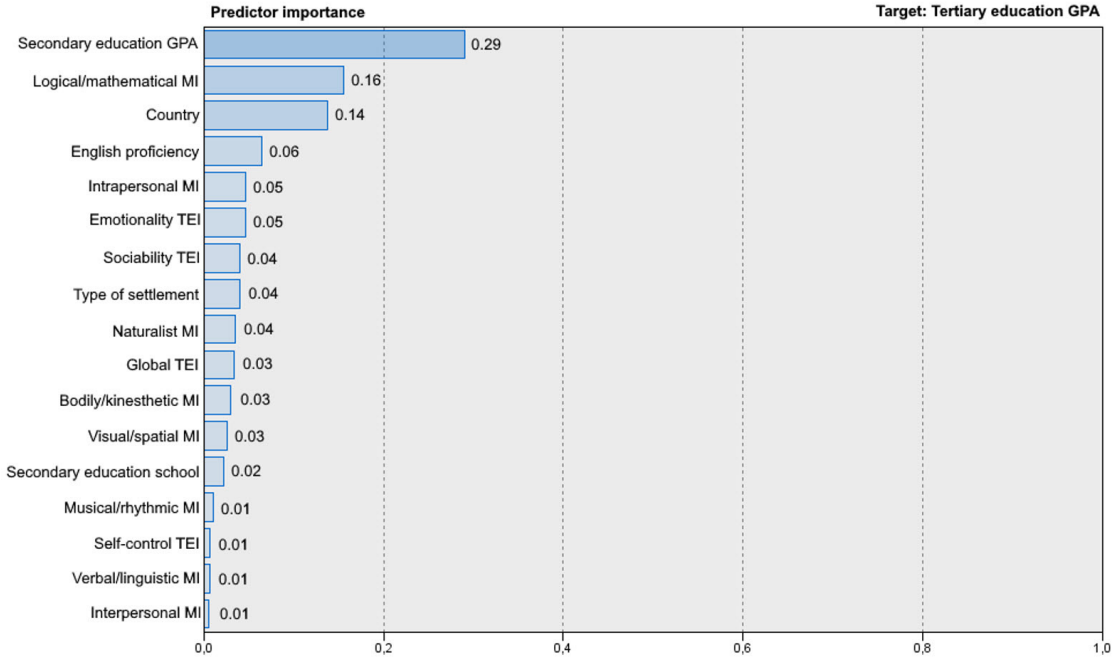

Figure 2. Predictor importance of the effects.

It should be noted that the values of the predictor importance are not the relative proportion of the variable coefficients. These values only describe the effect on the tertiary education GPA if the input variables change. However, the input variables were scaled differently.

Educational data mining provided far more optimized results compared to traditional factor analysis. Out of the 17 identified predictors, the effects of secondary education GPA [$\beta = .34$, $t(270) = 5.24$, $p < .001$], logical/mathematical intelligence [$\beta = .02$, $t(270) = 3.92$, $p < .001$], and the country that students live [$\beta = -.49$, $t(270) = -3.16$, $p = .002$] were far stronger on tertiary education GPA of IT students (and thus their academic success).

Multiple linear regression analysis was used to predict tertiary education GPA based on the five trait emotional intelligence factors (including global trait). A significant regression equation was found [$F (5, 282) = 4.33$, $p = .001$], with an $R2$ of .071. It was found that well-being trait [$\beta = -.03$, $p = .001$], self-control trait [$\beta = -.02$, $p = .001$], emotionality trait [$\beta = -.02$, $p = .022$], and global trait emotional intelligence [$\beta = .10$, $p = .001$] significantly predicted tertiary education GPA.

Multiple linear regression analysis was also used to predict tertiary education GPA based on the eight multiple intelligence factors. A significant regression equation was found [$F (8, 279) = 6.25$, $p < .001$], with an $R2$ of .152. It was found that bodily/kinesthetic [$\beta = -.01$, $p = .020$], logical/mathematical [$\beta = .02$, $p < .001$], visual/spatial [$\beta = -.01$, $p < .001$], intrapersonal [$\beta = .01$, $p = .031$], and naturalist intelligence [$\beta = .01$, $p = .031$] significantly predicted tertiary education GPA.

Discussions

The paper analyzed relations between trait emotional intelligence factors, multiple intelligences profile and the IT student academic success. The examination of hypotheses that were formulated following defined aims and goals was performed by empirical research on a sample of 288 university IT students from Serbia and Greece.

Even though secondary education GPA was identified as the most important predictor of university academic success, there was no significant difference detected for this factor between IT students in Serbia and Greece. Students from Serbia did achieve significantly higher tertiary GPA than students from Greece, which explains higher predictor importance of country of origin. In general, increases in secondary education GPA were correlated with increases in tertiary education GPA. These results are consistent with Blackmore, Hird and Anderton (2021), that identified high school STEM subjects' proficiency as a significant determinant of overall GPA, especially for engineering students. However, there were reports that point that high school GPA was not an effective predictor of success at higher levels of education (Noble and Sawyer, 2002). Even though female students reported significantly higher

secondary education GPA than males, gender difference was not identified as significant predictor of university academic success. These findings are not consistent with (Tessema, Ready and Malone, 2012), who reported a statistically significant moderate effect of gender on students' GPA.

The type of living environment (e.g., urban or rural) was not identified as a significant predictor of academic success, which is consistent with (Khan et al., 2012; Kurek and Górowski, 2020).

Students from Greece reported significantly higher English proficiency level than students from Serbia. English proficiency level was a significant predictor of academic performance. These findings are consistent with (Geide-Stevenson, 2018; Martirosyan, Hwang and Wanjohi, 2015).

The validity of Serbian and Greek translated and adapted 30-item versions of TEIQue-SF (Petrides, 2009) was confirmed. These findings are consistent with the results of referent research (Jolić-Marjanović and Altaras-Dimitrijević, 2014; Stamatopoulou, Galanis and Prezerakos, 2016). Students from Serbia achieved significantly higher scores than students from Greece in all trait emotional intelligence factors. There were significant gender differences in trait emotional intelligence factor scores, and female students achieved significantly higher scores in well-being and emotionality trait emotional intelligence. These findings are consistent with (Perera, 2015; Petrides and Furnham, 2000; Petrides and Mavroveli, 2018). There was no significant correlation between trait emotional intelligence and secondary education GPA, which is consistent with (Shipley, Jackson and Segrest, 2010). Contrary to (Herrera Torres, Buitrago Bonilla and Cepero Espinosa, 2017) findings, which reported significantly lower emotional intelligence scores in students living in rural areas, our research did not identify significant differences in the type of living environment. Increases in the proficiency level of English were correlated with decreases in well-being trait, emotionality trait, and global trait emotional intelligence scores. These findings are contrary to Dewaele (2018) who reported that English proficiency level positively correlated with emotionality and global trait emotional intelligence levels.

The educational data mining procedure using predictive neural network model confirmed that emotionality, sociability, self-control, and global trait emotional intelligence factors were significant predictors of tertiary academic success. This can be explained from two aspects. First, the structure of the university IT study programmes is very time and cognitive demanding, having a large number of electable subjects correlated to various areas of IT application, so students are often separated into small groups and directed towards self-regulated learning. Rode et al. (2007) stated that students with higher levels of emotional intelligence are more efficient at upholding the energy needed for high cognitive performance over longer periods of time, and redirecting negative emotions into productive behaviors. Second, university IT students are exposed to higher level of stress due to a large number of various tasks that are often related to the field of technological application and as such require advanced levels of digital skills and competence. In addition, a significant number of lecturers on contemporary IT courses are engaged from the IT industry, and consequently often use questionable teaching methods. Students with higher level of emotional intelligence are associated with lower level of acute and chronic stress (Singh and Sharma, 2012). It should be noted that several researchers reported no significant correlation between emotional intelligence and tertiary academic achievement (Wurf and Croft-Piggin, 2015).

Having in mind the presented findings, it can be concluded that hypothesis H1: The identified trait emotional intelligence factors are the predictors of IT students' academic success is confirmed.

The expected validity of the 119-item version of IPVIS is based on the results of referent research (Aleksić and Ivanović, 2016) that evaluated the instrument and concluded that it was valid and reasonably reliable. Female students achieved significantly higher scores in naturalist intelligence, which is consistent with (Aleksić and Ivanović, 2017). Students from Greece achieved significantly higher scores in musical/rhythmic intelligence. This finding can be explained by the strong socio-cultural influence of music on Greek society which is still permeated with vivid remnants of linguistic, cultural, architectural, and musical spheres of civilization that have flourished from the second millennium BC until the first millennium AD (Charidimou et al., 2022). Students from Serbia exceeded in intrapersonal and naturalist intelligence scores. Until the mid-twentieth century, Serbia remained a country of peasant smallholders starting from the Ottoman conquest in second half of the 14th and the first half of the 15th century (Šljukić, 2006). Most of the Serbian population lived simple lives, focused on themselves, recognizing own abilities, capacities, intuition and recognizing patterns in nature. This behavior patterns inevitably influenced the profile of the people who inhabited it, and obviously can still be recognized. Students living in rural areas achieved significantly higher scores in naturalist intelligence. Predictive neural network model confirmed that all multiple intelligence factors were significant predictors of tertiary academic success. Logical/mathematical intelligence was identified as the most important predictor, following intrapersonal intelligence, naturalist intelligence, etc., which is consistent with (Torreon and Sumayang, 2021) findings. This was expected, as university IT education relies heavily on proficient knowledge and skills in applied mathematics and logic,

that can be observed in programming which is a foundation of every contemporary IT curriculum.

Having in mind the presented findings, it can be concluded that hypothesis H2: The identified multiple intelligences profile is the predictor of IT students' academic success is confirmed.

Limitations

The research was realized with certain limitations. Even the sample was adequate in structure and size, and the psychometric instruments were reliable and valid, the conclusions about identified causal relationship between sociodemographic factors, trait emotional intelligence, multiple intelligences profile, and academic success were impossible to confirm due to the correlation nature of the research, so the focus of these relations should be clarified by longitudinal research which would add dynamic dimension.

Conclusions

With the rapid implementation of various digital educational platforms and services which gained additional importance during the Covid-19 emergency, an extremely large amount of new data on student activities is generated daily. This big data represents an exceptional pool from which various predictions of student behavior and performance can be derived. The present study examined the effects of trait emotional intelligence and multiple intelligences profile of IT students on their academic success at two universities from Serbia and Greece.

Secondary education GPA and logical/mathematical intelligence were the two most significant predictors of university IT students' academic success. In addition to the identified trait emotional intelligence and multiple intelligences profile predictors, further effects are relevant to discuss. Trait emotional intelligence factors related to multiple intelligences profile in a very complex manner. This was expected as both concepts expand the model of general intelligence (Spearman, 1961) by including often similar characteristics such as individual differences, academic intelligence, personality, interests, etc. These findings are consistent with (Keshavarz, Farahan and Khajehpour, 2014) but contrary to (Bay and Lim, 2006) findings that reported a significant number of negative correlations. In general, the developed educational data mining model proved its efficiency. Over 44% of the variance in the IT student tertiary education GPA can be explained. The extent to which the effects of trait emotional intelligence factors and multiple intelligences profile were predictive is remarkable. It should be emphasized that the effects of some factors were controlled by more or less typical predictors, such as prior schooling (secondary education GPA) and English proficiency level.

In the context of academic success, trait emotional intelligence and multiple intelligences profile are especially powerful as they can help university teachers understand IT education holistically. The sphere of IT disciplines and applications is constantly evolving and growing. Traditional software industry is nowadays under the onslaught of machine learning, artificial intelligence, blockchain and metaverse applications, and many new technologies are on the horizon. As more and more jobs in the IT industry are automated and taken over by computers, education stakeholders and university teachers clearly should pay more attention to their timely assessment and adaptation of teaching practice to create a learning environment that will empower students with appropriate current knowledge and skills, such as critical thinking, complex problem solving, design thinking, cognitive flexibility, business analytics, etc. Many of the listed abstract skills students can master much more efficiently if the content and teaching methods are adjusted to their individual characteristics, which can be observed via their trait emotional intelligence and multiple intelligence profile.

Future research will include experimental measurement points to better reflect the complex spectrum of academic performance and success. Due to the sample size and structure, student performance in various courses should be separately analyzed. Regardless of stated limitations, this research supports the importance of fostering a student-centered learning model through tertiary education, with special emphasis on taking into account students' personal dispositions and traits.

Conflict of interests

The authors declare no conflict of interest.

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Author Contributions

Conceptualization, V.A. and D.P.; Resources, V.A. and D.P.; Methodology, V.A.; Investigation, V.A. and D.P.; Data curation, V.A.; Formal Analysis, V.A. and D.P.; Writing – original draft, V.A. and D.P.; Writing – review & editing, V.A. All authors have read and agreed to the published version of the manuscript.

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