

Happiness, self-compassion, and insomnia predicting academic achievement among middle school students with learning difficulty

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ABSTRACT

Students who do not have sufficient academic achievement suffer a great deal of associated issues. They spend a lot of time in academics and lose out on many other aspects of their life, affecting their well-being. This study attempts to develop an optimal functioning model of academic achievement through factors that are helpful for their well-being such as happiness and self-compassion. Also, the optimal influences of insomnia are indicated. 196 students from classes 5 to 7, of ages 11 to 14 years were assessed using the Bergen Insomnia Scale (Pallesen, et al, 2008), Self-Compassion Scale Youth Version (SCS-Youth) (Neff et al, 2021) and the Subjective Happiness Scale (Lyubomirsky, 1999). Response Surface Methodology using the design expert 13 is used to arrive at an optimal model. The model fitness indicates that high levels of happiness and compassion towards self, accompanied by low levels of insomnia optimizes academic achievement for students with difficulties in academics.

Keywords: Happiness, self-compassion, insomnia, response surface methodology

INTRODUCTION

The social order of today has become competitive. The present state of students with learning disabilities, slow learning capacities, or other learning issues is a matter of serious concern in our country where the value of academic accomplishment is emphasized. Failure in school is frequently associated with failure in all spheres of life, and students who experience it are frequently belittled. The lives of many of these young people are miserable in a variety of ways. They typically have to spend all of their waking hours studying and trying to catch up on their never-ending academic work because they are not permitted to engage in their hobbies. They already find this monotonous schedule to be stressful, so when there is no break from it, it spirals out of control and makes things worse. (Muthusamy & Sahu, 2020) Consequently, their sense of well-being drops dramatically. Though the incidence of diagnosed learning disabilities in India is around 10 to 12 percent of the school going population, a significant number of students are undiagnosed. (Oberoi, 2022)

Students who encounter learning difficulties exhibit low self-confidence levels; they begin questioning their abilities and consistently doubt themselves, thus feeling helpless. (Service, 2012) These children often devote significant amounts of time to completing their academic backlog, and the lack of proper leisure activities serves only to further restrict them. Such a life devoid of success often leads many students to experience depression and anxiety (Jothi & Anandaraj, 2017). Another issue that is found to disturb students with learning difficulties is lack of sleep or sleep

disturbances. Insomnia is a common sleep disorder that affects people of all ages and backgrounds. It is particularly prevalent among students with learning difficulties, who often struggle with maintaining consistent and quality sleep patterns. Insomnia not only exacerbates their learning challenges but also affects their overall well-being and academic performance. Disturbed sleep is a major cause of poor performance in school and has adverse effects on cognitive functioning (Narasimhan, Anitha & Battula, 2020).

It is the need of the hour to identify certain positive traits that would function as protective factors against insomnia, stress, and eventual anxiety or depression among students with learning difficulties. Many factors, such as hope, happiness, optimism, resilience, courage, compassion, and empathy, would contribute to a student's sense of well-being. Self-compassion is one of many positive psychology constructs that is simple to cultivate. Self-compassion can indeed serve as a protective factor in the academic success of students with learning difficulties. Learning difficulties can create additional challenges and stress for learners, which can negatively influence their academic performance and total well-being. Moreover, self-compassion can help mitigate these negative effects and promote positive outcomes. Self-compassion when practiced regularly, can reduce self-blame and self-criticism, which is found to be very high in students with learning difficulties. (Nemati et al., 2021) By offering themselves self-compassion during times of stress, students can reduce anxiety and enhance their ability to cope effectively (Manavipour & Saeedian, 2016). Self-compassion encourages a mindset of

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growth, which indicates the belief that capabilities and multiple intelligences can be improved through practice and experience. Students with learning difficulties often face fixed mindset beliefs, perceiving their struggles as indicative of inherent limitations. Self-compassion helps students reframe their setbacks as opportunities for growth and learning, fostering a positive attitude towards challenges and promoting perseverance. Self-compassion promotes self-care and well-being, emphasizing the importance of taking care of one's physical and emotional needs (Willoughby & Evans, 2019). Students with learning difficulties may be prone to neglecting their well-being due to the demands of their academic challenges. By practicing self-compassion, students can prioritize self-care activities such as sufficient rest, relaxation, and engaging in activities they enjoy, which can enhance their overall academic performance, help cultivate better happiness, and reduce burnout. It is important for educators, parents, and students themselves to understand the value of self-compassion in supporting the academic achievement of students with learning difficulties. By promoting self-compassion, educational institutions can create an environment that fosters resilience, growth, and well-being, ultimately helping students overcome challenges and reach their full potential. (Ahmed & Raj, 2023)

This study attempts to optimize a model using the "Response Surface Methodology" (RSM), to try and locate the optimum levels of happiness, self-compassion and insomnia levels that will predict best possible academic scores.

An overview of available research studies was conducted. Children with learning disabilities are at a heightened risk for developing sleep disturbances and this in turn affects their functioning during day time (Wiggs, 2012) A study conducted by Wiggs & Stores (1996), establishes associations between sleep problems and challenging behavior as reported by parents. Incidentally, night waking as well as waking up early was reported in 44% of the children. The lack of sleep usually affects the prefrontal cortex of the brain, which is important for all forms of cognitive function. While sleep disturbances can cause learning trouble, there is also evidence that suggests that students with learning disabilities suffer from sleep related disorders. More specifically, the students with learning difficulties have a higher risk of developing breathing difficulties in sleep (Bernstein, 2021).

A very interesting study on the need for self-compassion to help in building self-advocacy, Stuntzner, (2014), reports that self-compassion is an underexplored area where disabilities are concerned and also reports evidence that increased self-

compassion brings better self-advocacy skills among disabled. This study reports a model where self-compassion provides self-soothing from feelings of hurt or humiliation, reduces insecurities and judgmental thinking. A study reports that making parents aware of the right learning environment at school and at home for the student with learning difficulties are necessary for their well-being. Developing well-being and self-esteem through self-compassion for students and parents are effective in nurturing and fulfilling the emotionality of children with learning difficulties. (Ehmke & Phillips, 2016) Another recent study reports that self-compassion mediates the interaction between adverse social relationships and self-esteem among intellectually disabled students (Davies, et al., 2021). Abooei et al, (2021) recommends use of self compassion training for students with learning difficulties as this training improves their mental health by bringing about increased emotional regulation and reappraisal.

A qualitative study where Haigh et al., (2013) interviewed 20 learning disabled people who claimed to be happy. The participants indicated that they had life satisfaction due to independence in choices, their coping strategies to overcome sadness, and their ability to look at the brighter side of life with positivity and self-compassion made them happy. There are many studies that talk about physical disabilities and quality of life and happiness (*Rethinking Childhood Disabilities - Happiness vs Healthiness*, 2014; Valli, 2021), but very few studies research the happiness level in relation to learning disabled children. This study is thus innovative in bringing forth the concept of happiness as measured by subjective well-being to be a part of the optimal functioning model for students with learning difficulties. This study claims that it is a challenge for the students with learning difficulties to have a sense of well-being.

NEED FOR THE STUDY

Students with learning difficulties face a multitude of issues. They experience a constant state of stress in academics as they lag behind most of their classmates in their academic work, suffer low self-esteem and lack confidence, have poor social interaction with peers owing to lack of time and their own lack of esteem causing social withdrawal. This scenario affects their psychological well-being and as a result even if they do not have a diagnosed learning disability, they suffer all the psychological effects that a student with diagnosed learning disability may face. Moreover, they are shorthanded as any diagnosed student of learning disability may get the concessions provided during examinations, these students do not get any such concessions as extra time or scribe. Hence the students

who are left undiagnosed suffer more. This study aims to develop an optimal model of functioning for such students, and further interventions can help them develop such an optimal model.

METHODOLOGY

The objectives for the present study are:

- To identify the level of insomnia, self-compassion and happiness among the students with learning difficulties
- To identify the associated academic achievement levels of these students with learning difficulties
- To establish a predictive model between insomnia, self-compassion, happiness and academic achievement of the students with learning difficulties.

HYPOTHESES

The hypotheses for the present study are as follows:

- There will be a significant correlation between insomnia, self-compassion, happiness and academic achievement of students with learning difficulties
- An optimal model comprising of low insomnia, high self-compassion and high levels of happiness predicting better academic achievement can be achieved for language, english, math and science performance of the students with learning difficulties

Sample

The sample for the present study comprises 196 students from classes 5 to 7th standard, (Age range= 11 to 14 years) all studying in public schools, all students having difficulty in academics, selected purposely after an initial survey of 500 students based on their academic performance in the past one year. All students had significant difficulty in academic performance indicated by poor marks scored in the past one year. The sampling technique used is purposive sampling.

Inclusion criteria

- Students of both genders were included
- Only students with poor academic performance for the past one year were included
- Only students from classes 5 to 7 were included

Exclusion criteria

- Students who had a poor academic performance due to certain physical ailments or any other significant reason were not included
- Students who were diagnosed as learning disabled were excluded

- Students who were not willing to participate in the study were excluded

Tools

The following tools were employed to collect data from the participants of the study:

- Informed consent form collecting consent to participate from students
- Parent consent form collecting consent from the parents
- School consent form collecting consent from the school
- The Bergen Insomnia Scale (Pallesen, et al, 2008) is a six item measure of clinical insomnia. This scale has the first three questions dedicated to onset of sleep, its maintenance and waking up earlier, while the last three questions pertain to day time difficulties due to poor sleep. The Cronbach alpha values 0.79, 0.87, and 0.80, respectively, when studied for 3 samples, one being the student population. The discriminant and convergent validity values were also sufficient (Pallesen, et al, 2008)
- The Self-Compassion Scale Youth Version (SCS-Youth) (Neff et al, 2021) consists of 17 items that give a measure of self-compassion of youth. This scale can be used in the age range of 10 to 14 years and has been specifically standardized for use with middle school students. The authors of the scale have established test-retest reliability and construct validity of the scale (Neff et al, 2021)
- The Subjective Happiness Scale (Lyubomirsky, 1999): This scale uses four items, with a rating scale ranging from 1 (less happy) to 7 (happier). More than 14 studies have proved the reliability and validity of this scale among adults, school students and college students. Cronbach alpha values of 0.77 have been reported (Lyubomirsky, S. 2020). Another study reported the Cronbach alpha values of 0.84 for a translated version (Alquwez et al. 2021)
- Academic performance: Average marks for the whole year were collected in Language, English, Math and Science subjects.

All the 196 participants of the study were administered the aforesaid tools. The data was collected and analyzed using the Design Expert Software version 13 for Response Surface Methodology (RSM) for process optimization.

RESULTS

The researchers choose six factors and four responses; that is six independent variables or factors are gender, age, class, happiness, self-compassion and insomnia.

The four dependent variables or responses are academic scores of language, english, math and science. The tables below show the distribution analysis of all the variables.

Table 1: Distribution analysis of independent variables/factors

Factor	Name	Type	Mini	Maxi	Mean	Std. Dev.
A	Gender	Categoric	Female	Male	Levels:	2.00
B	Age	Numeric	11.00	14.00	12.56	0.7788
C	Class	Numeric	5.00	7.00	6.19	0.6187
D	Happiness	Numeric	1.00	35.00	19.49	6.47
E	Self –compassion	Numeric	3.00	48.00	25.17	8.42
F	Insomnia	Numeric	1.00	18.00	9.39	4.55

Table 2: Distribution analysis of dependent variables/responses

Response	Name	Observations	Mini	Maxi	Mean	Std. Dev.	Ratio
R1	Language	196.00	22	80	57.15	16.38	3.64
R2	English	196.00	26	78	58.51	13.13	3.00
R3	Math	196.00	23	64	49.59	9.20	2.78
R4	Science	196.00	13	80	48.63	10.43	6.15

The above tables 1 and 2 show the mean and standard deviation values of all the variables. Next, the Pearson correlation values were correlated. The tables below show the correlation values.

Table 3: Pearson’s correlation between variables

Variables	Happiness	Self-compassion	Inso mnia	Lang	Englis h	Math	Scien ce
Hap pines s	1	0.232*	-0.276*	0.078	0.072	0.182	0.077
Self- compa s sion	0.232*	1	-0.573**	0.059	0.093	0.205*	0.248*
Inso mnia	-0.276*	-0.573**	1	-0.170	-0.293*	-0.27*	-0.271*
Language	0.0782	0.059	-0.170	1	0.499**	0.354*	0.243*
English	0.072	0.093	-0.293*	0.499**	1	0.543**	0.544
Math	0.182	0.205*	-0.277*	0.354*	0.543**	1	0.570**
Science	0.0770	0.248*	-0.271*	0.243*	0.544**	0.570**	1

*= Significant at 0.05 level
 **= Significant at 0.01 level

As can be seen in the above table, there is a significant negative correlation between insomnia and all the other variables except language scores, which indicates that as insomnia increases, the levels of happiness, self-compassion decreases and the scores of english, math and science decrease. It is significant to note that language scores do not have significant correlations with either happiness, self-compassion or insomnia. Thus the hypothesis, “There is a significant correlation between insomnia, self-compassion, happiness and academic achievement of students with learning difficulties” is partially accepted.

Further, the ANOVA models for Reduced Quadratic model were computed for three factors namely happiness, self-compassion, insomnia and the response of Language, English, Math and Science respectively.

1. Language: The ANOVA model for reduced quadratic model was calculated for language scores. The ANOVA table, model fit statistics and coefficients with VIF (Variance Inflation Factor) is presented below. The perturbation plot and optimization graphs are also seen below:

Table 4. a: ANOVA for happiness, self-compassion and insomnia for Language scores

Source	Coefficients	Sum of Squares	df	Mean Square	F-value	p-value	Significance
Model		6265.73	4	1566.43	6.49	< 0.0001	significant
Happiness		217.77	1	217.77	0.9029	0.3432	not significant
Self-compassion		5.84	1	5.84	0.0255	0.8734	not significant
Insomnia		2457.27	1	2457.27	10.19	0.0017	significant
Residual		46069.67	191	241.20			
Lack of Fit		45379.17	188	241.38	1.05	0.5841	not significant
Pure Error		690.50	3	230.17			
Core Total		52335.41	195				
R ²	0.1197						
Adjusted R ²	0.1013						
Predicted R ²	0.0636						
Adeq. Precision	12.6487						

- The **Model F-value** of 6.49 implies the model is significant. There is only a 0.01% chance that an F-value this large could occur due to noise.
- The **Lack of Fit F-value** of 1.05 implies the Lack of Fit is not significant relative to the pure error.
- There is a **58.41% chance** that a Lack of Fit, F-value could occur due to other causes. Non-significant lack of fit is indicative of good fit.

The table above shows that the model is fit. Only insomnia shows a significant difference in the language scores. It can be interpreted from the findings above that insomnia accounts for 58.41% of the academic performance in language. The model validation statistic, lack of fit is seen to be not significant, which is an indicator of a good model fit. The formula for lack of fit is given below:

$$\text{Lack of Fit F-test} = \frac{\text{Lack of fit MS}}{\text{Pure Error MS}}$$

where MS= Mean Square
 Pure Error MS

- The **Predicted R²** of 0.0636 is in reasonable agreement with the **Adjusted R²** of 0.1013; i.e. the difference is less than 0.2.
- “**Adequate Precision** measures the signal to noise ratio. A ratio greater than 4 is desirable.
- The obtained ratio of **12.649 indicates an adequate signal.**
- “This model can be used to navigate the design space”

The above table indicates that the model has an adequate fitness statistic. The R² values are however very low,

showing only a mild predictive ability. This can be due to the fact that happiness when taken separately does not have a significant predictive ability, but a combination of happiness and insomnia have higher model fit.

Table 4.b.: Coefficients in Terms of Coded Factors (Sum Contrasts) for Language Scores

Factor	Coefficient Estimate	df	Standard Error	95% CI		VIF
				Low	High	
Intercept	63.41	1	1.86	59.75	67.08	
Happiness	2.91	1	3.06	-3.13	8.94	1.10
Insomnia	-7.17	1	2.25	-11.61	-2.74	1.17

- “The coefficient estimate represents the expected change in response per unit change in factor value when all remaining factors are held constant. The intercept in an orthogonal design is the overall average response of all the runs.
- The coefficients are adjustments around that average based on the factor settings. When the factors are orthogonal the VIFs are 1; VIFs greater than 1 indicate multi-collinearity, the higher the VIF the more severe the correlation of factors. As a rough rule, VIFs less than 10 are tolerable.”

The above table indicates that Variance Inflation Factor (VIF) is greater than 1, but nearer to 1 indicating multi-collinearity. This can be due to the reason that the independent variables in the study are correlated. It has already been shown in the Table 3, that happiness and self-compassion both show a significant negative correlation with insomnia. Multiple linear regression hereby show that happiness and insomnia significantly predict the language scores. The fitted regression model was: Language Score= 63.41 + 2.91(happiness) -7.17 (Insomnia)

That is if a student is happy, it adds 2.91 to his/her language score, but having insomnia reduces the score by 7.17. The overall regression was statistically significant ($R^2=0.119$, $F(4, 191)=6.49$, $p < .000$).

1.1. Optimization graphs: The contour plot and the 3D graphical representations (Figure 1 and 2 respectively) showing the optimization values of the language scores plotted for happiness and insomnia values respectively. Both the plots again indicate that for the highest possible language score (<60), the happiness level should be high (<25) and the insomnia level (>6) should be low. The best interaction effect for maximum language scores are shown.

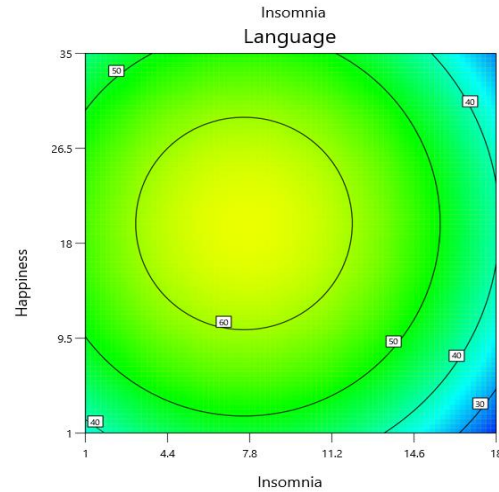


Figure 1. Contour Plot of insomnia and happiness values for optimum language scores

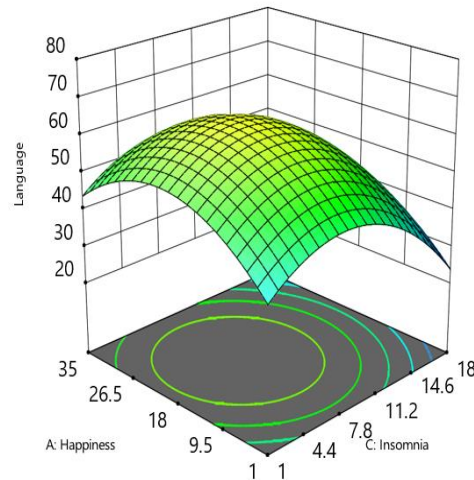


Figure 2. 3D Surface graph of insomnia and happiness values for optimum language scores

As can be seen in the above graphical optimization, for a score of above 60 in language, the happiness score should be 25.5 and the insomnia score should be only 6. As can be seen in the contour plot as the happiness levels go down and the insomnia levels go up, the scores go down and then 40 respectively as can be seen flagged.

2. English: The ANOVA model for reduced quadratic model was calculated for language scores. The ANOVA table, model fit statistics and coefficients with VIF (Variance Inflation Factor) is presented below. The perturbation plot and optimization graphs are also seen below:

Table 5. a.: ANOVA for happiness, self-compassion and insomnia for English scores

Source	Coefficients	Sum of Squares	df	Mean Square	F-value	p-value	Significance
Model		6238.08	6	1039.68	7.17	<0.001	significant
Happiness		11.66	1	11.66	0.08040.7770		not significant
Self-compassion		50.20	1	50.20	0.34620.5570		not significant
Insomnia		3513.26	1	3513.26	24.23	<0.001	significant
Residual		27404.92189	145	145.00			
Lack of Fit		27181.92186	146	146.14	1.97	0.3232	not significant
Pure Error		223.00	3	74.33			
Core Total		33642.99195					
R ²	0.1854						
Adjusted R ²	0.1596						
Predicted R ²	0.1155						
Adeq. Precision	13.1312						

- The **Model F-value** of 7.17 implies the model is significant. There is only a 0.01% chance that the F-value could occur due to any other chance.
- The **Lack of Fit F-value** of 1.97 implies the Lack of Fit is not significant relative to the pure error
- There is a **32.32% chance** that a Lack of Fit, F-value could occur due to any other chance. Non-significant lack of fit is a good fit.

The table above shows that the model is fit. Only insomnia shows a significant difference in the English scores. It can be interpreted from the findings above that insomnia accounts for 32.32% of the academic performance in English. The model validation statistic, lack of fit is seen to be not significant, which is an indicator of a good model fit.

- The **Predicted R²** of 0.1854 is in reasonable agreement with the **Adjusted R²** of 0.1596; i.e., the difference is less than 0.2.
- **“Adequate Precision** measures the signal to noise ratio. A ratio greater than 4 is desirable. “
- The obtained ratio of **13.1312 indicates an adequate signal.**
- “This model can be used to navigate the design space”

The above table indicates that the model has an adequate fitness statistic. The R² values are however low, showing only a mild predictive ability. This can be due to the fact that happiness and self-compassion when taken separately does not have a significant predictive ability, but a combination of happiness, self-compassion, and insomnia have higher model fit.

Table 5.b.: Coefficients in Terms of Coded Factors (Sum Contrasts) for English Scores

Factor	Coefficient Estimate	df	Standard Error	95% CI Low	95% CI High	VIF
Intercept	63.69	1	1.47	60.78	66.60	
Happiness	0.6774	1	2.39	-4.03	5.39	1.11
Self-compassion	-1.71	1	2.90	-7.43	4.01	1.58
Insomnia	-10.19	1	2.07	-14.27	-6.11	1.65
Happiness*Self-compassion	-10.52	1	7.96	-26.21	5.18	1.18
Happiness ²	-13.93	1	4.64	-23.09	-4.77	1.02
Insomnia ²	-10.39	1	3.31	-16.91	-3.86	1.14

- “The coefficient estimate represents the expected change in response per unit change in factor value when all remaining factors are held constant. The intercept in an orthogonal design is the overall average response of all the runs.”
- “The coefficients are adjustments around that average based on the factor settings. When the factors are orthogonal the VIFs are 1; VIFs greater than 1 indicate multi-collinearity, the higher the VIF the more severe the correlation of factors. As a rough rule, VIFs less than 10 are tolerable.”

The above table indicates that Variance Inflation Factor (VIF) is greater than 1, but nearer to 1 indicating multi-collinearity. This can be due to the reason that the independent variables in the study are correlated. It has already been shown in the Table 3, that happiness and self-compassion both show a significant negative correlation with insomnia.

Multiple linear regression hereby show that happiness and insomnia significantly predict the English scores. The fitted regression model was: English Score= 63.69 + 0.67(happiness) -1.71 (self-compassion) -10.19 (Insomnia)

That is if a student is happy, it adds 0.67 to his/her English score, but having insomnia reduces the score by 10.19. The overall regression was statistically significant (R²=0.1854, F(6, 189)=7.17, p=<.000.

2.1. Optimization graphs: The contour plot and the 3D graphical representations (Figure 3 and 4 respectively) showing the optimization values of the English scores plotted for happiness, and self-compassion values respectively. Both the plots again indicate that for the highest possible English score (<60), the happiness level should be high (<25) and the self-compassion level (<39) also should be high. To note that only the best 2 predictors for the English scores are shown.

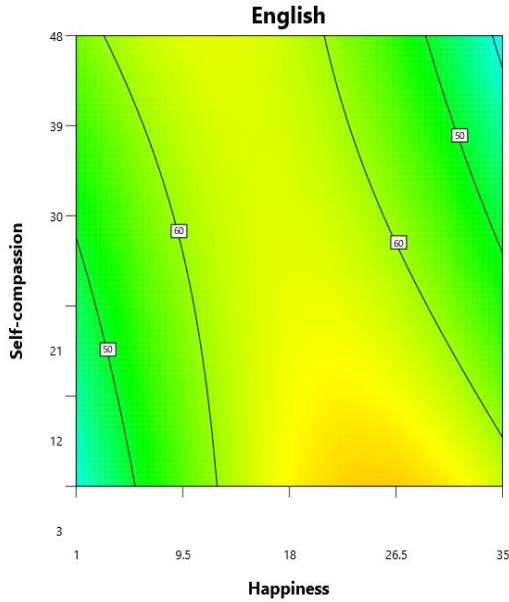


Figure 3. Contour Plot of happiness and compassion values for optimum English scores

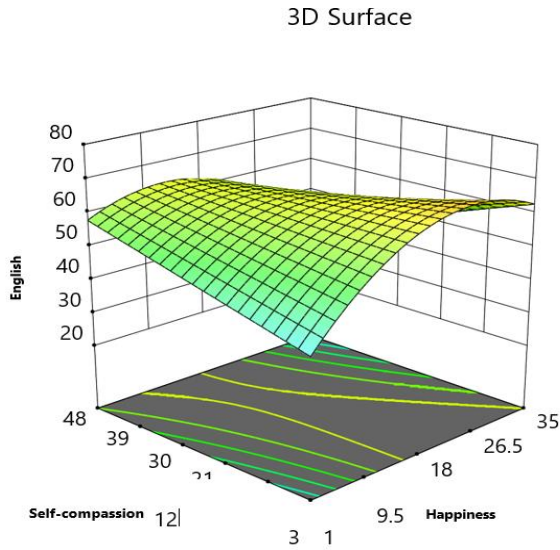


Figure 4. 3D Surface graph of happiness and self-compassion values for optimum English scores

As can be seen in the above graphical optimization, for a score of above 60 in English, the happiness score should be 35 and the self-compassion score should be 39. As can be seen in the contour plot as the happiness levels go up and the self-compassion levels go up, the scores go above 60 as can be seen flagged in the contour plot.

3. Math: The ANOVA model for reduced quadratic model was calculated for language scores. The ANOVA table, model fit statistics and coefficients with VIF (Variance Inflation Factor) is presented below. The perturbation plot and optimization graphs are also seen below:

Table 6. a.: ANOVA for happiness, self-compassion and insomnia for Math scores

Source	Coefficients	Sum of Squares	df	Mean Square	F-value	P-value	Significance
Model		1748.83	4	437.21	5.66	0.0003	significant
Happiness		235.97	1	235.97	3.06	0.0821	not significant
Self-compassion		14.72	1	14.72	0.19060	0.6629	not significant
Insomnia		619.74	1	619.74	8.02	0.0051	significant
Residual		14752.70	191	77.24			
Lack of Fit		14512.70	188	77.20	0.96490	0.6223	not significant
Pure Error		240.00	3	80.00			
Core Total		16501.53	195				
R ²		0.1060					
Adjusted R ²		0.0873					
Predicted R ²		0.0572					
Adeq. Precision		10.4647					

- The **Model F-value** of 5.66 implies the model is significant. There is only a 0.01% chance that the F-value could occur due to any other cause.
- The **Lack of Fit F-value** of 0.97 implies the Lack of Fit is not significant relative to the pure error.
- There is a **62.23% chance** that a Lack of Fit, F-value could occur due to other causes. Non-significant lack of fit is considered a good fit.

The table above shows that the model is fit. Only insomnia shows a significant difference in the math scores. It can be interpreted from the findings above that insomnia accounts for 62.23% of the academic performance in math. The model validation statistic, lack of fit is seen to be not significant, which is an indicator of a good model fit.

- The **Predicted R²** of 0.1060 is in reasonable agreement with the **Adjusted R²** of 0.0873; i.e. the difference is less than 0.2.
- “**Adequate Precision** measures the signal to noise ratio. A ratio greater than 4 is desirable.”
- The obtained ratio of **10.4647 indicates an adequate signal.**
- “This model can be used to navigate the design space”

The above table indicates that the model has an adequate fitness statistic. The R² values are however low, showing only a mild predictive ability. This can be due to the fact that happiness and self-compassion when taken separately does not have a significant predictive ability, but a combination of happiness, self-compassion, and insomnia have higher model fit.

Table 6.b.: Coefficients in Terms of Coded Factors (Sum Contrasts) for math scores

Factor	Coefficient Estimate	Standard df	Standard Error	95% CI		VIF
				Low	High	
Intercept	50.03	1	0.7595	48.54	51.53	
Happiness	3.04	1	1.74	-0.3911	6.48	1.11
Self-compassion	0.9096	1	2.08	-3.20	5.02	1.53
Insomnia	-4.23	1	1.49	-7.18	-1.29	1.61
Self-compassion* Insomnia	6.64	1	3.73	-0.7098	13.99	1.07

- “The coefficient estimate represents the expected change in response per unit change in factor value when all remaining factors are held constant. The intercept in an orthogonal design is the overall average response of all the runs.”
- “The coefficients are adjustments around that average based on the factor settings. When the factors are orthogonal the VIFs are 1; VIFs greater than 1 indicate multi-collinearity, the higher the VIF the more severe the correlation of factors. As a rough rule, VIFs less than 10 are tolerable.”

The above table indicates that Variance Inflation Factor (VIF) is greater than 1, but nearer to 1 indicating multi-collinearity. This can be due to the reason that the independent variables in the study are correlated. It has already been shown in the Table 3, that happiness and self-compassion both show a significant negative correlation with insomnia.

Multiple linear regression hereby show that happiness and insomnia significantly predict the math scores. The fitted regression model was:

$$\text{Math Score} = 50.03 + 3.04 (\text{happiness}) + 0.90 (\text{self-compassion}) - 4.23 (\text{Insomnia})$$

That is if a student is happy, it adds 3.04 to his/her math score, but having insomnia reduces the score by 4.23. The overall regression was statistically significant ($R^2=0.1060$, $F(4, 191)=5.66$, $p < .000$).

3.1. Optimization graphs: The contour plot and the 3D graphical representations (Figure 5 and 6 respectively) showing the optimization values of the math scores plotted for happiness, and self-compassion values respectively. Both the plots again indicate that for the highest possible math score (<55), the self-compassion level should be high (<30) and the insomnia level (>6) also should be low. To note that only the best 2 predictors for the math scores are shown.

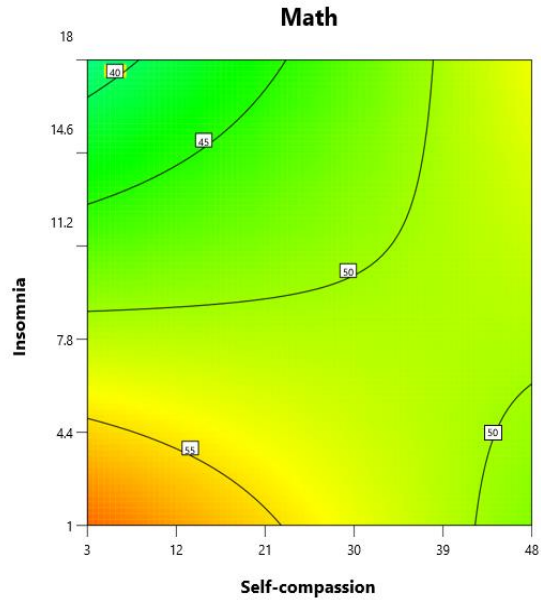


Figure 5. Contour Plot of self-compassion and insomnia values for optimum math scores

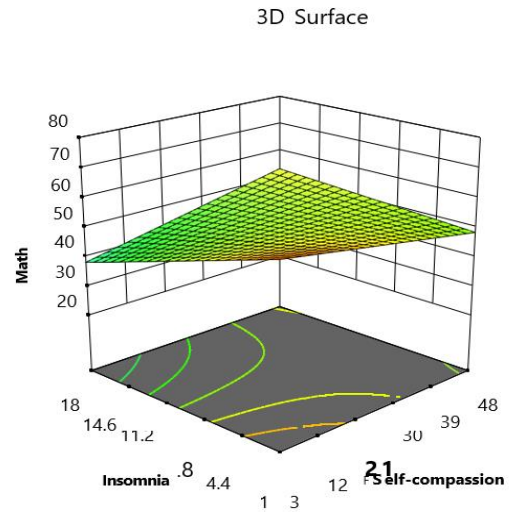


Figure 6. 3D Surface graph of insomnia and self-compassion values for optimum math scores

As can be seen in the above graphical optimization, for a score of above 55 in math, the self-compassion score should be 30 and the insomnia score should be 6. As can be seen in the contour plot as the self-compassion levels go up, the insomnia levels go down, the scores go above 55 as can be seen flagged in the contour plot.

4. Science: The ANOVA model for reduced quadratic model was calculated for language scores. The ANOVA table, model fit statistics and coefficients with VIF (Variance Inflation Factor) is presented below. The perturbation plot and optimization graphs are also seen below:

Table 7. a.: ANOVA for happiness, self-compassion and insomnia for Science scores

Source	Coefficients	Sum of Squares	df	Mean Square	F-value	p-value	Significance
Model		3090.63	5	618.13	6.48	<0.0001	significant
Happiness		1.61	1	1.61	0.0168	0.8969	not significant
Self-compassion		341.07	1	341.07	3.58	0.0602	not significant
Insomnia		926.66	1	926.66	9.71	0.0021	significant
Residual		18124.92	19095.39				
Lack of Fit		17908.92	18795.77	1.33	0.4774		not significant
Pure Error		216.00	3	72.00			
Core Total		21215.55	195				
R ²	0.1457						
Adjusted R ²	0.1232						
Predicted R ²	0.0919						
Adeq. Precision	13.5177						

- The **Model F-value** of 6.48 implies the model is significant. There is only a 0.01% chance that the F-value could occur due to any other cause.
- The **Lack of Fit F-value** of 1.33 implies the Lack of Fit is not significant relative to the pure error.
- There is a **47.74% chance** that a Lack of Fit, F-value could occur due to chance. Non-significant lack of fit is indicative of good fit.

The table above shows that the model is fit. Only insomnia shows a significant difference in the math scores. It can be interpreted from the findings above that insomnia accounts for 47.74% of the academic performance in science. The model validation statistic, lack of fit is seen to be not significant, which is an indicator of a good model fit.

- The **Predicted R²** of 0.1457 is in reasonable agreement with the **Adjusted R²** of 0.1232; i.e. the difference is less than 0.2.
- **“Adequate Precision** measures the signal to noise ratio. A ratio greater than 4 is desirable. “
- The obtained ratio of **13.5177 indicates an adequate signal.**
- “This model can be used to navigate the design space”

The above table indicates that the model has an adequate fitness statistic. The R² values are however low, showing only a mild predictive ability. This can be due to the fact that happiness and self-compassion

when taken separately does not have a significant predictive ability, but a combination of happiness, self-compassion, and insomnia have higher model fit.

Table 7.b.: Coefficients in Terms of Coded Factors (Sum Contrasts) for Science scores

Factor	Coefficient	df	Standard Error	95% CI	95% CI	VIF
	Estimate		Error	Low	High	
Intercept	49.96	1	0.8468	48.29	51.63	
Happiness	-0.2530	1	1.95	-4.10	3.59	1.13
Self-compassion	4.51	1	2.38	-0.1947	9.21	1.63
Insomnia	-5.22	1	1.67	-8.52	-1.91	1.64

- “The coefficient estimate represents the expected change in response per unit change in factor value when all remaining factors are held constant. The intercept in an orthogonal design is the overall average response of all the runs.”
- “The coefficients are adjustments around that average based on the factor settings. When the factors are orthogonal the VIFs are 1; VIFs greater than 1 indicate multi-collinearity, the higher the VIF the more severe the correlation of factors. As a rough rule, VIFs less than 10 are tolerable.”

The above table indicates that Variance Inflation Factor (VIF) is greater than 1, but nearer to 1 indicating multi-collinearity. This can be due to the reason that the independent variables in the study are correlated. It has already been shown in the Table 3, that happiness and self-compassion both show a significant negative correlation with insomnia.

Multiple linear regression hereby show that happiness and insomnia significantly predict the math scores. The fitted regression model was:

$$\text{Math Score} = 49.96 - 0.253 (\text{happiness}) + 4.51 (\text{self-compassion}) - 5.22 (\text{Insomnia})$$

That is if a student has self-compassion, it adds 4.51 to his/her science score, but having insomnia reduces the score by 5.22. The overall regression was statistically significant ($R^2=0.1457$, $F(5, 190)=6.48$, $p < .000$).

4.2. Optimization graphs: The contour plot and the 3D graphical representations (Figure 7 and 8 respectively) showing the optimization values of the science scores plotted for happiness, and self-compassion values respectively. Both the plots again indicate that for the highest possible math score (<60), the self-compassion level should be high (<39) and the happiness level (<35) also should be high. To note that only the best 2 predictors for the science scores are shown.

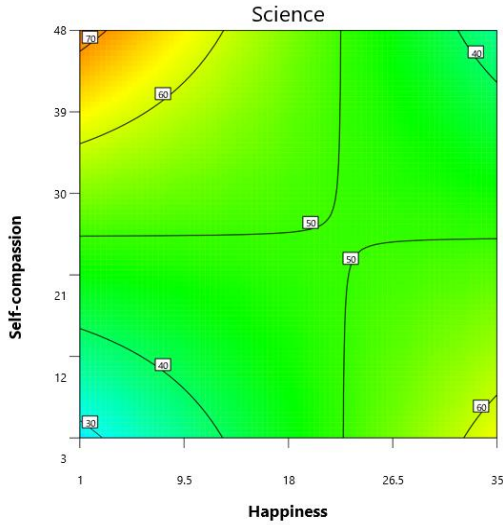


Figure 7. Contour Plot of self-compassion and happiness values for optimum science scores

3D Surface

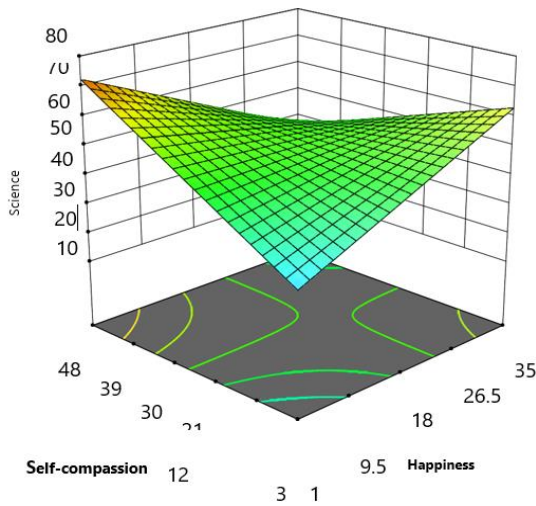


Figure 8. 3D Surface graph of happiness and self-compassion science scores

As can be seen in the above graphical optimization, for a score of above 60 in science, the self-compassion score should be 39 and the happiness score should be 35. As can be seen in the contour plot as the self-compassion levels go up, the scores go above 60 as can be seen flagged in the contour plot.

The above RSM optimization analysis for each of the subjects show that there is an optimum score that can be achieved against each of the independent variables taken up for study. The findings are summarized under table 8.

Table 8: Summarization of the optimization achieved in the model

Subjects	Scores	Happiness	Self-compassion	Insomnia
Language	>60	High (25.5)	No major effect	Low (<6)
English	>60	High (35)	High (39)	Low (<6)
Math	>55	High (30)	No major effect	Low (<6)
Science	>60	High (39)	High (39)	Low (<6)

Moreover, from the ANOVA tables, it is clear that insomnia is a significant predictor of academic achievement. Higher the insomnia, lower is the academic achievement scores. Happiness and self-compassion show more interaction effects.

Hence the hypothesis, “An optimal model comprising of low insomnia, high self-compassion and high levels of happiness predicting better academic achievement can be achieved for language, english, math and science performance of the students with learning difficulties” is accepted.

DISCUSSION

The results section presented above show that the academic achievement scores in language, english, math and science are significantly affected by insomnia. Students who suffer from higher levels of insomnia, get lower scores. Also, the happiness and self-compassion scores show an interaction effect on the academic scores. Both happiness and self-compassion when present together have a better effect on the academic scores of the students with learning difficulties. Similar findings were reported by Moussa & Ali, (2022), where they reported happiness to be clearly and positively associated with academic success. A supportive study by CAMHS (Child and Adolescent Mental Health Service) supports young people's mental health and wellbeing in North Derbyshire, reports that there is a dire need for parents and caretakers of the children with learning difficulties to introduce a sleep hygiene and compassion in a relatable and easy framework, a routine that is easy to follow, to help them fall asleep. This includes a pleasant bed time routine, visualizing time tables and making workable plans that will help to motivate them. A similar earlier report (Contributor, 2005) in the Nursing Times, shows the association between severe learning difficulties and sleep disturbances.

Insomnia is one of the predictors for poor academic achievement. Especially, when the students have difficulty in learning, their lack of sleep and disturbance in sleep only complicates the issue. Similarly, self-compassion plays a protective role and supports academic success. (Landgraf, 2013) A supportive study reports that teaching self-compassion to students with

learning disabilities decreases their sense of loneliness and increases their subjective vitality, thus enthralling them to perform better. (Shirani et al., 2020) It has been reported that persons with high levels of self-compassion are kind and not judgemental about their mistakes, at the same time recognising that failure is just another human experience, they feel bad about failure, but do not let themselves be controlled over negative emotions. (Chen, 2018, Zhao et al., 2021)

The journey of academics gives different success to different students. But, when the student faces learning difficulty, the journey itself through academics becomes more cumbersome. To negate the burdens of learning, this study shows an optimal model, where a combination of happiness and self-compassion has positive effects on academic achievement. A lesser level of insomnia is also seen as helpful in academic achievement.

CONCLUSIONS

The following conclusions can be drawn from the present study.

- There is a significant negative correlation between happiness and insomnia; and self-compassion and insomnia; while there is a significant positive correlation between happiness and self-compassion among students with learning difficulty.
- Optimization through response surface methodology, brings an optimal functioning model which shows, high happiness, high self-compassion and low insomnia to be optimal to better academic achievement in the four subjects measured namely language, english, math and science.

Limitations of the study

This study uses sample only from the middle school namely the classes 5th to 7th standards from two public schools. More students from higher classes and diverse schools could give a better understanding of the factors and responses and their interactions.

Implications for further research

Further research should focus on developing methodologies and interventions to build the happiness levels of students with learning difficulties. Training students on self-compassion and training parents to pay more attention to the need for proper sleep for their children would go a long way to ease this academic burden. Overall, it can be concluded effectively that happiness and self-compassion have a positive effect on academic achievement, while insomnia experienced has a negative effect on academic achievement of middle school students with learning difficulties.

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