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Original Article

Role of cognitive assessment for high school graduates prior to choosing their college major

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Abstract. [Purpose] Academic performance of college students can be impacted by the efficacy of students' ability and teaching methods. It is important to assess the progression of college students' cognitive abilities among different college majors and as they move from junior to senior levels. However, dearth of studies have been examined the role of cognitive ability tests as a tool to determine the aptitude of the perspective students. Therefore, this study assessed cognitive abilities of computer science and ART students. [Subjects and Methods] Participants were 130 college students (70 computer and 60 art students) in their first and final years of study at King Saud University. Cognitive ability was assessed using the Test of Nonverbal Intelligence, Third Edition. [Results] The cognitive ability of computer science students were statistically better than that of art students and were shown improvement from junior to senior levels, while the cognitive ability of art students did not. [Conclusion] The cognitive ability of computer science college students was superior compared to those in art, indicating the importance of cognitive ability assessment for high school graduates prior to choosing a college major. Cognitive scales should be included as an aptitude assessment tool for decision-makers and prospective students to determine an appropriate career, which might reduce the rate of university drop out.

Key words: Cognition, Education, TONI-3

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INTRODUCTION

The developmental phases of cognitive ability of students follow more or less predictable sequences. However, not all students develop at the same rate. Cognitive ability has been the focus of behavioral investigations for decades and is defined as processes in the mind that produce thought- and goal-directed action[1)]. The importance of cognitive ability assessment can be attributed to the relationships between communication, adaptive behavior, functional outcomes, and acquired knowledge in students.

People's cognition, including that of students, is assessed as a component that affects occupational performance in the areas of self-care, productivity, and leisure[2)]. Thus, cognitive assessment is part of the process of assessing occupational and academic roles and performance. It was recently recommended that cognitive scales should be included as an aptitude assessment tool for decision-makers and prospective students to determine an appropriate career. Cognitive ability differences among college students in health science and art were assessed, reporting that the health science college students' cognitive abilities were better than those of the art college students[3)]. Assessment of students' cognitive ability is crucial and can be used by clinical practitioners, counselors, personnel recruiters, and teachers as a diagnostic tool to measure a student's self-concept[4)].

Several measures have been developed to assess cognitive ability. One of them is the third edition of the Test of Nonverbal Intelligence (TONI-3). The TONI-3 measures skills such as perceptual organization, abstract reasoning, and problem solving. The advantage of the TONI-3 is that it covers a greater range of cognitive abilities compared to most cognitive screens, making it potentially more useful as a screening measure.

However, there is a dearth of studies investigating the status and progress of the cognitive abilities of junior and senior

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computer science and art college students. The present study endeavored to explore the level of cognitive ability among computer science and art students to determine the effect of academic program (computer science and art) on cognitive ability.

SUBJECTS AND METHODS

A convenience sample of 130 adult healthy male college students (70 computer science and 60 art students) in their first (junior) and final (senior) year of study at the King Saud University, with a mean age of 19 ± 2 and 23 ± 1 years respectively, who voluntarily participated in the study. All participants provided written informed consent before data collection. The present study was ethically approved by the Institutional Review Board of the King Saud University, Riyadh (Approval number: CAMS 055–37/38).

Cognitive ability was assessed using the third edition of the Test of Nonverbal Intelligence (TONI-3). Eligible participants were those who completed the TONI-3 evaluation form in a closed university classroom environment (to remove distractions) under the supervision of a qualified occupational therapist. All participants were given a detailed description about the test and the objectives of this study. The test duration was monitored by a stopwatch for each participant to calculate the average time for completion.

The TONI-3 is a language-free measure of intelligence, aptitude, abstract reasoning, and problem solving. There is no listening, speaking, reading, or writing required to administer the test or to respond to test items. It is a standardized test for healthy subjects that has been reported to be reliable and valid[5, 6] and was approved by the Federal Board of Psychology[7]. The TONI-3 consists of two forms ("A" and "B") that are used to establish multiple measures of an individual's cognitive ability. Each form includes a single test of 45 items of progressively increasing difficulty with 6 possible response options. The TONI-3 was administered according to the instruction manual procedures[6].

RESULTS

The cognitive ability of the junior and senior college students in computer science (CS) was statistically better than that of the junior and senior art students ($p<0.001$). Cognitive ability improved as college students progressed from junior to senior levels for computer science students ($p<0.001$), but not for art students ($p<0.15$) (Tables 1, 2).

DISCUSSION

This study was conducted to determine the TONI-3-based cognitive differences between computer science and art students. Its findings show that computer science students had better cognitive ability than art students. It also revealed that academic programs had a significant impact on the cognitive ability of computer science students, but not for art students. Previous studies also reported different cognitive ability levels among students from various colleges. It has been reported that the cognitive abilities of health science students were better than those of art students[3]. Science students have also been found to be more creative than commerce students[8]. These results could confirm that cognitive ability is varied among college students in different areas of study.

High school has mainly two tracks, science and art. The science track most likely fosters academic skills such as problem solving, interpretation, analysis, and the meaningful application of knowledge. The art track tends to foster academic skills like memory and understanding. The various skills acquired in science and art tracks may explain why the cognitive ability of junior computer science students was better than for art students.

Academic courses in math, physics, electronics, programming, etc., are widely taught in computer science colleges through active and interactive learning in labs, tutorials, and lectures, whereas a traditional lecture-based program is most likely followed in art colleges. Differences in the mode of classroom teaching and student's attention between computer science and art programs might also affect cognitive functional differences among our study groups.

Computer science courses are reported to expose students to computational thinking that involves problem-solving, using concepts like abstraction and decomposition. This computational thinking is applicable and useful in daily life[9] and may better explain cognitive ability for computer science college students than for art college students. According to social cognitive theory, interacting with a computer system influences observers' perceptions of their own ability to perform the behavior, or

Table 1. Comparison between junior and senior level CS vs. Art students

Students	TONI-3 ± SD
Junior CS (n=35)	32.51 ± 6.3*
Junior Art (n=30)	27.4 ± 5.4
Senior CS (n=35)	39.43 ± 3.2*
Senior Art (n=30)	31.9 ± 6.5

*Between group comparison ($p<0.05$) and †($p>0.05$).

Table 2. Cognitive ability of junior vs. senior students in CS and Art

Students	TONI-3 ± SD
Junior CS (n=35)	32.51 ± 6.3
Senior CS (n=35)	39.43 ± 3.2*
Junior Art (n=30)	27.4 ± 5.4
Senior Art (n=30)	31.9 ± 6.5†

*Between group comparison ($p<0.05$) and †($p>0.05$).

self-efficacy, and the expected outcomes that they perceive, and provides strategies for effective performance[10].

The academic curriculum for computer science seems to be more challenging than art college curriculum. Therefore, it can be suggested that the curriculum of art colleges should be revised to stimulate the creative thinking of students and encourage new and innovative ideas, rather than dogmatic and rote learning. Teaching methods and strategies in art colleges should be altered so as to induce creative thinking, compelling students to become more active participants rather than passive listeners.

Moreover, art college students usually deal with a single language (i.e., Arabic) within their academic curriculum, whereas computer science college students deal mostly with both English and Arabic languages, as this is necessary for most the English-based software programs. A previous study reported that the cognitive control outcomes for bilinguals vary as a function of the mechanisms recruited during bilingual management and the amount of experience managing the bilingual demands[11]. Moreover, those who frequently switch between languages have enhanced cognitive control[12].

Traditionally, grade point averages (GPA) have been the primary criteria used by admission personnel, and students with higher scores always opt for computer science colleges as one of their top primary choices. GPA is highly correlated with cognitive ability[13]. At the university where the sample of this study was recruited, admission to the college of computer science required a very high GPA compared with the modest GPA admission requirement for the college of art, which may explain the better cognitive ability among computer science students compared to ART students. This finding may also suggest that cognitive assessment is a good predictor of academic achievement. Subsequently, cognitive assessment should yield scores that distinguish between students prior to their academic guidance or choice of college majors.

The significant cognitive progress from junior to senior levels for computer science students, but not for art students, can be explained on the basis of evolutionary game theory. Humans have an evolved cognitive specialization for social exchange[14]. Computer science students, in particular, are exposed to social media. However, this progression did not occur with the art students, which could be due to the time they spend in a traditional classroom setting, whereas students of computer science spend more time in practical labs and tutorial classes.

Based on the current results, it is proposed that art college curriculum should incorporate more computational practices and computational perspectives to foster developmental and cognitive science considerations. Moreover, TONI-3 assessments may complement contemporary talent search procedures. Eventually, we intend to promote computational literacy in humanities classrooms and the artistic community.

Conflict of interest

None.

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