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# The Relationship between Jordanian Students' 21st Century Skills (Cs21) and Academic Achievement in Science

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## ABSTRACT

The present research aimed to determine the relationship between Jordanian students' 21st century skills (Cs21) and academic achievement in science. The sample of the research consisted of a total of 96 eighth-grade students drawn from four rural and four urban schools in Irbid Qasaba in the governorate of Irbid. Randomly cluster sampling was used to select the sample of the study. To collect data, a Cs21 survey was adapted from the Malaysian Cs21 Instrument (M-21CSI), which was itself based on the enGauge Cs21 framework by Metiri Group and NCREL. The adapted survey was used to measure students' Cs21 and academic achievement in science in the 2015–2016 academic year. The data were analyzed by using descriptive (mean and standard deviation) and inferential statistics (simple linear regression and independent samples t-test). The findings showed that the Cs21 was a significant predictor of the students' academic achievement in science (R = .353, p = .000). The analysis also showed that urban and female students were better in acquiring the Cs21 than rural and male students. However, their parents' job types had no significant difference in the students' mean scores of Cs21. Therefore, it is recommended that the Cs21 should be integrated into all curricula to improve students' academic achievement and to train future citizens, who are ready for the challenges of the 21st century.

**Keywords:** Academic Achievement, Science Education, 21st Century Skills.

## INTRODUCTION

### a) 21st Century Skills (Cs21)

Advances in information technology (IT) have significant impacts on the politics, economy, and society of countries in the world. So, students need to be equipped with suitable skills, which effectively deal with future life complexities and today's competitive world (Alhababha, 2016; Lemke, Coughlin, Thadani, & Martin, 2003; Poropat, 2009; Soh, Arsad, & Osman, 2010; Turiman, Omar, Daud, & Osman, 2012). Therefore, educational systems should keep up with these rapid changes to prepare students for new life challenges (Lemke et al., 2003; Soh, Arsad & Osman, 2010). The 21st century skills (Cs21) prepare young people

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for effective workers and citizens in the modern knowledge society in future (Ananiadou & Claro, 2009).

The Cs21 enable the current generation to face future challenges, which could encompass changes in industry, economy, society, technology, and information (Lemke et al., 2003). These skills get students to acquire critical thinking, problem solving, decision making and innovation (Hirsch, 2009; Silva, 2009). The Cs21 include digital literacy, inventive thinking, effective communication and high productivity. They also include skills in learning, innovation, media, technology, information, and core subjects as well as life and career skills (Lemke et al., 2003).

Even though the assessment of the Cs21 is one of the most important educational issues, how to measure the Cs21 has still been unexplored (Finegold & Notabartolo, 2010; Geisinger, 2016). Also, although the definition of the Cs21 has still been argued, the Cs21 are the skills, that make a person active, productive, and adaptable in the new [21st] century (Autor, Levy, & Murnane; 2003; Kyllonen, 2012; Levy & Murnane, 2004). Several organizations have attempted to develop frameworks of the Cs21 (Dede, 2010). For instance, NCREL and Metiri Group (Lemke et al., 2003) developed four main Cs21 domains: (1) digital-age literacy including multicultural literacy, information literacy, technological literacy, visual literacy, and scientific literacy (2) inventive thinking containing higher-order thinking and informal reasoning, self-direction, managing complexity, adaptability, curiosity, creativity, and risk taking (3) effective communication incorporating interactive communication, interpersonal skills, personal responsibility, civic responsibility, social responsibility, collaboration, and teaming (4) high productivity involving in using real-life tools, producing relevant and high-quality products, and results, prioritizing, planning, and managing.

### b) The CS21 and Science Education

The general objective of science teaching is to enable students to understand all technological types, so that they can use them in their daily lives (Ministry of Education, 2016). Moreover, science education aims at developing students' problem solving skills so that they can solve their daily problems. Although the acquisition of basic science skills is essential for students, these skills are not enough to become creative problem solvers, transfer their knowledge to real-world situations, use various sources to generate innovative ideas, and to face the challenges of modern life (Soh, Arsad, & Osman, 2010). Science education plays a critical role in preparing the 21st century workforce (Bybee & Fuchs, 2006).

In this scope, teaching the Cs21 can contribute to improve science education, and science pedagogy as well as standardizing curriculum to constantly changes in new technology and globalized society (Hirsch, 2009; McFarlane, 2013). Also, educating students with the Cs21 will make a contribution to society in the 21st century and make them more productive (Volkmann, et al., 2009). Recognizing the importance of the Cs21 has led to its integration into the educational system, as enGauge Framework by Metiri Group and NCREL. They have purposed to integrate the teaching of the Cs21 into curricula, so that students can participate fully in modern life (Dede, 2010).

### c) The CS21 and Academic Achievement

Academic achievement, which is the goal of the entire educational system, is the main indicator for assessing student progress in an educational system (Tabbodi, Rahgozar, & Abadi, 2015). Knowledge, which is essential for success in the 21st century, yields successful learning and achievement in any time (Mishra & Kereluik, 2011). In such traditional academic domains as science, the Cs21 skills, frequently cited as an essential for success,

embrace core content knowledge and high academic achievement. In other words, excellence in any traditional academic domain is considered to be the basis for developing other Cs21 (Gardner, 2008). Many empirical studies over years have found that academic achievement is closely connected with cognitive skills (Mishra & Kereluik, 2011). Lemke et al. (2003) suggested improving students' academic achievement and the Cs21 skills, which are pre-requests for the qualified workforces. In addition, it is argued that the use of educational technology improves students' achievement (Cuban, 2001; Dede, 1998; Harter & Harter, 2004; Oppenheimer, 2003; Safari & Taheri, 2015). In addition to digital-age literacy, high productivity and effective communications, inventive thinking has been identified as an important skill for academic achievement (North Central Regional Educational Laboratory and Metiri, 2003).

**d) CS21 and Jordan**

There is an urgent need to assess the Cs21 in Jordan, so that deficiencies in curricula, especially science curriculum, can be revealed and addressed to properly prepare students for their current and future life skills (Bybee & Fuchs, 2006; Kyllonen, 2012). Due to rapid advances in IT and knowledge-based economy, the concept of the 'k economy' has arisen to address the gap between various curricula offered by different educational systems and the needs of the world community in the 21st century (Turiman, Omar, Daud, & Osman, 2012). Jordan, as a part of this community, started to implement technology-enriched educational reforms under the title "Education Reform for the Knowledge Economy" (ERfKE) in 2003 (Chisholm & Steiner-Khamsi, 2015; Lightfoot, 2014). Hence, such Cs21 as collaboration, communication, critical thinking, problem solving, and information and communication technology (ICT) literacy were integrated into the curriculum (Kozma, 2010). The aim of the Curriculum and Assessment Department of the Jordanian Ministry of Education is to foster sustainable economic development through well-skilled workforces and to educate population with lifelong learning experiences via their recent and upcoming requirements (Kozma, 2010).

Nonetheless, Jordan was ranked 57th among 65 countries in the Programme for International Student Assessment (PISA) assessing curricula Cs21 (PISA, 2012). In 2011, the Trends in International Mathematics and Science Study (TIMSS) showed that Jordanian eighth-grade students had the lowest results among the participant countries (Mullis, Martin, Foy, & Arora, 2012). Therefore, there is an urgent need to improve the factors that affect students' academic achievement and to integrate the Cs21 into science curriculum meeting the needs for the modern world. Also, little research has been conducted on the effect of digital literacy on student achievement (Brown, 2009).

To date, there has been no published research on the relationship between the Cs21 and academic achievement in science, but many researchers have examined the relationship between students' digital literacy and academic achievement (Brown, 2009; Pagani et al., 2016; Prensky, 2005). These studies have revealed that the use of technology improves students' academic achievement. On the other hand, some studies showed a positive relationship between thinking skills (e.g., creative thinking and critical thinking) and academic achievement (Anwar, et al., 2012; Bowles-Terry, 2012; Naderi et al., 2010; Zirak & Ahmadian, 2015). This research will explore the relationship between Jordanian students' Cs21 skills and academic achievement in science or elicit variations in the Cs21 for Jordanian students.

## CONCEPTUAL DEFINITION

### a) Digital-Age Literacy

The digital-age literacy is the most predominant skills needed to negotiate the complexities of digital lifestyle (Belshaw, 2012). Digital-age literacy is defined as the "ability to use digital technology, communications tools and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (Educational Testing Service, 2002, p.2). For this research, digital-age literacy is defined as the needed skills and capabilities to effectively deal with the complexities of life. This effectiveness facilitates scientific literacy, technological literacy, visual and information literacy, multicultural literacy, global awareness, using technology in interpersonal, collaborate communication, and productivity of an individual's ability to use and manage technology.

### b) Inventive Thinking

Inventive thinking is defined as "an ability to effectively solve non-typical (creative) problems in various domains avoiding a large number of trials and errors" (Sokol, et al., 2008, p.36). In this research, inventive thinking, which involves in curiosity, self-direction, creativity, risk taking, adaptability, sound reasoning and higher-order thinking, is defined as being able to creatively deal with complex learning.

### c) Moral Values

Moral values are defined as an exceptional fundamental spiritual development of a person (Aramavičiūtė & Martišauskienė, 2014; Covey, 2007). In this research, moral values reflect the Jordanian society's basic values and norms (named Jordanian identity) while using technology.

## PURPOSE OF THE STUDY

The primary aim of this research is to identify the relationship between Jordanian students' academic achievement in science and Cs21. The secondary aim of this research is to determine these students' demographic differences in terms of the Cs21.

## RESEARCH QUESTIONS

This research attempts to answer the following research questions:

1. Is there any relationship between the Jordanian students' Cs21 and academic achievement in science?
2. Is there any significant difference between male and female students' Cs21 skills?
3. Do students from rural and urban school locations impact the students' Cs21 skills?
4. Do students' parents' jobs (educational and non-educational) influence their Cs21 skills?

This research is expected to integrate the Cs21 into the Jordanian government's curricula in general and serve for science curriculum at the primary school level purposing to equip students with these skills. Also this research will play a crucial role in training students

with the expertise, knowledge, and skills that they need to be productive citizens and workers and to face the challenges of globalization. Moreover, the results will give Jordanian educational leaders valuable feedback that can be used to inform educational policy on such areas as professional development for teachers, curriculum development, accountability, and assessment. In addition, this research will pave the way for other researchers to further improve the integration of the Cs21 into science curricula and to improve science pedagogies and related assessment tools. Also, relevant educational leaders may find this beneficial for further actions.

## RESEARCH METHODOLOGY

### a) Research design

Within survey research design, this research explored the relationship(s) between the Cs21 and academic achievement in science. That is, this study viewed the Cs21 as a predictor variable and academic achievement in science as the criterion. Hence, the current study employed a survey to generalize the data from the sample of the study to a large-size population.

### b) Research sample

The target population of this prediction study consisted of public primary schools in Irbid governorate in Jordan during the 2015–2016 academic year. The accessible population was 96 government primary schools in Irbid Qasaba. A random cluster sampling technique was used for selecting the sample. Firstly, 480 primary school students from eight government schools (four each from rural and urban areas) were randomly drawn from the schools in the Irbid Education Directorate. Then, 48 students from each school were randomly selected for this research. Finally, given Krejcie and Morgan's (1970) criteria in determining a proper sample size, 384 primary school students participated in the current study. The demographic features of the sample are shown in Table 1. It was deemed that the sample of the study would represent eighth-grade students in public primary schools in the Qasaba district in the Irbid governorate.

**Table 1.** *The sample of the Study*

| | | Number of Students | Percentages |
|---|---|---|---|
| School Location | Rural | 171 | 45 |
| | Urban | 213 | 55 |
| Gender | Male | 194 | 51 |
| | Female | 190 | 49 |

### c) Instrument and procedures

One of the most used measurements in educational research is the self-rating or self-assessment. The instrument used for this research was adapted from the 'Malaysian 21st Century Skills' Instrument (M-21CSI) (Osman, Soh, & Arsad, 2010), which was, in turn, based on the enGauge Cs21 framework (Lemke et al., 2003). The M-21CSI included 106 items within five factors. This instrument was translated from English into Arabic. Then, it was pilot-studied with thirty students to take their feedbacks. The pilot-study showed that the students had a problem in responding the instrument in scheduled time due to its length. Further, they were bored with the items and mentioned that "the meaning of every item overlapped other ones". Due to these problems, the instrument was revised by selecting more

related items to the factors. Afterwards, the instrument items consisted of 49 items at five factors; 13 items in digital-age literacy, 19 items in inventive thinking, 5 items in effective communication, 5 items in high productivity and 7 items in spiritual values.

Then, the instrument was sent to a group of experts (two science educators and two education technologists) for content validation. They suggested to insert items at the "effective communication and high productivity" factors to the digital-age literacy factor as well as adding more 7 items to the 'spiritual values' factor and renaming it to moral values. The instrument was improved based on their suggestions (see Table 2). A three-point Likert scale (Disagree--1 point-- to Agree--3 point) was employed to collect data.

**Table 2**. *Factors of the Instrument*

| Subscale No. | Factors |
|---|---|
| 1 | Digital-Age Literacy |
| 2 | Inventive Thinking |
| 3 | Moral values |

A group of four experts examined this instrument to check content validity (Osman et al., 2010). Later, the instrument was exposed to a factor analysis. The results of factor analysis emerged three factors, explaining 30.74 percent of the overall variance (see Table 3).

**Table 3**. *Factors and percentages of variance*

| Factors | % of variance | Cumulative % |
|---|---|---|
| Digital-Age Literacy | 20.542 | 20.542 |
| Inventive Thinking | 10.201 | 30.743 |
| Moral values | 9.712 | 40.455 |

The reliability of each factor was calculated by Cronbach's alpha co-efficient. In addition, a pilot study was conducted to obtain the reliability index of the instrument. As seen in Table 4, the reliability (Cronbach's alpha) values ranged from 0.78–0.83 for three factors, while that for the entire instrument was found to be 0.81. This means a high level of internal consistency for the scale. In the case of the original M-21CSI, reliability (Cronbach's alpha) values ranged from 0.74–0.92 for five factors (Osman, Soh, & Arsad, 2010).

**Table 4.** *Cronbach's alpha (α) values of the factors and entire scale*

| Factors | Cronbach's alpha values |
|---|---|
| Digital-Age Literacy | .81 |
| Inventive Thinking | .78 |
| Moral values | .83 |
| Total | .81 |

### d) Data analysis

Descriptive statistics were used to obtain the mean scores and standard deviations. Simple linear regression was used to determine whether the Cs21 scores have any influence on the scores of academic achievement in science. Finally, an independent samples t-test was used to compare between two groups' Cs21 skills at .05 of significance level for all tests.

## FINDINGS

The findings showed that mean scores of academic achievement in science and Cs21were 83.96 (±13.96) and 132.84 (±12.78).

As observed in Table 5, the results of a simple linear regression analysis of the Cs21 scores acted as a predictor of academic achievement in science. The Cs21 scores significantly predicted academic achievement in science ($r = .353$, $F = 54.29$, $p = .00 < 0.05$). An increase in a total of the Cs21 scores revealed that academic achievement in science is expected to increase by .385 times.

**Table 5**. *The results of the Simple Linear Regression Analysis for Productiveness of the Cs21 Scores*

| Variable | B | Standard Error(B) | Beta | t | P |
|---|---|---|---|---|---|
| Cs21 Score | .385 | .052 | .353 | 7.363 | .000 |

As can be seen from Table 6, mean score of rural students' Cs21 was 128.60 (±13.47), while that for urban students was 136.24 (±13.47). Also, mean score of male students' Cs21was 128.75 (±14.66) whilst that for female students was 137.02 (±13.07). On the other hand, mean score of father jobs' Cs21 was 134.51 (±16.05) for educated ones while that for was 132.43 (±13.41) for non-educated ones. Finally, mean score of mother jobs' Cs21 was 132.30 (±14.06) for educated ones whereas that was 132.98 (±13.98) for non-educated ones.

**Table 6. The** *Students' Cs21 Scores of School Location, Gender, Father's Job, and Mother's Job*

| | | Mean score | Std. Deviation | t | df | P |
|---|---|---|---|---|---|---|
| School Location | Rural | 128.60 | 13.47 | -5.22 | 382 | .000 |
| | Urban | 136.24 | 13.47 | | | |
| Gender | Male | 128.75 | 14.66 | -6.06 | 382 | .000 |
| | Female | 137.02 | 13.07 | | | |
| Father's Job | Educated | 134.51 | 16.05 | 1.167 | 382 | .244 |
| | Other | 132.43 | 13.41 | | | |
| Mother's Job | Educated | 132.30 | 14.06 | -.393 | 382 | .695 |
| | Other | 132.98 | 13.98 | | | |

The independent samples t-test of the Cs21 scores showed that mean score of the Cs21 of students at urban areas was statistically higher than that for rural areas ($t = -5.22$, $p = .000$). Also, there was a statistically significant difference between female and male students' mean scores of the Cs21 ($t = -6.06$, $p = .000$). However, there was no statistical difference between mean scores of educated and non-educated fathers' jobs ones ($t = 1.167$, $p = .244$). Likewise, there was no significant difference between mean scores of educated and non-educated mothers' jobs ($t = -.393$, $p = .695$).

## DISCUSSION

To predict the effect of the Cs21 scores on the eighth-grade students' academic achievement in science, a simple linear regression was carried out. .

The results demonstrated that the students' Cs21 scores were significant predictors of their academic achievements in science. These findings are in line with previous ones (Anwar, et al., 2012; Bowles-Terry, 2012; Brown, 2009; Naderi et al., 2010; Pagani et al., 2016; Prensky, 2005; Zirak & Ahmadian, 2015), reporting that academic achievement is positively related to digital literacy, critical thinking, and creative thinking. Also, Turiman et al. (2012) argued that students' mastery of the Cs21 would improve their academic performances.

This may stem from students' abilities of the Cs21. That is, they might understand scientific concepts, acquire knowledge of scientific processes, share information effectively

by using various types of media, solve their real-life problems, and manage their time and make decisions. Moreover, they might learn science material individually or collaboratively by analyzing, evaluating, and collecting information from new resources (Lemke et al., 2003).

Innovate and creative students are also able to apply a wide range of knowledge and skills to effectively produce, evaluate, present, and clarify new ideas (Mishra & Kereluik, 2011). Students, who have acquired critical thinking, problem solving, communication, and ethical awareness, have the ability to discuss information and make creative decisions. They can also solve problems in achieving their desired aims effectively, communicating verbally and writing and using various forms of technology and social media. Moreover, they should be able to adapt to live in different cultures and societies and share their feelings with others by acquiring the necessary knowledge and skills (Mishra & Kereluik, 2011).

The results of this research supported the idea "integrating the Cs21 into students' science curricula will have a positive effect on developing their academic achievement in science." The students' Cs21 scores may act as predictors of their potential academic levels. So, it could inform school principals and teachers impressions about their new students' science knowledge, skills, and attitudes, which need to be taken into consideration at the beginning of any new academic year.

A significant difference between mean scores of the Cs21 of the students from rural and urban depicts that the students from villages have difficulties in using technology (Lu & Overbaugh, 2009). Moreover, education service, e.g., teachers' qualifications, buildings, instruments, educational supervision, managers etc, are also better at anywhere closer to the city center. A significant difference between the female and male students' means scores of the Cs21 means that females are better at acquiring the Cs21 than males. These results do not indicate any different academic capacities regarding gender, but give some information on the effects of societal gender stereotyping (Albadi, 2014; Nwosu & Ibe, 2014). In Jordan, females have few opportunities to spend time outdoors because of cultural restrictions, so they have more time to spend on schoolwork and use media to share information. This cultural background may explain the significant difference in the effect of the Cs21 on gender.

In addition, no significant difference between mean scores of the students' Cs21 of educated and non-educated parent jobs reveals that whatever their parent jobs are well-educated; these do not affect their children's Cs21 scores. It has been argued that students' self-directed learning skills are associated with their ages (Morris, 1995). So, since eighth-grade students are more self-reliant in their academic learning activities than younger ones, parental roles are restricted to create a good learning environment for core learning activities. Therefore, the parent jobs and their own academic experiences may not have an effect on their children's acquisitions of the Cs21.

This research made a contribution not only to research on the prediction of academic performance in science, but also to practice the applicability of this instrument. Hence, teachers will be able to get valuable feedbacks of their students' deficiencies and progresses in acquiring the Cs21. Thereby, adjustments will be made to improve their achievement levels throughout the academic year. In other words, the Cs21 survey instrument can be used as a diagnostic test.

## CONCLUSION

Because this research adapted a valid and reliable Cs21 instrument into the Arabic, it can be easily used to measure the Jordanian students' Cs21 levels. Since it also examined the relationship between the Jordanian eighth-grade students' Cs21 and academic achievement in science, a significant relationship between the Cs21 and academic achievement in science was found. Namely, the Cs21 significantly predicted academic achievement in science. Also,

gender and school location significantly influenced the Cs21 scores, whereas there was no significant difference for the effect of the educated and non-educated parent jobs on the Cs21 scores. Therefore, the current research suggests that the Cs21 is one of the factors contributing to higher academic achievement in science. Therefore, it is recommended that the Jordanian Ministry of Education integrate the Cs21 into its curricula, which play an important role in students' academic achievements and their progresses in all subjects, help them to keep up with this complicated century.

Finally, because this research had some limitations of characteristics and skills of the sample, future studies should be conducted with a large- sample size from different governorates and grades. However, even though the sample was selected from one governorate, no significant difference between mean scores of the students from urban and rural areas appeared. To identify further differences, further researches should focus on how family incomes impact their Cs21 scores and academic achievement levels. Further studies could also examine the effects of the Cs21 on other types of academic achievement.

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