

# Differences in cognitive ability assessment results between Millennial and Generation Z cohorts

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**Abstract**—The Flynn effect is a well-known phenomenon that has been documented by researchers in a variety of developed countries around the world. This phenomenon refers to the fact that people’s cognitive test scores are increasing by about 3 points every decade. Many researchers have documented this spanning several decades since it was first defined by James Flynn in the 1980s. According to recent studies, this upward trend in cognitive assessment scores has reached a halt in certain nations and may possibly be reversing, a phenomenon known as the negative Flynn effect. The goal of this study is to see if the Flynn effect can be detected across generations in a developing country like RN Macedonia. The data for this study came from a competitive test for obtaining a scholarship for work-related courses. The test consisted of 40 questions that evaluated the participants in a variety of areas. The test was completed by 2700 participants. The key research groups include two generations: millennial and generation-z. Multiple cognitive areas were evaluated, including arithmetic reasoning, logical thinking, visual reasoning, attention to detail, abstract thinking, spatial and verbal reasoning, and more. The findings prove that cognitive test scores of people in RN Macedonia are improving, with a notable difference in average scores between the two generation groups in every field studied and a 1.79 points difference in collective intelligence results.

**Index Terms**—Flynn effect, intelligence, IQ, cognitive tests, millennial, generation-z

## I. INTRODUCTION

If one is about to search any digital resource about IQ tests, how they work and whether they are a precise representation of a person’s intelligence, there is a big chance one will run into and get familiar with a phenomenon known as the Flynn effect. It is named after James Flynn, a psychologist who first documented the fact that every decade the average IQ score increases by 3 points [1]. These claims are not clearly evident and were easily overseen by other researchers because of the way IQ scores are calculated. If we compare the results from IQ tests from one generation with the results of same tests from another generation we will not see evident difference because the tests are regularly being calibrated to keep the mean at 100. Flynn compared the results on the same scale and found an obvious 3 IQ points difference which can not be neglected. This means that person with IQ of 100 in 2020s, would have had IQ of around 118 back in the 1960s and could have been considered intelligently gifted, while vice-versa, person with IQ of 100 in 1960s would have had around 82 IQ points today, which would have put that person on the verge

of mental retardation. The occurrence of this effect sparked many discussion whether IQ tests measure intelligence which is innate or one that is taught. It can also justify the lower cognitive scores of elderly people as not being a result of aging, but rather general differences among generations.

There is available research from the past 10 years that that the Flynn effect is already stalling and even reversing - a phenomena known as negative Flynn effect [2] [3] [4]. Such research is usually conducted in developed countries, like Sweden [5], and the main reasons usually pointed out for this are the lower fertility rates [6], the decrease in quality of living, like increased air pollution [7], and even the increased migration since immigrants usually score lower on cognitive test etc [8]. Some radical and controversial reasons for this negative phenomenon were also pointed out through the years, like genetic deterioration also known as dysgenics, which will be discussed more in the related work section.

The goal of this paper is to analyze the trends of cognitive test scores in a developing country like RN Macedonia. This research represents a modified version of the Flynn effect occurrence model, since the scores from the tests were not gathered throughout the years, but rather a test was assigned at the same time to people born in different generations. Main focus is to show whether there is clear difference in the scores from people belonging to the millennial generation (people born between 1977 and 1995) and the people belonging to the Z generation (born between 1996-2015). The data gathered and presented in this paper can serve as starting point for tracking trends in the upcoming years.

The data that is analyzed was collected by organizing a competition which awarded the top 10 participants with a full scholarship for a year-long course for learning digital skills like computer programming, digital marketing, data science, graphic design and similar. The lower-ranked participants were given a smaller scholarship which they could use to co-finance their re-qualification. The incentive is high, mostly due to the increased digital transformation in many business domains which sky-rocketed the demand for IT professionals in 2022. Because of this incentive and the valuable award system, a total of 2700 people successfully completed the test and entered the competition. Another 2366 students attempted to solve the test but didn’t made it to the end or their time expired.

This paper is organized in 5 sections. Section I is the introductory section, where the research question is proposed and an introduction to the topic is given. Section II provides an overview of the available literature for the Flynn effect in general and the most common reasoning why it may be happening. Section III outlines the methodology used, how the data was gathered and how it was analyzed. Section IV sums up the results from the research offering both visual and numerical representation of the findings as well as the limitations of the study. Section V wraps up the research paper with a conclusion from the reported findings and presents the future work that becomes available as a result of the findings and the data collected from this research.

## II. RELATED WORK

A lot time and money has been invested into demystifying intelligence [9] and although many fields of study have seen ground-breaking advancements, intelligence still remains extremely vague. This can be witnessed in computer science as well - computers have mimicked a lot of our human skills, but the field of artificial intelligence is struggling with its progress [10].

The term Flynn effect by which this study was inspired was coined after James Flynn, who first documented this effect back in the 1980s. Flynn found out a rise in mean IQ of 13.8 points between Americans from 1932 to 1978 [11]. Other researchers easily omitted this evident trend because IQ scores are calculated relatively to the average score of the group, so they are regularly being calibrated, and the results of the cohorts usually oscillate around the mean of 100. However, when results from different cohorts are compared on the same scale, the spread of values is evident.

Francis Heylighen had an interesting viewpoint on the implications from this effect [12]. He uses the Flynn effect as justification for the lower IQ test scores of older generations compared to the younger generations. Before, it was believed that intelligence diminishes with age, but this finding now proves that older people were simply raised in a period when the general intelligence was lower. This is supported by a study on US adults from 2019 which finds that cognitive function is improving over time for US citizens aged over 60 years as a result of the greater educational attainment [13]. This is contrary to the findings of a more recent study from 2021 which analyzed the cognitive abilities of people older than 50 years in Germany, Sweden and Spain [5]. In this study Julia et al. tested different age cohorts using Wechsler tests to conclude that cognitive abilities diminish as people age. They did the research between 2004 and 2013 and they also confirmed that later generations have higher cognitive abilities, although these abilities still start diminishing after 50 years of age. These higher cognitive abilities represent the Flynn effect. They confirmed this finding happening in Germany and Spain, while in Sweden the gap between the generations was not notably big, which led them to believe that maybe there is an upper limit up to which these gains in IQ scores can go. It is unclear whether improvements in countries like Sweden are not happening because a ceiling effect has occurred or further improvements in the educational system and society in general can lead to further improvements.

There are various interpretations of the fact that IQ scores are increasing year by year. James Flynn himself argues that

IQ test don't actually measure inborn intelligence [14], but rather one that can be and has been taught. So, as education becomes more available and of higher quality, people get better at standardized test. Others, like Richard Lynn argue that this is the act of dysgenics, meaning that the quality of species deteriorates with time because people with poor genes, usually from lower socioeconomic classes are outbreeding people with good genes because of their higher fertility rate, something which we deem as a non-sense elitism on a verge of racism.

Mitchum and Fox in their work from 2013 [15], analyzed the scores that people in the 1960s got on a Raven's Progressive Matrices test and the scores that people get today. They confirmed the Flynn effect occurring and also concluded that the average scores from 50 years ago would certainly be below average now. However, they reason that these phenomena isn't bound to changes in intelligence, but rather in the environment. People today are faced with math algebra at a very early age and the tech-driven world which is inevitable part of modern life is a great beneficial factor toward one's abstract thinking skills. In their research they point out that even things we take for granted today, like computer's file system, with folders and files is a very advanced abstraction compared with the things people 50 years ago had access to. They see this rise in abstraction in everyday life too - the humour in comedy shows today is far more abstract than the one decades ago.

Flynn himself approves this theory as he concludes that in the 1900s only 3% of people in the USA worked jobs that were cognitively demanding (like doctors or teachers) [16], while in 2006 there, a huge 35% of the working population in the US works cognitively demanding professions [17].

There are evidences that intelligence is also influenced by the environment. Among others, Carmi points out that intelligence is not only biological but the culture, social structure, and the environment have effects on it [18]. This is backed up by another research from Nisbett who has shown a 12-point to 18-point increase in IQ when children are adopted from lower socioeconomic families to middle-class homes [19]. Similar findings were publicized in 1970 by Scarr who found out that poor performance of black children in IQ tests tremendously increased once they were adopted by white families [20], which back then was also a matter of socioeconomic effects.

When it comes to defining generations, a work by Michael Dimock from 2019 has been one of the most cited ones [21]. He defines Generation Z as people born starting 1997 and later, and Millennial generation as people born between 1981 and 1996. Our research primarily relies on a classification proposed by Jason Dorsey [22], one of the most popular and influential researchers and speaker on the topic of generations and future-proofing, especially on Millennial and Z generations [23]. His cut-off year between these two generations is 1995-1996.

We believe that for developing countries like RN Macedonia, the cutoff should happen later, because generations are defined by technological, economic, political and social shifts which usually come into effect later in developing countries. For this reason, besides the classification proposed by Jason, we will do a comparison of the results when year 1999-2000 is taken as year separating Millennial and Generation Z people. Because the time-span of a generation has historically

been and is analytically meaningful at around 16 to 20 years, we will increase the start year to 1980, so that Millennial are people born between 1980 to 1999 while Generation Z falls between 2000 and 2017.

### III. METHODOLOGY

A competitive test consisting of 40 questions was organized to collect the data that is part of this research. The test was open for exactly one month and rewarded the best participants with full and partial scholarships for attending workplace related courses.

TABLE I  
TEST PARTICIPANTS BY GENERATION

Generation	Birth year	# tests	# completed tests
baby-boomers	1946 - 1964	9	7
gen-x	1965 - 1976	203	79
millennials	1977 - 1995	2927	1490
gen-z	1996 - 2015	1927	1124
millennials*	1980 - 1999	3775	1997
gen-z*	2000 - 2015	892	529

\* Generations if 1999/2000 is taken as a cutoff year

The test was supposed to be solved mostly by millennials, people born between 1977 and 1995, since they were most likely to be interested in professional re-qualification. Surprisingly, together with the millennials there were a lot gen-z people (people born between 1996 and 2015) among the users that took the test. The exact numbers of participants by generation are shown in Table I. Because there are not enough representatives from the other two present generations, baby-boomers and gen-x, these will be left-out from this research and the focus will be on millennial and gen-z participants.

The condition to gain a full scholarship for a year long course was to score best on a test that consisted of 40 questions which evaluated different skills among the contestants. The categories in which the participants contested, total number of questions from each category for all participants combined and total number of correct answers for each category is given in Table II.

Worth noting is that the contestants were not aware that different cognitive skills are measured and this did not even play a role in the final scholarship standings. The rules were simple, each participant gets 40 random questions with 25 minutes to solve. Each correct answer brings 1 point, each wrong question is discarded. A maximum of 40 points can be acquired. If more participants have same test scores, then

TABLE II  
ALL CATEGORIES, TOTAL NUMBER OF POLLED QUESTION AND NUMBER OF CORRECT ANSWERS IN EACH CATEGORY

Category	Total questions		Correct answers	
	Millennial	Gen-z	Millennial	Gen-z
Basic Numeracy	2628	1819	1239	887
Numerical reasoning	4107	2810	1810	1257
Logical reasoning	3855	2793	1946	1474
Inductive reasoning	3710	2686	1613	1242
Spatial reasoning	3496	2962	1902	1632
Short logic puzzles	3856	2861	2161	1638
Verbal reasoning	6043	4742	2997	2368
Attention to details	5563	4313	3217	2539
Abstract thinking	3992	3114	2271	1815
General knowledge	22350	16860	10961	8274

they are ordered by the time left for completing the test, so the faster are the better.

The distribution of participants in the quiz by birth year is shown in Fig. 1. We can see that the most applications came from people just around the discussed cutoff years (late 1990s), so changing the year where Millennial ends and Generation Z begins by even a single year, will have a big impact on the results.

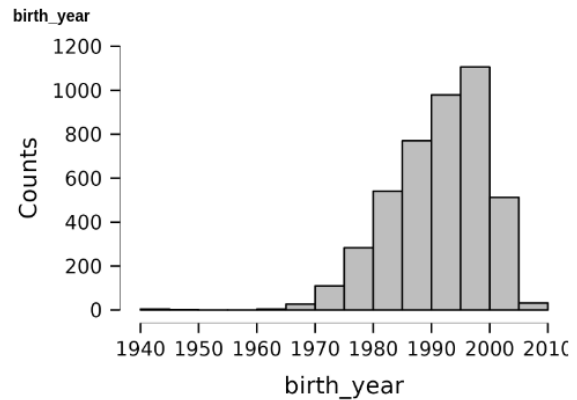


Fig. 1. Age distribution of quiz participants

Because the test consists of questions divided up into categories, the first analysis is a comparison of the scores different generations got in different categories. The results are calculated as percentage of correct answers out of the total possible answers. If a participant gave 20 correct answers, then the score will be 50 because 40 is the total number of questions.

Before analyzing the trends in cognitive scores between the 2 generations, the results are calibrated in order to show whether there are any precursors indicating the Flynn effect. The mean average of all 2700 participants is calculated, and everyone’s score is calculated as percentage of this mean. For example, if the mean of all correct answers is 20, then 20 correct answers mean a score of 100, 30 correct answers equal score of 150, 10 correct answers equal score of 50 and so on. The average of these scores is then calculated for the 2 generations in order to prove or discard existence of Flynn effect.

### IV. RESULTS AND DISCUSSION

The first result of this paper shows that the participants representing generation-Z scored higher in all categories, except in general knowledge where the difference is unnoticeable. This was to be expected, as the Flynn effect affects only the abstract thinking skills and general knowledge has already proven to be deteriorating [14]. This result can be extracted from the data available in Table II. The differences in each category between the two generations are given in Table III and graphical representation of this finding is given in Fig. 2.

The more interesting analysis is the analysis of combined cognitive skills. After dividing the participants in two groups and calculating these groups’ average means, the result shows that the average number of correct answers given by millennial people is 20.21, while the average number of correct answers given by gen-z participants is 20.57. Indeed, this is not a huge difference, until we see how this reflects when presented in a way IQ scores are calculated.

TABLE III  
SCORES FOR EACH GENERATION BY CATEGORY  
(MILLENNIALS: 1977-1995, GEN-Z: 1996-2015)

Category	Millennial score	Gen-z score	Difference*
Basic Numeracy	47.1461	48.7631	1.62
Numerical reasoning	44.0711	44.7331	0.66
Logical reasoning	50.4799	52.7748	2.29
Inductive reasoning	43.4771	46.2398	2.76
Spatial reasoning	54.4050	55.0979	0.69
Short logic puzzles	56.0425	57.2527	1.21
Verbal reasoning	49.5946	49.9367	0.34
Attention to details	57.8285	58.8685	1.04
Abstract thinking	56.8888	58.2852	1.40
General knowledge	49.0425	49.0747	0.03

\* Difference = Generation-z score - Millennial score

For that purpose we first calculate the mean of correct answers given by the whole population (both millennial and generation-z participants). This number is 20.37. Then each participant's score is calculated relatively to this number. So if someone gave 20 correct answers his score will be  $(20/20.37)*100\%$ , or score of 98.18. The formula for calculating participants score is shown below "(1)", where  $\overline{score}$  is the mean average of all participants scores.

$$f(score_i) = \frac{score_i}{\overline{score}} \times 100 \quad (1)$$

This calculation replicates the way scores from IQ tests are measured and helps to evaluate each user relative to the average result of the whole group. This is why the effect of increasing IQ points was not noticed for many years, until Flynn calculated each person's score relative to the complete population scores. After the test scores are calculated for every participant, an average of these scores is calculated for the 2 focus groups, shown in Table IV.

TABLE IV  
AVERAGE SCORES BY GENERATION

Generation	Average score	Generation	Average score
millennials	99.24	millennials*	100.03
gen-z	101.03	gen-z*	99.87

\* Generations if 1999/2000 is taken as a cutoff year

From Table IV we can see that the average score of the millennial groups is 99.24 and the average score of the gen-z group is 101.03, the difference being 1.79 points. This result confirms the findings from other available research which confirm the presence of the Flynn effect, or at least some increase in cognitive ability test score for newer generations.

If we compare the results of the two generations after shifting the year separating the two generations of interest to year 2000, as proposed in Section II due to the latency in technological and social progress in developing countries, the results are presented in Fig. 3 and in Table V accordingly. The differences are even more expressed in most categories. The Millennial generation still scores better when evaluating general knowledge but also beats the Z generation when it comes to extroverted skills like verbal reasoning. We can see that differences in inductive reasoning and abstract thinking are by far most evident when considering this classification, which comes at no surprise.

In Table IV, we can see that the if proposed cutoff year is considered 2000, then Millennial generation performs better

TABLE V  
SCORES FOR EACH GENERATION BY CATEGORY  
(MILLENNIALS: 1980-1999, GEN-Z: 2000-2017)

Category	Millennial score	Gen-z score	Difference*
Basic Numeracy	48.0434	46.6334	-1.41
Numerical reasoning	44.5750	44.6241	0.05
Logical reasoning	51.2556	51.8634	0.6
Inductive reasoning	43.8376	47.3726	3.53
Spatial reasoning	54.3469	55.8625	1.51
Short logic puzzles	56.6712	57.1747	0.5
Verbal reasoning	50.1158	48.1230	-2
Attention to details	58.4374	59.0691	0.63
Abstract thinking	56.9372	59.6179	2.68
General knowledge	49.5610	47.7505	-1.81

\* Difference = Generation-z score - Millennial score

TABLE VI  
AVERAGE SCORES BY YEAR

Birth year	Participants	Score	Std. Deviation
1995	130	99.42	26.26
1996	141	99.34	26.89
1997	156	104.81	25.82
1998	164	99.46	28.82
1999	134	98.88	27.74
2000	147	97.66	28.12

at collective level than Generation Z. For that reason, guided by the density of participants born in late 1990s seen in Figure 1 we analyzed the scores year by year, for the years where the cutoff can be made and found that 1997 has the biggest impact on the final results as shown in Table VI.

#### A. Limitations

A known limitation of this research is that the data was gathered at once from different generations. This means that the members of the two generations are at different age at the time of testing which means that one generation had acquired longer life knowledge as preparation for the test. As such, this research is not exactly representing the differences in cognitive ability test scores between the generations because the test wasn't conducted in each generation's prime time.

Another limitation is that the participants in the study do not exactly replicate the general population of RN Macedonia in demographic characteristics and should be carefully selected to do so for the next iterations, so that clear conclusions concerning the whole countries can be made.

The findings are still confirming the findings of Francis Heylighen discussed in Section II. As he used the Flynn effect to conclude that intelligence is not diminishing as people age, but rather newer generations get a head-start for cognitive tests as the general intelligence levels are rising with time. This is evident in the results of this research. Although millennial and generation-z people are not that far apart in age, the constant difference in test scores, confirms that the more recent, Generation Z, already experiences gains in general intelligence.

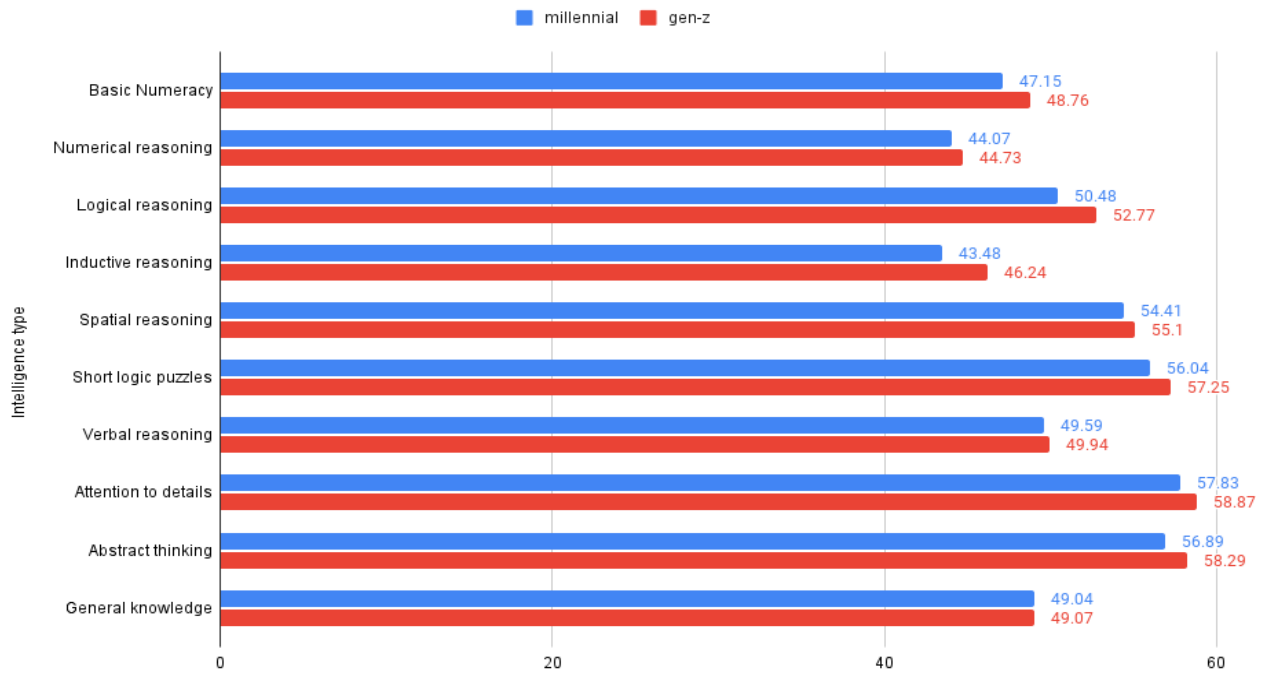


Fig. 2. Scores by category compared between millennial and generation-z participants (millennials: 1977-1995, gen-z: 1996-2015)

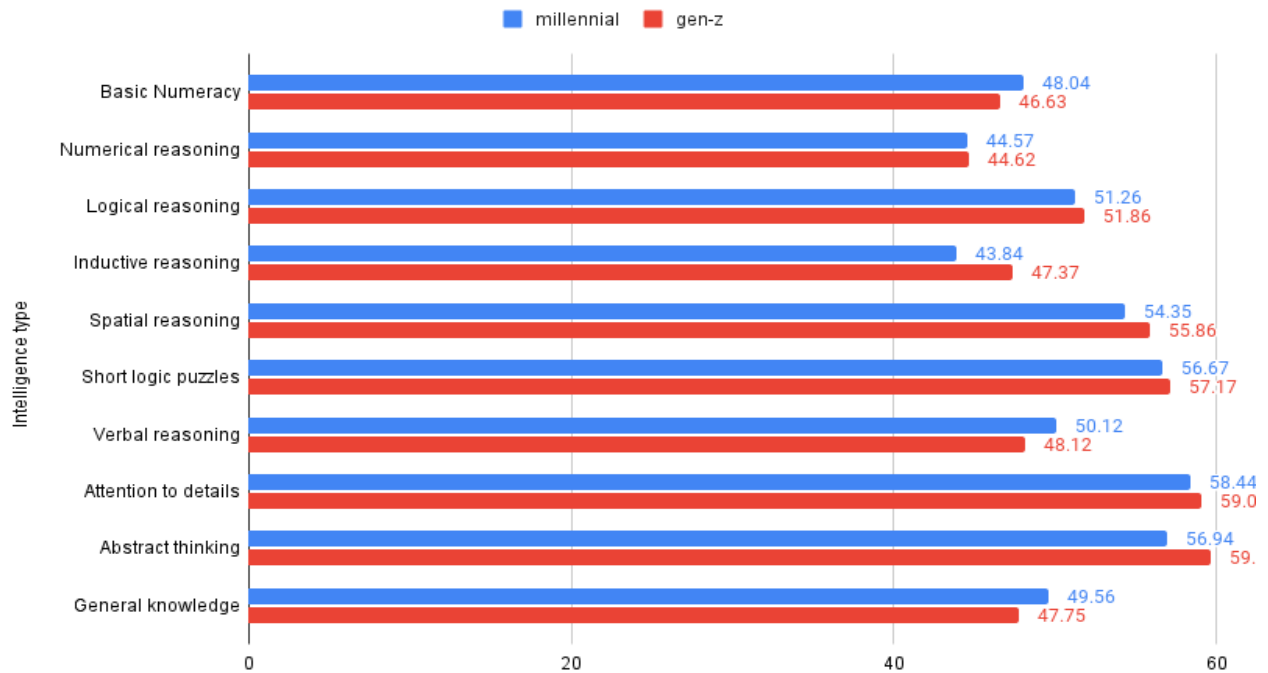


Fig. 3. Scores by category compared between millennial and generation-z participants (millennials: 1980-1999, gen-z: 2000-2017)

### V. CONCLUSION AND FUTURE WORK

The findings in this research give a clearer perspective as to where RN Macedonia stands regarding having positive or negative Flynn effect. The fact that both generations solved the test in the same time can only diminish the effect of the findings, since the people from the senior generation had more time to develop their cognitive skills. Even with such

hypothesis, the participants from the newer generation (gen-z) outsourced their predecessors by almost 2 IQ points.

Comparing the scores on each category separately confirms these results - in every category except general knowledge (which is expected), newer generation scored clearly better results than its preceding generation. This result did not change even when shifting the year that defines when Millennial

generation ends and Generation Z begins in the range between 1995 and 2000.

These findings certainly contribute toward concluding that the Flynn effect is present among the people in developing countries like RN Macedonia, and these results will undoubtedly serve as starting point for more exact documentations of the Flynn effect phenomenon in the future.

The results from this study provide a preliminary insight in how generations in RN Macedonia are developing their cognitive skills. The collected data in this research presents a firm starting ground for future research in this field. The same data gathering process will be performed in the upcoming years with the focus on same age groups and in couple of years a true evaluation of the Flynn effect will be available.

It would be of great importance to compare the results of the upcoming, generation alpha, now that the results for generation-z are available.

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