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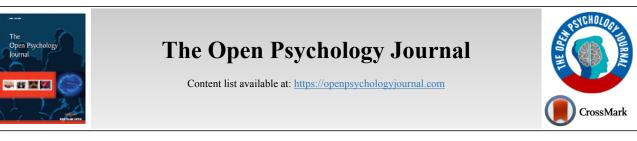Content list available at: https://openpsychologyjournal.com

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RESEARCH ARTICLE

Impact of Motivation, Learning Strategy, and Intelligence Quotient on Medical Students' Grades

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Abstract:

Background:

Medical students were faced with a problem-based learning (PBL) curriculum that required them to think critically. PBL requires a student to have the ability to think logically and collect integrated information, which is reflected in their IQ scores. Learning and motivation strategies were factors that could contribute to their academic achievement. High intelligence does not ensure academic achievement, and students need to recognize the learning strategies that work best for them. This study aimed to investigate the association of medical students' motivation for learning and their intelligence quotient with their course grades in their first semester.

Methods:

This study was an observational study of first-semester undergraduate medical students with 134 respondents. *Intelligenz Struktur Test* (IST) was used to assess IQ and the Motivated Strategies for Learning Questionnaire (MSLQ) form was used to measure students' academic motivation and their use of different learning strategies. Course grades were collected from their biomedical system course in the first semester. Linear regression analysis was used to determine the association between IQ scores and average biomedical grades.

Results and Discussion:

Linear regression analysis showed that IQ might play a role in determining biomedical system course grades both in the crude and adjusted analysis (p-value <0.001). None of the investigated motivation and learning scales modified the association between IQ scores and average biomedical grades.

Conclusion:

Intelligence can predict students' academic performance in their first semester courses. Motivation for learning did not differ between different IQ groups and did not modify the association between intelligence and academic achievement.

Keywords: Intelligence quotient, MSLQ, Medical student, Academic achievement, Motivation, Linear regression analysis.

1. INTRODUCTION

Intellectual capacity, as estimated by Intelligence Quotient (IQ), is one of the determinants of academic performance. IQ indicates an individual's overall capability to comprehend com-plex ideas, adapt efficiently to the circumstances, learn from experience, engage in various forms of reasoning, and overcome obstacles by making decisions [1]. Problem-based learning (PBL), which is a logical step towards developing students' abilities to synthesize concepts from a clinical scenario, is the most common method implemented in medical schools [2]. This method requires a student to have the ability to think logically and collect integrated information, which is reflected in their IQ scores. IQ was correlated with problem solving and educational performance [3].

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Another factor that can contribute to academic achievement is the learning and motivation strategies. High intelligence does not ensure academic achievement, and students need to recognize learning strategies that work best for them [4]. Since there is much information to be learned, as a medical student, efficient learning strategies are important [5]. Students who have high motivation in their academic education should have an excellent opportunity to have a better academic performance. They could obtain higher scores, show more effort, and be better at planning their performance and time management [6]. Furthermore, there is a body of evidence suggesting that motivations affect various aspects of cognitive function, from rudimentary cognition [7] to more complex attention [8], learning [9], memory, and control [9].

A previous study provides direct evidence that motivation plays a role in students' success and academic achievement [10]. Another study also found that attitude, motivation, and intelligence quotient were predictors of academic achievement in mathematics [11]. Good academic achievement is of high value to educators, hence the requirement to determine the major components which contribute to academic performance among students. This study aimed to investigate the association of medical students' motivation for learning and their intelligence quotient with their course grades in their first semester.

2. METHODS

2.1. Subjects

This study was observational on first-semester undergraduate students from the Faculty of Medicine, University of Muhammadiyah Makassar, Indonesia. This study was conducted from September 2019 to February 2020. A total of 134 students participated in this study. The criteria for the subjects in this research were students enrolled in Biomedical System I, Biomedical System II, and Biomedical System III courses. Biomedical system courses consist of human anatomy, histology, biochemistry, and physiology. Average Biomedical Grades were calculated as the mean of Biomedical I, Biomedical II, and Biomedical III grades. Exclusion criteria were students with minimum course participation of less than 80%.

2.2. Instrumentation

In this study, two main instruments were used: Intelligenz Struktur Test (IST) to assess students' IQ and the Motivated Strategies for Learning Questionnaire (MSLQ) form to measure students' academic motivation and their use of different learning strategies. IST forms were filled out during the admission process at the beginning of the semester, while the students filled out the MSLQ forms throughout the semester. Data about parents' income were collected by the academic office of the faculty using a self-reported questionnaire. These questionnaires were filled out during the admission process when students were first admitted into the university. Data about students' body weight, height, blood pressure, and heart rate were collected by the faculty clinic during the admission process. All other information, such as students' demographic characteristics and course grades, was collected from the faculty academic office.

2.2.1. Motivated Strategies for Learning Questionnaire (MSLQ)

Student's motivation and learning strategies were assessed using the Motivated Strategies for Learning Questionnaire (MSLQ). This questionnaire consists of 81 items. MSLQ questionnaire is a self-reported questionnaire and was developed for evaluating undergraduate student's motivation and their self-regulated learning towards a particular course [12, 13]. The questionnaire was designed on a 7-point Likert scale format, starting from "very untrue of me" to "very true of me." There are two sections in MSLQ: a motivation section and a learning strategies section. The motivation section included 31 items in 6 subscales for assessing students' goals, values, and beliefs toward a specified course, thoughts about their ability to achieve a category, and test anxiety. The six subscales of the motivation section encompass intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety. The training strategies section includes 31 items in 9 subscales for assessing students' use of cognitive-metacognitive strategies and resource management strategies. The nine subscales of the learning strategies section assess rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment management, effort regulation, help-seeking, and peer learning. Also, the training strategies section includes 19 items concerning student management of various resources [13, 14]. Scale is constructed by taking the mean of the items that make up the scale. For example, extrinsic goal orientation has four items. So, student individual scores for extrinsic goal orientation would be computed by summing the four items and taking the average [15]. Higher scores on motivation scales and learning strategies indicate that students can regulate their cognition, affect, and motivation during their study [16].

This instrument has been tested for reliability in various studies. When it was first developed, this instrument's reliability was very strong; it had a Cronbach's alpha value on each subscale ranging from 0.52 to 0.93 and had a moderate significant subscale correlation [15]. In another study involving 411 students, the reliability of each subscale ranged from 0.745 to 0.788 [17]. Furthermore, in a study with 1,114 respondents, the correlation between item scores and total scores that had been corrected ranged from 0.58 to 0.15 (p-value <0.01) on the motivation subscale aspect and 0.68 to 0.19 (p-value <0.01) on the sub-scale part learning strategy scale [18].

2.2.2. Intelligent Quotient (IQ) Test

We measured the level of intelligence in this study using the IST. The IST consists of 176 questions, which are divided into nine subtests. The scoring process in the IST is to give a score of 1 for the correct answer and a score of 0 for the wrong answer on each sub-test. The scores obtained are grouped into three categories based on the tertiles; high IQ group (IQ score > 96), average IQ group (IQ score 90 – 96), and low IQ group (IQ score <90).

2.3. Data Analysis

First, baseline data will be tabulated by students' IQ level groups. Normally distributed data (such as Biomedical System I, II, and III course grades, blood pressure, heart rate, body mass index [BMI], body height, and body weight) were presented as the mean and standard deviation. Categorical data, such as gender and parents' income, were presented in numbers and percentages. Chi-square test was used to test the difference in the proportion of gender and parents' income between different IQ groups. One-way ANOVA test was used to determine whether there were any statistical differences in Biomedical System courses grades, blood pressure, heart rate, BMI, and body height and weight between different IQ groups. Kruskal-Wallis H test was used to test if there were differences in motivation and learning strategies scales between different IQ groups. All statistical tests were considered as significant if the p-value <0.05. Linear regression analysis was used to determine the association between IQ scores and average biomedical system grades. Finally, a subgroup analysis was done to investigate if certain motivation and learning scales/subscales modify the association between IQ scores and average biomedical system grades. The data obtained was processed using SPSS 23 (IBM Corporation, New York, USA) for Macbook.

3. RESULTS

The study included 134 students. Respondents were classified into three groups: high IQ group (n=42), average IQ group (n=47), and low IQ group <90 (n=45). Participants in different IQ groups were not different in terms of gender, parents' income, blood pressure, heart rate, BMI, body height, and body weight. Data on the characteristics of the respondents can be seen in Table **1**.

Biomedical System I course grades were higher in the high IQ group rather than in other groups, although not statistically significant. Meanwhile, for Biomedical System II and III, the average IQ group had higher grades than the other two groups (p-value < 0.05) (Table **2**). On the other hand, motivation and learning strategies scales and sub-scales were not statistically

different between different IQ groups (Table **3**).

The result of linear regression analysis showed that IQ might play a role in determining Biomedical course grades both in the crude and adjusted analysis. A one point increase in IQ score was associated with a 0.48 (95% CI 0.20 – 0.75, p <0.001) higher mean Biomedical course grades after adjustment for gender, parents' income, BMI, and blood pressure (Table **4**).

In the subgroup analysis, none of the investigated motivation and learning scales modified the association between IQ scores and average biomedical grades (Table **5**).

4. DISCUSSION

The present study showed that higher IQ scores were independently associated with higher average biomedical grades during the first semester. Motivation and learning scales/subscales did not modify the association. This study has limitations because it did not assess other factors contributing to the relationship, such as parental guidance, learning support facilities, health, socio-economic status, emotional intelligence, and spiritual intelligence. Nevertheless, it was the first study to investigate motivation and learning strategies among IQ groups in medical students in relation to their academic achievement in the first semester.

Based on the results on gender characteristics, it was found that both genders have no difference in the IQ category (Table **1**). Several studies have also shown the equivalence of IQ scores between males and females [19, 20]. These findings are also consistent with the metanalysis of the general population that showed no sex difference in IQ [21]. Although anatomically, the male brain is 8-10% larger and the female brain has a thick corpus callosum, some researchers concluded that these structural differences would lead to comparable intellectual performance overall. IQ scores have a positive relationship with the density of gray matter in the cerebral cortex, limbic system, and cerebellum. Physiologically, these regions play an essential role in verbal function: executive function, error detection, and memory (especially working memory) [22].

Table 1. Descriptive statistics of respondent's characteristics.

Variables	Total (n = 134)	High IQ score (n = 42)	Average IQ score (n = 47)	Low IQ score (n = 45)	P-value
Gender • Male • Female	25 (18.7%) 109 (81.3%)	10 (22.2%) 35 (77.8%)	7 (14.9%) 40 (85.1%)	8 (19.0%) 34 (81.0%)	0.66**
Parents' income/month • Low income • High income	70 (52.2%) 64 (47.8%)	21 (46.7%) 24 (53.3%)	29 (61.7%) 18 (38.3%)	20 (47.6%) 22 (52.4%)	0.27**
Blood Pressure (mmHg) • Systolic • Diastolic	107.9±8.3 73.9±6.3	108.1±8.3 72.8±5.5	106.3±7.6 73.6±6.0	109.3±8.8 75.3±7.2	0.23* 0.17*
Heart Rate	79.1±4.7	79.0±5.0	79.6±4.8	78.3±4.2	0.26*
Body Mass Index	21.1±4.2	21.1±4.3	20.8±3.5	21.3±4.8	0.83*
Height (Kg)	157.5±7.1	157.9±7.1	156.7±7.2	158.0±7.0	0.60*
Weight (m)	52.4±11.4	52.8±12.0	51.2±10.0	53.2±12.3	0.69*

*Data expressed as mean ± SD and p-value with One-Way ANOVA test
** Data expressed as frequency (percentages) and p-value with Chi-square test

Table 2. Biomedical course grades between IQ Groups.

Variables	Total (n = 134)	High IQ score (n = 42)	Average IQ score (n = 47)	Low IQ score (n = 45)	P value
Course Grades					
• Biomedical I	62.2±19.6	66.9±17.0	63.5±22.5	56.5±17.6	0.04*
• Biomedical II	66.6±17.55	70.2±16.6	72.8±11.2	56.7±19.5	<0.01*
• Biomedical III	58.8±18.7	62.8±17.4	65.6±10.4	48.0±21.9	<0.01*

*Data expressed as mean ± SD and p-value with One-Way ANOVA test.

Table 3. Descriptive Statistics of motivated strategies for learning questionnaire (MSLQ).

Scales	Sub-scales	High IQ score (n = 42)	Average IQ score (n = 47)	Low IQ score (n = 45)	P-value
Motivation Scales	Intrinsic goal orientation	6.05±0.82	5.73±0.85	5.85±0.82	0.93
	Extrinsic goal orientation	6.42±1.04	6.13±1.03	6.40±0.64	0.64
	Task value	6.34±0.94	6.16±0.84	6.35±0.49	0.21
	Control of learning beliefs	6.06±0.88	6.01±0.82	6.11±0.78	0.74
	Self-efficacy for learning and performance	6.14±0.97	5.85±0.94	5.99±0.70	0.90
	Test anxiety	3.91±1.24	4.29±1.29	4.12±1.12	0.33
Learning Strategies Scales	Rehearsal	6.00±0.62	5.66±0.93	5.67±1.16	0.33
	Elaboration	5.80±0.85	5.52±1.13	5.59±1.26	0.67
	Organization	5.72±0.95	5.29±1.27	5.46±1.28	0.38
	Critical thinking	5.71±0.73	5.40±0.90	5.50±1.21	0.24
	Metacognitive self-regulation	5.47±0.61	5.29±0.86	5.38±1.06	0.65
	Time and study environment	5.26±0.52	5.04±0.70	4.95±1.03	0.22
	Effort regulation	4.79±1.02	4.94±0.85	4.77±1.01	0.86
	Help seeking	5.21±0.59	5.26±0.93	5.11±1.09	0.84
	Peer learning	5.88±0.82	5.68±0.91	5.85±1.08	0.30

*Data expressed as mean ± SD and p-value with Kruskal-Wallis H Test

Table 4. Association between students' IQ scores and their average Biomedical grades in first semester.

		Average Biomedical Grades	
		Coefficients (95% CI)	P-value
IQ Scores	Crude	0.44 (-5.07 – 46.25)	<0.001
	Adjusted*	0.48 (0.20 – 0.75)	<0.001

*Regression models adjusted for gender, parents' income, BMI and blood pressure

Table 5. Subgroup analysis on the association between motivation and learning scales scores and Average Biomedical grades across different IQ groups.

Sub-scales	Average Biomedical Grades								
	High IQ score			Average IQ score			Low IQ score		
	Coefficients	95% CI	P-value	Coefficients	95% CI	P-value	Coefficients	95% CI	P-value
Intrinsic goal orientation	-7.29	-22.56; 7.96	0.33	-1.87	-9.47; 5.71	0.61	2.28	-6.05; 10.61	0.58
Extrinsic goal orientation	-1.86	-14.49; 10.76	0.76	-4.84	-12.78; 3.10	0.22	-2.83	-14.84; 9.17	0.63
Task value	7.99	-9.49; 25.48	0.35	-1.35	-10.22; 7.51	0.75	-1.44	-17.39; 14.49	0.85
Control of learning beliefs	3.69	-5.76; 13.16	0.42	-2.20	-10.79; 6.39	0.60	5.52	-2.85; 13.90	0.18
Self-efficacy for learning and performance	-5.59	-23.56; 12.38	0.52	8.24	-3.00; 19.49	0.14	7.49	-5.48; 20.46	0.24
Test anxiety	-1.20	-7.97; 5.56	0.71	2.95	-0.48; 6.38	0.09	5.02	-0.16; 10.21	0.05
Rehearsal	-13.18	-28.72; 2.34	0.09	7.49	-0.89; 15.89	0.07	11.10	-1.19; 23.40	0.07
Elaboration	4.58	-12.16; 21.33	0.57	0.19	-12.53; 12.92	0.97	-11.37	-31.52; 8.76	0.25
Organization	7.29	-3.23; 17.82	0.16	5.03	-3.91; 13.99	0.26	12.22	-3.21; 27.65	0.11
Critical thinking	0.21	-13.78; 14.22	0.97	-3.32	-15.64; 8.98	0.58	-2.23	-15.59; 11.12	0.73

(Table 5) contd.....

Metacognitive self-regulation	-14.98	-34.88; 4.92	0.13	-6.94	-16.96; 3.07	0.16	0.70	-18.97; 20.38	0.94
Time and study environment	4.82	-11.55; 21.20	0.55	-4.49	-12.25; 3.26	0.24	5.68	-4.10; 15.46	0.24
Effort regulation	-0.09	-10.46; 10.27	0.98	-2.64	-9.26; 3.97	0.42	-1.71	-9.94; 6.50	0.67
Help seeking	8.70	-8.43; 25.85	0.30	-1.71	-8.35; 4.93	0.60	-12.59	-25.37; 0.19	0.05
Peer learning	0.64	-6.57; 7.86	0.85	5.65	-1.35; 12.66	0.11	2.30	-8.81; 13.43	0.67

This study reported no difference in IQ levels between low- and high-income families (Table **1**). These results contradict those reported by previous studies that low economic status has an impact on IQ and academic performance. Students who come from families with low economic status generally experience conditions of poor nutritional fulfilment and low parental education and, in the end, have low cognitive abilities [23, 24]. Nutritional status described by BMI did not make a difference to IQ levels (Table **1**). BMI was computed as weight in kilograms divided by the square of height in meters. The relationship between BMI and IQ is complicated, and it cannot be explained by one factor alone. Several studies reported a significant correlation between BMI and IQ in children after adjusting for type of delivery, kind of baby food or complementary feeding, residence location, family income, and parental education [25, 26].

Significant results were obtained from the correlation between IQ level and biomedical scores of students (Table **2**). IQ has traditionally been thought of as a predictor of educational performance. The relationship between IQ scores and academic achievement is due to differences in receiving lessons [27]. Students with a higher IQ score are more likely to achieve lessons taught in classes than other students who have lower IQ scores. IQ also has a vital function in decision making that has an important role when the subject answers exam questions [27, 28]. Individuals with higher IQ scores were able to respond more appropriately to a question. Research shows that IQ value plays a role in determining the subjects' accuracy in responding to a questionnaire [29]. Another study shows that intelligence is the best predictor of GPA, where it is found that the value of intelligence has a moderate to strong correlation with GPA [30]. Students with a high IQ will have good abilities in analyzing, imagining, and making judgments logically and accurately, thus indirectly improving their achievement [31].

In addition to intelligence, student success in learning is also influenced by psychological factors. Learning motivation was thought of as the most important psychological aspect that provides direction for learning activities carried out by students so that the desired goals can be achieved. Another study concluded that motivation can act as a factor that impacts intelligence [32]. Students who have a high motivation would demonstrate more effort, better information organization, better time management, and show better performance [6]. Our findings, however, showed that there are no differences in motivation scale between different IQ groups (Table **3**). The same result was reported in another study, which showed that motivation was not related to intelligence [33]. In another study, motivation does not come from a steady and adaptive individual. At this point, the relation of the motivation test will disintegrate with IQ results. However, conditions that are called "nonintellective" traits, such as competitiveness and a tendency to try harder, in people with low intelligence, can be a strong motivation that will increase their IQ results [34].

We found that IQ can be a predictor of academic achievement (Table **4**), but there are many other factors as well. Learning motivation factors, parental guidance, learning support facilities, health, socio-economic status, emotional intelligence, and spiritual intelligence also participate in determining success in achieving academic achievement. Although the subgroup analysis results of the components of motivation and learning scales did not provide meaningful results, there were exciting findings on the regression coefficient values. Rehearsal is a scale measuring how often students use study strategies such as rereading notes, course readings, and memorizing lists of keywords and concepts. A high score means students use these strategies reasonably often. According to our findings, a one-point increase in the rehearsal subscale may be associated with lower biomedical grades in the high IQ group (β -Coefficients -13.18), while in the other two groups, the grades were higher grades with a positive β -Coefficients. Even though this regression is not statistically significant, probably because of the limited number of subjects in the study, it still can be concluded that there is a tendency for people with low intelligence to try harder, which can increase their motivation scale in trying to achieve better grades [34]. Another interesting result was found in help seeking subscale. This is a scale that identifies students' ability to seek some assistance, such as peer help or individual teacher assistance that facilitate student achievement [15]. The effect of help seeking was associated with higher biomedical grades in the high IQ group, while in the low IQ group, the effect was negative. In another study, self-efficacy, selfregulation of learning, and academic achievements are positively correlated [35]. Different from the result of the previous study, our results showed no difference in self-efficacy for learning and performance among IQ groups.

CONCLUSION

Intelligence can predict students' academic performance in their first semester courses. Motivation for learning did not differ between different IQ groups and did not modify the association between intelligence and academic achievement.

Future implications from this study can bring benefits to educators/lecturers. For example, knowing students' cognitive strategies in learning and identifying motivational factors and goals for their academic performance can help educators/lecturers better understand the factors that will affect student performance.

Therefore, educators/lecturers should recognize their

students' motivations, internal or external motivations, and overall learning strategies and encourage them to learn to achieve better academic performances.

ETHICS APPROVAL AND CONSENT TO PARTI-CIPATE

This study was approved by the Health Medical Research Ethics Committee of the Faculty of Medicine and Health Science, University of Muhammadiyah Makassar (Makassar, Indonesia), with registration number 056/UM.PKE/IX/40/2019 on October 31, 2019.

HUMAN AND ANIMAL RIGHTS

No animals were used at any stage of this research. All research procedures involving humans were performed in accordance with the ethical standards of the responsible institutional and/or national research committee on human experimentation and with the 1975 Helsinki Declaration and its later amendments or comparable ethical standards.

CONSENT FOR PUBLICATION

The participants participated voluntarily and have given their individual consent to participate on an informed consent form.

STANDARDS OF REPORTING

STROBE guidelines have been followed.

AVAILABILITY OF DATA AND MATERIALS

Data supporting the finding of the article are available in the Zenodo Repository at zenodo.org, with reference number https://doi.org/10.5281/zenodo.5720946 .

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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