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ENHANCING ACADEMIC ACHIEVEMENT IN PROSPECTIVE TEACHERS: APPLYING DESIGN THINKING TO METACOGNITION AND COGNITIVE ABILITY PREDICTORS

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Abstract:

Twenty first century skills is one of the most discussed topics in the last decade. Studies and experiments are done in all levels of education on developing these essential skills in the learners. In this context, the researcher tried to find the nature of relation between Meta-cognition, cognitive ability and the academic achievement applying the principles of Design Thinking. Design thinking involving five major steps namely, empathise, define , prototype , ideate and test were used when considering the preparation of test and materials. Prospective teachers were considered as sample for this study. 191 B.Ed. students from a College of Education were taken as the sample for this study. Meta-cognitive Inventory, Cognitive Ability Test and Achievement Test were used for collecting the data. Pearson's Product moment correlation and Regression analysis was done. This study records a positive, linear correlation between the three selected variables. The study also records meta-cognition and cognitive ability of prospective teachers as predictors of their academic achievement.

Keywords: Academic achievement, cognitive ability, Meta-cognition, prospective teachers

Introduction:

Empathize: The cognitive ability to reason has a significant limiting impact on whether or not young people succeed academically. Cognitive aptitude, which includes attention, memory, and reasoning skills, refers to the capacity of the human brain to process, store, and retrieve information. For people to successfully accomplish an activity, it is a crucial psychological component (Sternberg and Sternberg, 2009). According to Stadler et al. (2016), cognitive capacity is presently one of the most thoroughly studied and reliable indicators of academic performance. Previous research (Miriam et al., 2011) has concentrated on the direct relationship between individual-level cognitive capacity and academic success. Selective attention, short-term memory, and reasoning ability were revealed to be important predictors of language and math performance in a study by Xu and Li (2015) including 4,749 junior high school students.

Define: "Enhancing Academic Achievement in Prospective Teachers: Applying Design Thinking to Meta-Cognition and Cognitive Ability Predictors" refers to a specific research or educational initiative that focuses on improving the academic performance of individuals aspiring to become teachers. Let's break down the key components of this title:

"Enhancing Academic Achievement": This suggests the primary goal of the initiative, which is to improve the academic performance of prospective teachers. The term "academic achievement" typically refers to the level of success and proficiency in academic subjects or coursework.

"Prospective Teachers": This refers to individuals who are in the process of preparing to become teachers. These individuals may be enrolled in teacher training programs or pursuing degrees in education.

"Applying Design Thinking": Design thinking is a problem-solving and innovation methodology that involves a user-centered approach to finding solutions. In this context, it implies that design thinking principles and techniques will be employed to address the challenges related to academic achievement.

"Meta-Cognition": Meta-cognition involves thinking about one's own thinking. It refers to the ability to reflect on and control one's cognitive processes, including problem-solving, memory, and learning strategies.

"Cognitive Ability Predictors": These are factors or assessments that are used to predict an individual's cognitive abilities, such as IQ tests, standardized tests, or other measures of intellectual aptitude.

Ideate: Selective attention and short-term temporal memory have an indirect impact on academic achievement through reasoning ability, whereas reasoning skill has a direct impact on academic performance. According to Rohde and Thompson's research from 2007, there is a strong association between cognitive ability and academic success, up to 0.38. The greater portion of the diversity in academic performance can be explained by the moderate to high degree of association between cognitive ability and academic achievement in language and mathematics (Plomin, 2011). Deary et al. (2006) reported that the connection between general cognitive ability at age 11 and academic performance at age 16 was 0.81 in a 5-year follow-up study of more than 70,000 British youngsters. The strongest predictive ability can explain 58.6 and 48% of the variation in the dependent variable, respectively.

These research results also lend credence to the information processing theory (Li, 2015), which contends that higher cognitive ability in students translates into faster and more accurate processing of important information, effective memory coding, and the output of more useful information (Zhang and Zhang, 2021). In contrast, a portion of the information will be lost throughout the information processing process if the general level of cognitive ability is poor or a specific cognitive ability is weak (Miriam et al., 2011). This results in a reduction in the production of effective knowledge and lower academic achievement. Chen (2016) thinks that high school students' prospects and preferences for postsecondary education are influenced by their cognitive talents. Higher cognitive ability kids are more likely to enroll in traditional high schools, while lower cognitive ability students are more likely to enroll in vocational schools. According to the findings of earlier studies, cognitive capacity frequently contributes significantly to attaining superior academic performance.

Prototype: It is challenging to accurately depict the intrinsic relationship between general cognitive capacity and academic performance, despite the fact that the relationship between the

two can better reflect how closely the two are related. In fact, learning activities not only involve various specific abilities but are also related to how these various abilities work together, so "in the learning context, cognitive ability is very important in human learning activities, which can be reflected in a deeper level by including specific cognitive abilities in the scope of the investigation," (David, 2005). The relationship between cognitive capacity and academic achievement has generated much debate across numerous studies (Formazin et al., 2011). Zhang (2008) discovered that while the thinking transformation ability (TCA) was not substantially connected with the scores of the two topics, the logical reasoning ability (LRA), Chinese language, and mathematics scores all had correlation values of around 0.3. Although representation ability (RA) and performance in Chinese and mathematics have a connection coefficient between 0.4 and 0.5, Xu and Li (2015) revealed that thinking TCA had a strong link with performance in the two areas. These findings demonstrate that when focusing on the influence of a single cognitive ability dimension on a single academic performance, it is challenging to thoroughly and methodically show the complex interaction of individual cognitive elements on academic success. Furthermore, research on the influencing elements of cognitive ability on the complete performance of numerous subjects is lacking because prior studies tended to focus on the influencing aspects of cognitive ability on a single subject.

Ideate: Understanding one's own thought process is beneficial. Teachers' awareness of metacognition will aid them in managing their thoughts and emotions, which is highly helpful while interacting with students. Academic achievement is positively impacted by metacognitive awareness (zcakmak, Korolu, & Bolat, 2021; Nongtodu, 2017). Meta-cognitive awareness is recommended by Abdelrahman (2020) as a useful method for assessing academic achievement. Academic achievement and cognitive abilities as measured by several psychometric tests are positively correlated, according to research. In many topics, including mathematics, cognitive capacity is the most significant predictor of academic accomplishment (Hames & Baker, 2015).

Prototype: Every person's ability to be aware of their own metacognition is regarded as a crucial component of creativity, critical thinking, and self-confidence (Memnun & Akkaya, 2009). Meta-cognition came into being as a result of both internal and external potential. In order to overcome learning challenges, one must have the capacity for meta-cognition awareness, according to Joseph (2010). The capacity for planning, organising, and monitoring learning directly enhances academic achievement and is referred to as meta-cognitive awareness. Students who have a high level of metacognitive awareness will find it simpler to control and supervise their class, and they will be better able to supply important details and apply learning strategies to any difficulty with ease.

Objectives of the study:

1. To assess the relationship between Cognitive ability, Meta-cognition and Academic achievement of prospective teachers
2. To determine whether the Cognitive ability and Meta-cognition of prospective teachers can predict their academic achievement

Hypotheses of the study:

1. There is no relationship between Cognitive ability, Meta-cognition and Academic achievement of prospective teachers
2. There is no significant influence of cognitive ability and Meta-cognition on academic achievement of prospective teachers.

Material and Methods :

The study followed normative survey method. 191 prospective teachers from B.Ed. college of education constituted the sample for this study. Meta-cognitive Awareness Inventory (Schraw and Denison, 1994), Cognitive Ability test (Maheswari & Indu, 2020) and Achievement test (Maheswari & Indu, 2020) were used to get the necessary data. The data collected were tabulated and subjected to statistical analysis. For the analysis of the data the researchers employed Pearson's product moment correlation and regression analysis.

Results and Discussion:

Test

Relation between Cognitive Ability, Meta-cognition and Academic Achievement of Prospective Teachers

The relation between cognitive ability, Meta-cognition and academic achievement of prospective teachers was investigated using Pearson's product-moment correlation. Table 1 discusses the outcome of the analysis

Table-1

Relation between Meta-cognition, Cognitive Ability and Academic Achievement of Student Teachers

Variables	Meta-cognition	Cognitive Ability	Academic Achievement
Meta-cognition	*1*		
Cognitive Ability	*0.757***	*1*	
Academic Achievement	*0.777***	*0.843***	*1*

Note. ** denotes the value is significant at 0.01 level.

The correlation coefficient between meta-cognition and cognitive ability of student teachers is 0.757, which is significant at a 0.01 level of significance. The correlation coefficient value r = 0.757 shows a positive and high correlation between the meta-cognition and cognitive ability of student teachers.

The correlation coefficient between meta-cognition and academic achievement of student teachers is 0.777, which is significant at a 0.01 level of significance. The correlation coefficient value r = 0.777 shows a positive and high correlation between the meta-cognition and academic achievement of student teachers.

The correlation coefficient between academic achievement and cognitive ability of student teachers is 0.843, which is significant at a 0.01 level of significance. The correlation coefficient value r = 0.843 shows a positive and high correlation between the academic achievement and cognitive ability of student teachers.

The analysis of the nature of relation between meta-cognition, cognitive ability and academic achievement of student's teachers reveals that there exists a linear, positive, strong correlation between these three selected variables at .01 level of confidence.

The relation of Meta-cognition, cognitive ability and academic achievement is depicted in Figure 1, Figure 1 and Figure 3.

Figure 1

Graphical Representation of Correlation between Meta-cognition and Cognitive Ability of Student Teachers

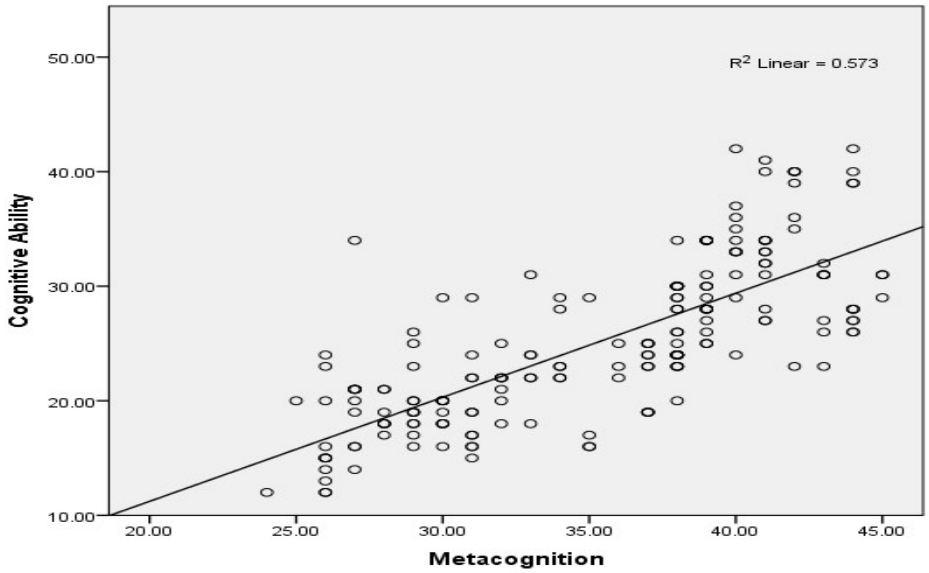


Figure 2

Graphical Representation of Correlation between Meta-cognition and Cognitive Ability of Student Teachers

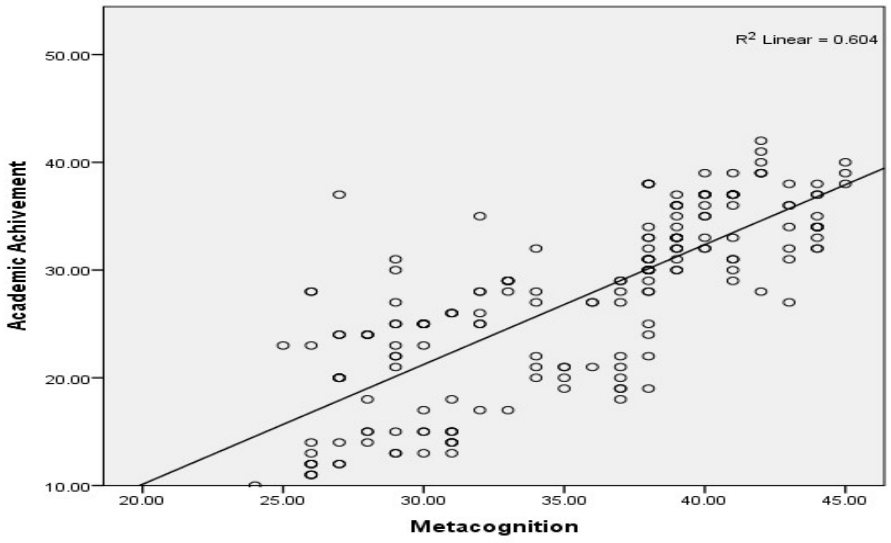
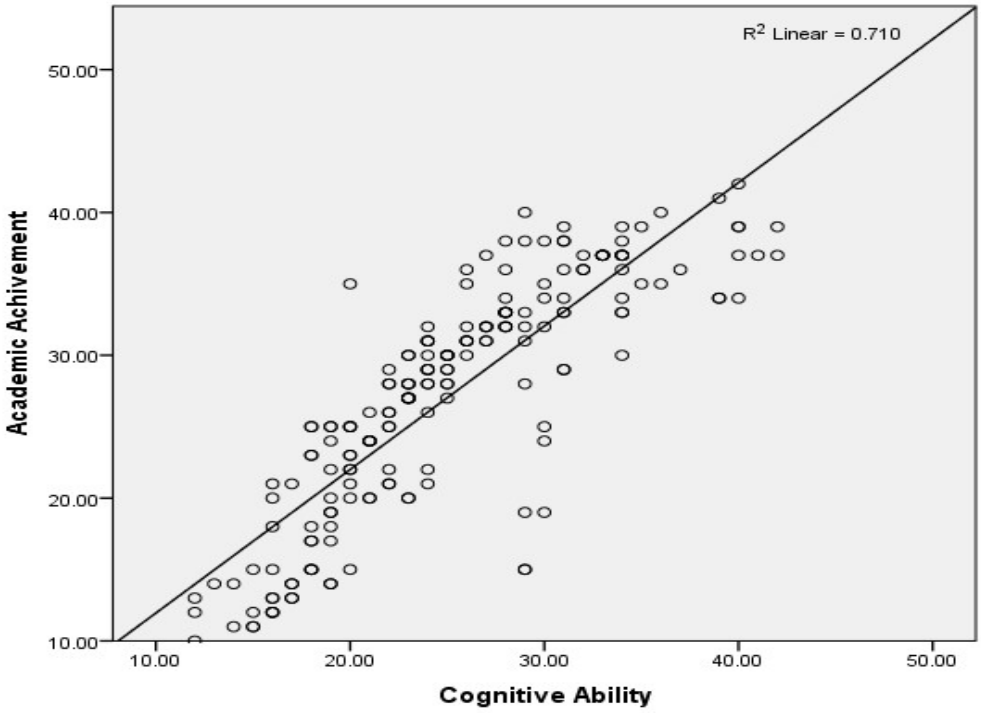


Figure 3

Graphical Representation of Correlation between Meta-cognition and Cognitive Ability of Student Teachers



Predictability of Academic Achievement of Prospective Teachers in terms of Cognitive Ability and Meta-cognition

The researcher tried to know the predictive ability of the Meta-cognition and cognitive ability to predict their academic achievement. For this researcher applied linear regression. Table-2 presents the regression model summary.

Table-2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.869[a]	.756	.753	4.08003

a. Predictors: (Constant), Cognitive Ability, Meta-cognition

From Table-2, it is clear that the R value is .869, which shows that there is significant correlation between the predictor variable and outcome variable. The value of R^2 is obtained as .756. This tells that Meta-cognition and cognitive ability can account for 75.6 percent of the academic achievement of the student teachers. That means, there are many other factors that are influencing the academic achievement of the sample. Among them 75.6 percentage is by Meta-cognition and cognitive ability.

Table-3
ANOVA

Model	Sum of Squares	Df	Mean Square	F[a]	Sig.
Regression	9689.748	2	4844.874	291.042	p <.0001[b]
Residual	3129.571	188	16.647		
Total	12819.319	190			

a. Dependent Variable: Academic Achievement

b. Predictors: (Constant), Cognitive Ability, Meta-cognition

Table-3 show that the F value obtained is 291.042 which is significant at .01 level of significance. The *F* value obtained shows that the regression model can significantly do better prediction of academic achievement of the student teachers in terms of Meta-cognition and cognitive ability.

Table 4 shows the t value is significant with a significant value of .000. This denotes that Meta-cognition and cognitive ability of the student teachers makes a significant contribution (p< .001) to predict the academic achievement of the student teachers.

The regression analysis carried out shows that that the Meta-cognition and cognitive ability of the student teachers can make a significant contribution to the prediction of their academic achievement with a p value less than .0001.

Table-4
Coefficients

Coefficients[a]					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-7.190	1.903		-3.778	.000
Meta-cognition	.467	.079	.326	5.918	.000
Cognitive Ability	.710	.066	.596	10.798	.000

a. Dependent Variable: Academic Achievement (Pre-Test)

The prediction of the academic achievement of the student teachers with the values of Meta-cognition and cognitive ability can be done using the equation,

Academic achievement = -7.190 + 0.467 Meta-cognition + 0.710 Cognitive Ability

Findings of the Study:

From the analysis of the data in accordance with the formulated hypothesis, the researcher came to the following findings:

1. Cognitive ability of the prospective teachers possesses a positive, strong linear correlation with Meta-cognition and academic achievement.

2. Metacogniton and academic achievement of prospective teachers are in a strong, positive linear correlation
3. The prediction of the academic achievement of the student teachers with the values of Meta-cognition and cognitive ability can be done using the equation,
   Academic achievement = -7.190 + 0.467 Meta-cognition + 0.710 Cognitive Ability

Conclusion:

This research aimed to explore the intricate interplay between cognitive ability, meta-cognition, and academic achievement among prospective teachers, guided by the principles of design thinking. The findings revealed a robust and positive linear correlation among these variables, emphasizing the pivotal role of cognitive ability and meta-cognition as predictors of academic success in this cohort. Importantly, this study underscores the imperative to shift our focus towards innovative strategies within the learning environment. In the spirit of design thinking, we advocate for a dynamic and iterative approach to educational practices, with a specific emphasis on enhancing both cognitive ability and meta-cognition among future educators. This transformative perspective encourages the continuous refinement and implementation of targeted strategies, fostering a holistic and adaptive learning experience for aspiring teachers.

Limitation:

This study was limited by its small sample size, which means that the results may not be generalizable to the wider population. Therefore, it is important to replicate this study in other settings with larger samples to confirm the findings.

Ethical approval:

This study was conducted in accordance with the Declaration of Helsinki-Ethical principle for research involving human subjects. Accordingly, the ethical clearance was obtained from Institutional Human Ethics Committee, Avinashilingam Institute for Home Science and Higher Education for women, Coimbatore Tamilnadu vide reference no: AUW/IHEC/EDU-20-21/XPD-04 dated 07-12-2021. All individuals who took part in the study gave their informed consent, and data confidentiality was ensured.

Data availability:

All data sets generated or analyzed during this study are included in the manuscript.

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Conflicts of interest:

No potential conflict of interest was reported by the authors.

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Authors' contributions:

G. Maheswari had the idea for this study, the principal investigator of the research work, performed data collection and edited the manuscript. Dr.H. Indu, designed the study protocol, conducted the

analyses and drafted the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work. All authors have read and agreed to the published version of the manuscript.

References:

Abdelrahman, R.M. (2020). Meta-cognitive awareness and academic motivation and their impact on academic achievement of Ajman university students. *Heliyon, 6,* https://doi.org/10.1016/j.heliyon.2020.e04192

Chen, W. (2016). The difference in income return between vocational education and ordinary high school education. Chin. J. Sociol. 2, 167–190. doi: 10.15992/j. cnki.31-1123/c.2016.02.008

David, F. L. (2005). The role of nonverbal ability tests in identifying academically gifted students: an aptitude perspective. Gift. Child Q. 49, 111–138. doi:10.1177/001698620504900203

Deary, I. J., Steve, S., Pauline, S., and Cres, F. (2006). Intelligence and educational achievement. Intelligence 35, 13–21. doi: 10.1016/j.intell.2006.02.001

Denning, P. J. (2013). Design thinking. Communications of the ACM, 56(12), 29-31.

Formazin, M., Schroeders, U., Kller, O., Wilhelm, O., and Westmeyer, H. (2011). Studierendenauswahl im fach psychologie. Psychol. Rundsch. 62, 221–236. doi:10.1026/0033 3042/a000093

Hames. E and Baker. M. (2015). A Study of the Relationship between Learning Styles and Cognitive Abilities in Engineering Students. *European Journal of Engineering Education*, 40(2), 167-185.

Joseph, N. (2010). Metacognition needed: Teaching middle and high school students to develop strategic learning skills, Preventing School Failure, 54 (2), 99- 103.

Memnun, D.S. & Akkaya, R. (2009). The levels of metacognitive awareness of primary teacher trainees, Procedia social and Behavioral Sciences 1, 1919- 1923.

Miriam, V., Franzis, P., and Heinz, H. (2011). Mental abilities and school achievement: a test of a mediation hypothesis. Intelligence 39, 357–369. doi: 10.1016/j.intell.2011.06.006

Nongtodu, S. (2017). Meta-cognition and its relation with academic achievement among college going students of Meghalaya, *International Journal of Edcuation and Psychological Research, 6* (7)

Nosratinia, M., Saveiy, M. & Zaker, A. (2014). EFL learners' self-efficacy, metacognitive awareness, and use of language learning strategies: how are they associated? Theory and Practice in Language Studies. 4(5), 1080-1092.

Onyeizugbo, E. U. (2010). Self-efficacy and test anxiety as correlates of academic performance. Educational Research, 1(10): 477-480. [Online] Available: http://www.interesjournals.org/ER

Ormrod, J.E. (2003). Educational Psychology: Developing Learners. (4th ed.) New Jersey: Merrill-Prentice Hall.

Özçakmak, H., Köroğlu, M., Korkmaz, C., and Bolat, Y,(2021). The effect of Meta-cognitive awareness on academicsuccess. *African Educational Research Journal*, 9(*2*): 434-448.

Plomin, R. (2011). IQ and human intelligence. Am. J. Hum. Genet. 65:1476. doi: 10.1086/302632

Pooja, P. (2017). A study on the relationship between cognitive abilities and academic achievement of higher secondary school students, *IJARIIE, 3*(3), 234-246.

Rohde, T. E., and Thompson, L. A. (2007). Predicting academic achievement with cognitive ability. Intelligence 35, 83–92. doi: 10.1016/j.intell.2006.05.004

Stadler, M., Miriam, A., Nicolas, B., and Samuel, G. (2016). Choosing between what you want now and what you want most: self-control explains academic performance beyond cognitive ability. Personal. Individ. Differ. 94, 168–172. doi: 10.1016/j.paid.2016.01.029

Sternberg, R. J., and Sternberg, K. (2009). Cognitive Psychology, 6th Edn. Belmont, CA: Wadsworth,Cengage Learning.

Xu, F., and Li, C. H. (2015). The influence of junior middle school students' cognitive ability on academic performance. J. Psychol. Sci. 1, 11–18. doi: 10. 16719/j.cnki.1671-6981.2015.01.033.

Zhang, J. J. (2008). Comparison of LRA, metacognition, attention level and academic performance of primary and middle school students. J. Psychol. Sci.3, 707–710. doi: 10.16719/j.cnki.1671-6981.2008.03.035

Zheng, F., and Zhang, H. X. (2021). The influence of self- middle school habits on middle school students and their cultivation. Mod. Commun. 2, 4–6.