Team 15: Does Time Management Influence the Academic Performance of NTU Students?

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Introduction

To exceed at a top university, students must allocate enough time out of the day to finish their school work and studies. There are many other possible things that could influence a student's grade point average, but we want to focus on some specific factors that could influence GPA, which is the time management.

Effective time management is expected to be associated with greater academic performance in students; however, many students find it hard to find a balance between their studies and their day-to-day lives. Our project examines the self-reported time management behaviors of students in National Taiwan University (NTU) in the 2019 fall semester.

Introduction

We are curious about if the difference of time management of NTU students has an association with their academic performance. To be more concrete, we want to answer the the following questions:

1. Is it true that the more time the students spend on the study, the higher GPA they archive?
2. Is it true that the more time the students spend on the Internet for entertainment, the less GPA they receive?
3. What is the correlation between communication time and GPA?
4. Is there an association between regular exercise with academic performance?
5. Does the difference of time management explain the variation of the GPA in the last semester well?

Lecture Review

- Richelle V. Adams and Erik Blair (2019), "Impact of Time Management Behaviors on Undergraduate Engineering Students' Performance" in *SAGE Journal*, found that, for 289 undergraduate students in Department of Electrical and Computer Engineering (DECE), although time management behaviors seemed to have positive influence on academic performance, they only accounted for a small percentage of the variability of the cumulative GPA.
- An article, "The relationship between cell phone use, academic performance, anxiety, and Satisfaction with Life in college students" in *Computers in Human Behavior*, by Andrew Lepp, Jacob E. Barkley, Aryn C. Karpinski (2014) showed that high frequency cell phone users tended to have lower GPA relative to their peers who used the cell phone less often in a sample with sample size 496 users,

Lecture Review

- 王淑娟 (2009), "The study on the Association between Internet Addiction and Sleep Disturbance among Nursing Students of Junior Colleges". The results of multiple logistic regression analysis on a data with 889 students showed that the students with poor school performance ranking were more likely to become addicted to the Internet, spending time online for more than 14 hours per week and more than 3 times per week on average.
- Marcelo Sampaio de Alencar (2016), *Communication, Management and Information Technology*, used a network model to analyze 1248 students' data and found there is a negative correlation between students that have low GPA and high commuting time.

Lecture Review

- Joseph Carnagio, Nicholas Storm, Ryan Hunt, and Chris Haile (2016) in an online article, "Relationship Between Exercise and GPA for College Students", concluded that students in the University of Illinois who work out three or more times a week, on average, will achieve a higher GPA than students who do not work out regularly.

The First Model: MLR

Suppose the GPA in the last semester represents the average academic performance of NTU students. Our first model assumes *GPA* is a linear model with 7 explanatory variables, including *study*, *web*, *read*, *com*, *sleep*, *exercise*, *eat* with an error term $\epsilon \overset{\text{iid}}{\sim} (0, \sigma^2)$. The meaning of each variables are listed in the next slide.

The First Model: MLR

1. *GPA*: the GPA in the 2019 fall semester (range from 0-4.3)
2. *study*: the average study time per day (unit: hour)
3. *web*: the average time using the Internet for entertainment per day (unit: hour)
4. *read*: the average reading time per day for fun (unit: hour)
5. *com*: the average communication time per day (unit: hour)
6. *sleep*: the average sleeping time per day (unit: hour)
7. *exercise*: the average exercise time per day (unit: hour)
8. *eat*: the average time for eating per day (unit: hour)

The First Model: MLR

That is,

$$GPA = \beta_0 + \beta_{study}\, study + \beta_{web}\, web + \beta_{read}\, read + \beta_{com}\, com \\ + \beta_{sleep}\, sleep + \beta_{exercise}\, exercise + \beta_{eat}\, eat + \epsilon.$$

Here, we are most interested in the sign and magnitude of the first two coefficients, β_{study} and β_{web}. The coefficients, β_{com} and $\beta_{exercise}$, well be discussed to compare the result of the reference. Also, the model performance is considered.

The Second Model: MLR with Quadratic Terms

This model is inspired by the implement result of the first model. By adding the quadratic terms of each explanatory variables, the second model aims to adjust the weird result of the previous one. From the glimpse of a simple regression,

$$GPA = \beta_0 + \beta_{study}\, study + \beta_{study2}\, study^2 + \epsilon,$$

we notice that the p-value of the $\hat{\beta}_{study}$ is improved significantly but the VIFs become greater. Thus, our second model is the first model plus quadratic terms, which become a linear model with 14 explanatory variables.

The Third Model: MLR with Control Variables

Since the multicollinearity arises in the second model, we then consider to add some control variables, such as *gender*, *home*, *grade*, *college*, and *club* to the second model. This leads to a linear model with 12 explanatory variables. The details of each control variables are listed in the next slide.

The Third Model: MLR with Control Variables

- *gender*: The gender of subjects. If a subject is female, then *gender* $= 0$. Otherwise, *gender* $= 1$.
- *home*: The hometown of subjects. Assign the values of *home* from 0 to 4 for the Northern Taiwan, the Central Taiwan, the Southern Taiwan, the East Taiwan, and the other.
- *grade*: The grade of subjects. Assign the values of *grade* from 0 to 4 for Freshman, Sophomore, Junior, Senior, to Graduated.
- *college*: The college of subjects. Assign the value from 0 to to 8 for different colleges. The base group of the college is the College of Social Sciences.
- *club*: The number of clubs subjects joined in the last semester.

The Forth Model: MLR with Quadratic Terms and Control Variables

The model performance in either the second model or the third model is still not well enough. $\bar{R}^2$ is relatively small in our later implement, and so are the p-values of our interested variables. Thus, we consider to combine them into a linear model with 19 explanatory variables.

The Last Model: Stepwise Selection

With the control variables, the forth model results in a higher $\bar{R}^2$ and lower VIFs. However, the coefficients of each variables become non-significant, and moreover the issue of multicollinearity still occurs. This may result from adding too many variables in our model, and our collected data are not large enough to estimate that much parameters precisely. Therefore, we apply the stepwise selection method to find fewer the important expanatory variables in the third model. The final model becomes

$$\begin{aligned} GPA = \beta_0 + \beta_{study}\, study + \beta_{com}\, com + \beta_{exercise}\, exercise + \beta_{study}\, study^2 \\ + \beta_{read2}\, read^2 + \beta_{com2}\, com^2 + \delta_{gender}\, gender + \delta_{home}\, home + \epsilon, \end{aligned}$$

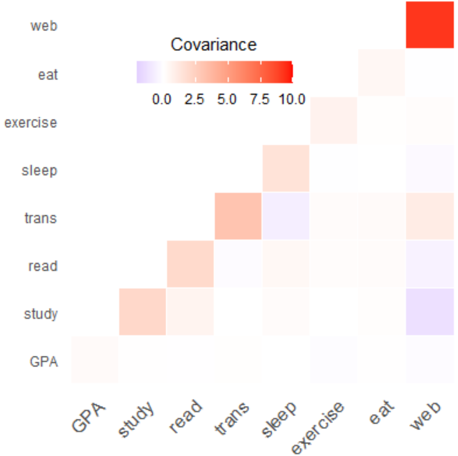
which becomes a linear model with only 8 explanatory variables.

Data Summary

The data are collected by our online questionnaire from 70 NTU students in the club of Facebook. The variables are *study*, *web*, *read*, *com*, *sleep*, *exercise*, *eat*, *gender*, *home*, *grade*, *college*, and *club*, which we have mentioned previously. Note that the base group of *gender*, *home*, *grade*, and *college* represents females, from the Northern Taiwan, Freshmen, and studying in College of Social Sciences, respectively.

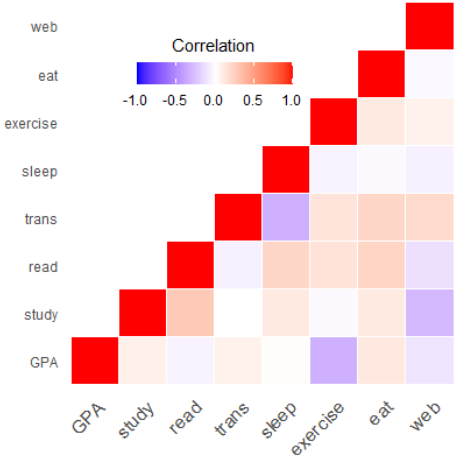
Data Summary: In the First Model

The covariance matrix suggests that our interesting variables *study* and *web* have small covaraince to the *GPA*. In fact, the covariance of these two variables with *GPA* are 0.05 and -0.16.



Data Summary: In the First Model

The correlation matrix also suggests that these two variables are almost uncorrelated to the *GPA* with correlation 0.08 and -0.11.



Data Summary: Control Variables

The proportions of female and male are about 34% and 65%.

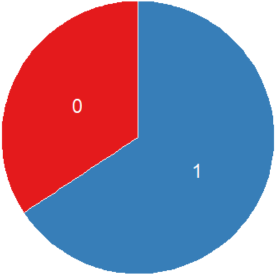


Figure: Proportion of gender

Data Summary: Control Variables

The proportions of each group are about 58%, 21%, 14%, 1%, and 4% in the order of the group, which means over half of subjects comes from the Northern Taiwan.

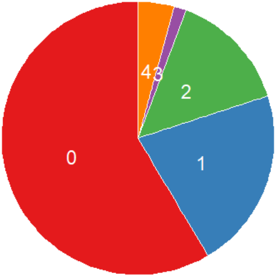


Figure: Proportion of hometown

Data Summary: Control Variables

The proportions of each group are about 47%, 12%, 27%, 5%, and 7%, which means about half of subjects are Freshmen in our data.

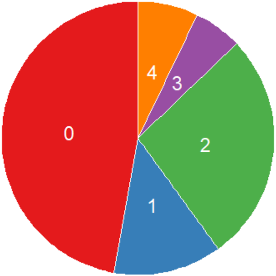


Figure: Proportion of grade

Data Summary: Control Variables

The first three groups have proportion about 22%, 15%, and 18%, which are also the first three largest groups in our data. They represent students in College of Social Sciences, College of Engineering, and College of Management, respectively.

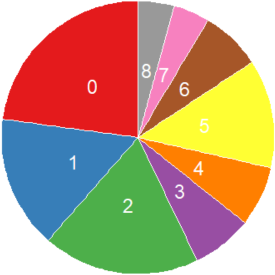
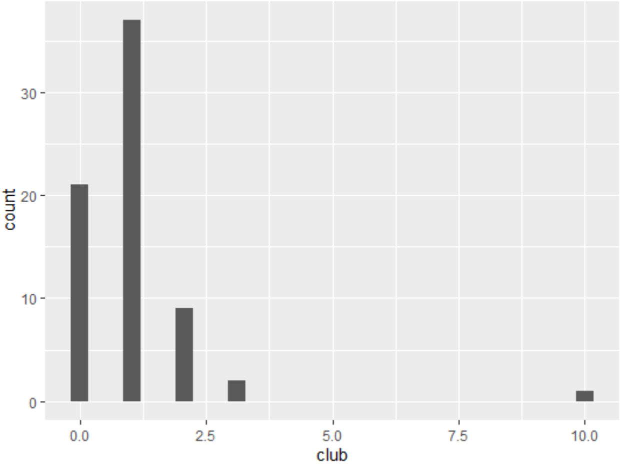


Figure: Proportion of college

Data Summary: Control Variables

There may be a registration error for the case *club* $= 10$. 52% of subjects have joined one club, and 30% of subjects have not join any club in the last semester.



Implement Result: The First Model

We regress *GPA* on *study*, *web*, *read*, *com*, *sleep*, *exercise*, *eat*. Then, we obtain $R^2 = 0.1652$, $\bar{R}^2 = 0.07094$, and the p-value 0.1133 with the following table. (*, **, and *** mean significant at 0.05 level, 0.01 level, and 0.001 level, respectively.)

Coefficient	Estimate	Std. Error	p-value
(Intercept)	3.40981	0.29899	$<$ 2e-16 ***
study	0.01223	0.04370	0.78052
web	-0.01597	0.02029	0.43424
read	-0.01647	0.04513	0.71637
com	0.03479	0.03663	0.34584
sleep	0.01509	0.05130	0.76962
exercise	-0.21896	0.07245	0.00364 **
eat	0.10212	0.09330	0.27797

Table: The first model

Implement Result: The First Model

To confirm the homoscedasticity assumption, the BP test results in p-value $= 0.4282$. One can also check via the residual plot. For the consideration of multicollinearity, the largest VIF is 1.254311 only.

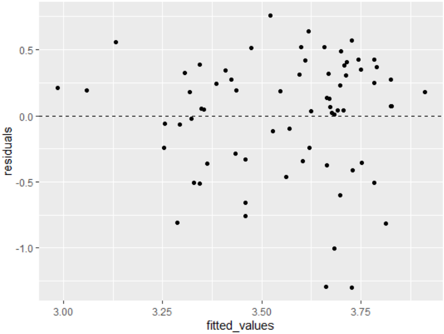


Figure: Residual plot of the first model

Implement Result: The Second Model

The second model is inspired by the simple regrssion of *GPA* on *study* and *study*^{2}. $R^2 = 0.04681$, $\bar{R}^2 = 0.01836$, and p-value $= 0.2007$ (., *, **, and *** mean significant at 0.1 level, 0.5 level, 0.01 level, and 0.001 level, respectively.)

Coefficient	Estimate	Std. Error	p-value
(Intercept)	3.32402	0.15034	$<$ 2e-16 ***
study	0.23482	0.12955	0.0744 .
study^2	-0.04015	0.02368	0.0946 .

Table: The simple regression of study and its quadratic term

Implement Result: The Second Model

$R^2 = 0.2616$, $\bar{R}^2 = 0.07367$, and the p-value $= 0.1885$ (*, **, and *** mean significant at 0.05 level, 0.01 level, and 0.001 level, respectively.) Although the result seems worse, the magnitude of $\hat{\beta}_{study}$ and $\hat{\beta}_{web}$ increases, and both of their p-value decreases.

Coefficient	Estimate	Std. Error	p-value
(Intercept)	3.5832004	0.5467726	$<$ 2.03e-08 ***
study	0.2058653	0.1626423	0.211
web	-0.0999184	0.0734452	0.179
read	0.0594453	0.1284223	0.645
com	-0.0667920	0.1415250	0.639
sleep	0.1854709	0.1384869	0.186
exercise	-0.2200598	0.1934564	0.260
eat	0.1621748	0.3682095	0.661

Table: The second model (part I)

Implement Result: The Second Model

$R^2 = 0.2616$, $\bar{R}^2 = 0.07367$, and the p-value 0.1885 (*, **, and *** mean significant at 0.05 level, 0.01 level, and 0.001 level, respectively.)

Coefficient	Estimate	Std. Error	p-value
study^2	-0.0360050	0.0278962	0.202
web^2	0.0066522	0.0046401	0.157
read^2	-0.0193463	0.0253826	0.449
com^2	0.0082270	0.0119579	0.494
sleep^2	-0.0329434	0.0243676	0.182
exercise^2	-0.0003846	0.0620334	0.995
eat^2	-0.0258260	0.0920461	0.780

Table: The second model (part II)

Implement: The Second Model

The BP test results in p-value $= 0.7485$, so the homoscedasticity assumption is not rejected. The residual plot is as follows. However, the largest VIF is 18.78109. Thus, the issue of multicollinearity occurs.

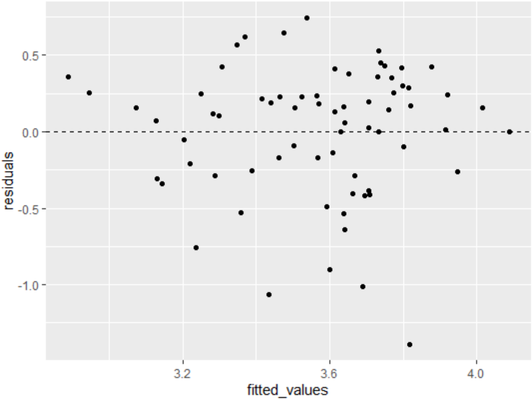


Figure: Residual plot of the second model

To increase the $\bar{R}^2$ and R^2 and decrease the VIF, we add the control variables to the first model, *gender*, *home*, *grade*, *college*, and *club*. This leads to $R^2 = 0.2984$, $\bar{R}^2 = 0.1507$, and the p-value $= 0.03882$ (., *, **, and *** mean significant at 0.1 level, 0.05 level, 0.01 level, and 0.001 level, respectively.)

Coefficient	Estimate	Std. Error	p-value
(Intercept)	3.70502	0.32028	$<$ 2e-16 ***
study	0.01314	0.04370	0.76477
web	-0.01757	0.02109	0.40828
read	-0.03386	0.04451	0.44996
com	0.02057	0.03627	0.57281
sleep	0.03121	0.05085	0.54173
exercise	-0.20348	0.07331	0.00744 **
eat	0.08049	0.09295	0.39014

Table: The third model (part I)

Implement: The Third Model

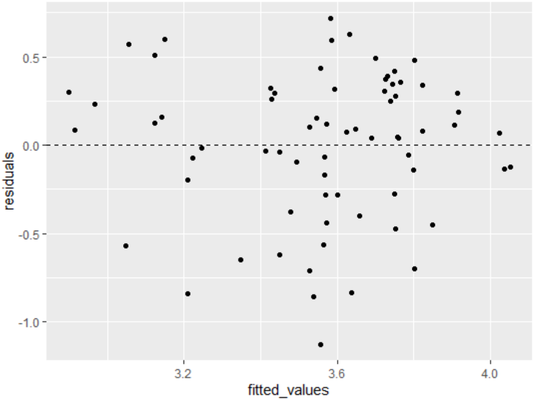
$R^2 = 0.2984$, $\bar{R}^2 = 0.1507$, and the p-value $= 0.03882$ (., *, **, and *** mean significant at 0.1 level, 0.05 level, 0.01 level, and 0.001 level, respectively.)

Coefficient	Estimate	Std. Error	p-value
gender	-0.17019	0.13132	0.20018
home	-0.15566	0.05566	0.00703 **
grade	0.06224	0.04745	0.19493
college	-0.02389	0.02482	0.33978
club	0.05062	0.04700	0.28604

Table: The third model (part II)

Implement: The Third Model

The BP test results in p-value $= 0.1973$, so the homoscedasticity assumption is not rejected. The residual plot is as follows. Also, the largest VIF is only 1.361261, we are not not worried about the problem of multicollinearity.



Implement Result: The Forth Model

By combining the second and the third models, this leads to $R^2 = 0.4239$, $\bar{R}^2 = 0.205$, and the p-value $= 0.032$ (., *, **, and *** mean significant at 0.1 level, 0.05 level, 0.01 level, and 0.001 level, respectively.)

Coefficient	Estimate	Std. Error	p-value
(Intercept)	4.356702	0.565264	$<$ 4.73e-10 ***
study	0.268421	0.157556	0.09465 .
web	-0.059917	0.072422	0.41198
read	0.051986	0.125694	0.68094
com	-0.302657	0.147907	0.04601 *
sleep	0.073686	0.144742	0.61293
exercise	-0.233086	0.183532	0.20996
eat	0.217237	0.345654	0.53255

Table: The forth model (part I)

Implement Result: The Forth Model

$R^2 = 0.4239$, $\bar{R}^2 = 0.205$, and the p-value $= 0.032$ (., *, **, and *** mean significant at 0.1 level, 0.05 level, 0.01 level, and 0.001 level, respectively.)

Coefficient	Estimate	Std. Error	p-value
study^2	-0.042487	0.027087	0.12307
web^2	0.004490	0.004763	0.35038
read^2	-0.020695	0.024863	0.40917
com^2	0.027130	0.012498	0.03472 *
sleep^2	-0.013607	0.025410	0.59467
exercise^2	0.001676	0.059189	0.97752
eat^2	-0.044249	0.086223	0.61008

Table: The forth model (part II)

Implement Result: The Forth Model

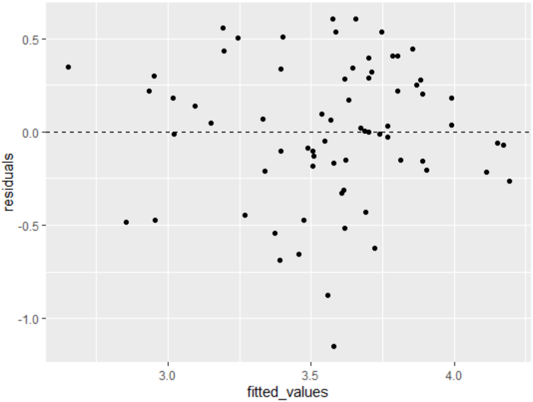
$R^2 = 0.4239$, $\bar{R}^2 = 0.205$, and the p-value $= 0.032$ (., *, **, and *** mean significant at 0.1 level, 0.05 level, 0.01 level, and 0.001 level, respectively.) Notice that $\hat{\beta}_{study}$ becomes better, but $\hat{\beta}_{web}$ becomes worse.

Coefficient	Estimate	Std. Error	p-value
gender	-0.254892	0.134132	0.06317 .
home	-0.211128	0.068183	0.00321 **
grade	0.071416	0.046811	0.13341
college	-0.020689	0.025438	0.41988
club	0.027969	0.053379	0.60261

Table: The forth model (part III)

Implement Result: The Forth Model

The BP test results in p-value $= 0.2631$, so we have no enough evidence to reject the homoscedasticity assumption. The residual plot is as follows. Yet, the largest VIF is 23.90258. Hence, the problem of multicollinearity does not be solved.



Implement Result: The Last Model

Finally, we apply the stepwise selection method to improve our result in the previous model. This leads to a linear model with only 8 explanatory variables as we have mentioned:

$$
\begin{aligned}
GPA = \beta_0 + \beta_{study}\, study + \beta_{com}\, com + \beta_{exercise}\, exercise + \beta_{study}\, study^2 \\
+ \beta_{read2}\, read^2 + \beta_{com2}\, com^2 + \delta_{gender}\, gender + \delta_{home}\, home + \epsilon.
\end{aligned}
$$

Implement Result: The Last Model

$R^2 = 0.3523$, $\bar{R}^2 = 0.2674$, and the p-value $= 0.0005271$ (., *, **, and *** mean significant at 0.1 level, 0.05 level, 0.01 level, and 0.001 level, respectively.) The variable *web* is dropped out, but $\hat{\beta}_{study}$ becomes significant at a higher level.

Coefficient	Estimate	Std. Error	p-value
(Intercept)	4.415629	0.419510	$<$ 2.42e-15 ***
study	0.250856	0.118050	0.037646 *
com	-0.286282	0.128151	0.029164 *
exercise	-0.200200	0.066680	0.003879 **
study^2	-0.041254	0.021359	0.058080 .
read^2	-0.012270	0.008061	0.133146
com^2	0.027216	0.011204	0.018102 *
gender	-0.207495	0.117962	0.083594 .
home	-0.220039	0.058249	0.000362 ***

Table: The last model

Implement Result: The Last Model

To confirm the homoscedasticity assumption, the BP test results in p-value $= 0.5036$. One can also see via the residual plot.

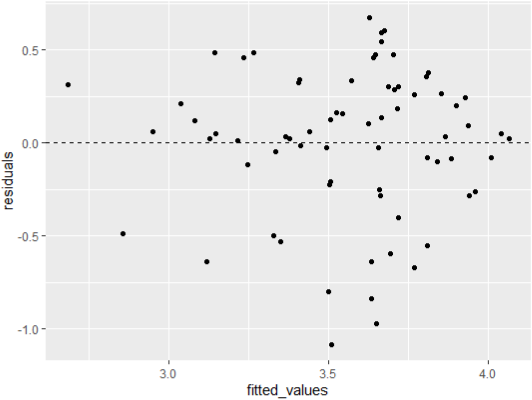


Figure: Residual plot of the last model

Implement: The Last Model

However, the result of VIF shows that there still exists multicollinearity among the variables.

Variable	VIF
study	11.013656
com	19.471468
exercise	1.135747
study^2	10.791751
read^2	1.193731
com^2	19.962638
gender	1.223544
home	1.443047

Table: The VIF of the last model

Implement: The Last Model

In addition, we report the robust standard errors for the last model. The p-value of $\hat{\beta}_{study}$ becomes a litte of greater than 0.05. (., *, **, and *** mean significant at 0.1 level, 0.05 level, 0.01 level, and 0.001 level, respectively.)

Coefficient	Estimate	Robust Std. Error	p-value
(Intercept)	4.4156288	0.3293940	$<$ 2.2e-16 ***
study	0.2508562	0.1256050	0.050272 .
com	0.0973170	0.0973170	0.004608 **
exercise	-0.200200	0.0619766	0.001994 **
study^2	-0.041254	0.0209235	0.053189 .
read^2	-0.012270	0.0049676	0.016324 *
com^2	0.027216	0.00933144	0.004947 **
gender	-0.207495	0.1106015	0.065434 .
home	-0.220039	0.0673296	0.001781 **

Table: The robust standard error of the last model

Conclusion

- Among five models, we find that the models including quadratic terms result in the problem of multicollinearity. Thus, we only interpret the sign of coefficients in such models. The effect of our interested variables, *study* and *web*, are not significant in the third model. This may result from the choice of our control variables. They may not be suitable for *study* and *web* as control variables.
- Overall, the difference of time management cannot explain the variation of *GPA* well. In our third model, the highest $\bar{R}^2$ is about 15% only, which means other omitted variables may be better to explain *GPA*, such as the *GPA* before the last semester and the IQ score. This result is identical to Adams and Blair's analysis (2016) on DECE students, low $\bar{R}^2$ and lack of significance. In addition, they also mention some other factors, such as study skills, problem solving, socioeconomics, and personality, which need to be explored.

Conclusion

- To analyze the partial effect of *study* on *GPA*, we find

$$\widehat{GPA} = \hat{\beta}_{study}\, study + \hat{\beta}_{study2}\, study^2 + (\text{other variables})$$

  with $\beta_{study} > 0$ and $\beta_{study2} < 0$. This may be interpreted as the decreasing marginal return of learning processes. To be more specific, the partial effect of *study* in the third model is 0.01314.
- The effect of *web* is negative, but not significant in the third (-0.01757) and forth (-0.059917) model, dropped out in the last model. Besides, the estimated effect has small economical significance. The sign of *web* can be interpreted similar as the result of 王淑娟 (2009): Academic performance and the time using the Internet are negative correlated,

Conclusion

- The sign of *com* is not the same. In the third model $\hat{\beta}_{com} = 0.02057$, in the forth model, $\hat{\beta}_{com} = -0.302657$, and in the last model $\hat{\beta}_{com} - 0.286282$. Only the last two model agrees with Marcelo Sampaio de Alencar's (2016) finding.
- The *exercise* has negative effect on *GPA* with significant at 0.05 level in the third model. The estimated partial effects are -0.20348, -0.233086, and -0.200200. This result disagrees with the hypothesis of Joseph, Storm, Hunt, and Chris (2016): Students that work out regularly will on average have a higher grade point average than students who do not work out.

Conclusion

- There are also some potential weakness of our data source. First, our sample size is not quite enough. The analyzed data in the references have sample size greater than 200. Some of them has over 1000 even. By contrast, our sample size is only 70. Thus, the estimate cannot be precise.
- Another issue comes from our experiment design. Because our data collected process is not randomized, the estimated partial effects may not hold for the whole population of NTU students. In fact, our analysis may restrict to the NTU students who are active on the Internet.

The End

Thank you for your attention.