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## The Impact of ICT on Shaping Reflexes and Manual Coordination in Children and Teenagers: Pupils' and Teachers' Opinions

(pp. 337–356)

### Abstract

The article presents part of a diagnostic and correlational study of mixed character that establishes pupils' information competency in the use of ICT methods and tools. It investigates the effects of children's and teenagers' ICT use (importance levels of new media influence) on improving reflexes and manual coordination. To obtain the data, the author used a diagnostic survey method (questionnaire and interview) and statistical methods (chi-square test of independence and Pearson's correlation coefficient). Together, 2,510 pupils and 1,110 teachers were surveyed. It was found that in the aggregated importance hierarchy of ICT effects, the category 'reflexes and manual coordination' was given a high weight by the pupils (third place) and a very high weight by the teachers (second place). There was a faint and negative correlation ( $r @ -0.009$ ) between pupils' opinions and teachers' observations on the effects of ICT use by children and teenagers in the improvement of reflexes and manual coordination. The calculations of differential factors revealed statistically significant differences between the opinions of the two groups and gender, educational stage, place of learning and the gender of teachers. There was a noticeable discrepancy between the pupils' and teachers' opinions: a not very significant 'separation'

of the world of children and teenagers ('us') from the world of teachers ('them'). This may raise concerns as teachers' recognition and understanding of students' needs, according to the ideas of constructivism, is one of the key factors in the success of the educational process.

*Keywords:* media pedagogy, diagnostic and correlational studies, correlation of opinions, information competency, ICT use, reflexes and manual coordination

## Introduction

Today, almost all forms of activity are supported by the methods and tools of information and communication technology (ICT), treated as key technologies of modern civilisation, as clearly demonstrated during the COVID-19 pandemic (Bailenson, 2020; Doucet et al., 2020; D'Souza, 2020; Murphy, 2020). The reality of the digital age places ever higher demands on students and teachers to develop specific information competencies (van Deursen & van Dijk, 2014, pp. 43–62), guiding the development and performance of school and extracurricular tasks. Therefore, the main objective of the research was to determine students' information competency in the use of ICT in the context of new technological trends and accompanying civilisational changes. An attempt was made to identify the knowledge, understanding, actions and attitudes of children and teenagers, manifested in their approach to new ICT trends. In addition to the opinions of the students themselves, the opinions of teachers turned out to be equally interesting, especially regarding the effects of this ICT use. The broad influences of modern technology (the 'rewards' reaped from new media) included reflexes and manual coordination, both the ability to orient oneself quickly in a situation and to react appropriately (consciously) to it – a 'quick reaction' to stimuli of the external and internal environment in the world of stimuli generated by ICT tools – and 'dexterity', referring to the precision of hand and finger movements or proficiency in handling electronic instruments 'occupying' the hands (Jodzio, 2017, pp. 122–137; Raczek, 2010, pp. 51–60; Zimbardo & Gerrig, 2014,

pp. 157–166). Exercises – the practical and systematic application of ICT methods and tools through manually operated input devices – develop manual skills. Furthermore, activities aided by ICT instruments (Osiński, 2019, pp. 275–289) – especially those that demand fast movements and thus short reaction times – train the reflexes and develop the ability to orient oneself quickly and to react appropriately in a given situation.

In recent years, the market for game manipulators has grown rapidly and a number of motion-controlled games have emerged that contradict the stereotypical belief that gaming is incompatible with playing 'real sports'. Thanks to the development of ICT, players also experience an increasingly strong immersion in virtual reality. This encourages the development of very diverse forms of digital sport (sports games, exergaming, cybersport and e-sport). The global boom of e-sports has become the subject of academic studies, and e-sports viewership and player earnings are rising to the level of traditional professional sports (Steinkuehler, 2020). There are also proposals to integrate e-sports into educational contexts where learning motor skills and being introduced to sports culture is crucial (van Hilvoorde & Pot, 2016).

The question arises: To what extent do ICT tools used in practice support the development of reflexes and manual coordination in children and teenagers? By comparing the data obtained from students and from teachers (expressed through the degree of dependence and correlation), it was possible to identify the differences and similarities in the needs and expectations of these participants of education. These findings are relevant to the understanding of the teaching and learning process, especially in the context of the eternal conflict between generations (see Protzko & Schooler, 2019).

### **Research assumptions**

The theoretical position is delineated by 1) the concepts of critical pedagogy, which assume 'constant opposition to the obvious', visions and goals open to social dialogue; 2) the postmodern approach, taking into

account ambiguous emancipation – ‘ambiguous modernity’ and ‘liquid modernity’; 3) indications of self-education, self-realisation, self-determination and open education (Bauman, 2015); 4) a proposal for the formation and development of information competency, seeing the foundations of teaching and learning in constructivist theory (with particular reference to the sociocultural perspective), indicating one way of thinking about knowledge formation: learning about ICT methods and tools through ICT (Henson, 2015); 5) positive visions for a future in which media and technology can be used effectively to support learning and healthy development (Berdik, 2020); and 6) the educational usefulness of ICT tools that support the development of reflexes and manual coordination (van Hilvoorde & Pot, 2016). In an attempt to explore the practice, the educational reality was compared with the dominant scientific theories that draw a picture of the ‘new learner’, who fully exists and is realised in the Internet cyberspace, in the world of ‘new new media’ (Levinson, 2013), which enable the multisensory transfer of information and multisensory learning, or the ‘connected’ (online) learner, who has unlimited possibilities to use the new spaces of e-education. It was assumed that the path of development is marked by the global cultural imperative to participate in the process of constructing and negotiating symbols, values and meanings, and in which the learner’s main partners are techniques, machines and tools (Gabriel & Röhrs, 2017). It was recognised that teaching success is achieved when the pupil feels accepted and that their problems are recognised and understood. It is then that the pupil’s mind ‘opens up’ and an opportunity is born to use the full potential with which they came to school (Rasfeld & Breidenbach, 2014, pp. 109–115). At the conceptual stage of the project, it was assumed that it would take the form of diagnostic/correlational research (Ferguson & Takane, 2016, pp. 33, 233–254) of a mixed (qualitative/quantitative) nature (Urbaniak-Zajac, 2018, p. 122), mainly embedded in media pedagogy. Two techniques were used: a questionnaire (Babbie, 2016, pp. 247, 255–264) and an open interview (Frankfort-Nachmias et al., 2015, pp. 240–265). The proceedings and techniques included elements of analysis and explanation of a qualitative and quantitative nature. This triangulation (between education, technique



and information) enabled a more complete understanding and presentation of the research problem from two different points of view (Furmanek, 2016, pp. 21, 28). Statistical methods – the chi-square test of independence and Pearson's correlation coefficient (King & Minium, 2020, pp. 165–181, 458–478) – helped establish the relationship between pupils' information competency in the use of ICT and pupils' opinions and teachers' observations, and helped determine which factors differentiate the studied phenomena.

The main study, involving teachers who teach various subjects<sup>1</sup> and pupils at particular stages of education,<sup>2</sup> was conducted in purposely selected institutions of the Lubuskie and neighbouring voivodeships. The group of students (whole sample) comprised 2,510 pupils, who were enrolled in integrated primary school (372 [14.8%]), primary school (730 [29.1%]), junior high school (753 [30.0%]) and high school (655 [26.1%]). The respondents displayed a uniform distribution of gender: 1,272 (50.7%) girls and 1,238 (49.3%) boys.

The group of teachers (whole sample) comprised 1,110 teachers, who taught the curriculum of integrated primary school (141 [12.7%]), primary school (323 [29.1%]), junior high school (255 [23.0%]), high school (269 [24.2%]) and a small group of educators working at two education stages simultaneously (89 [8.0%] in primary school and high school and 33 [3.0%] in junior high school and high school). The vast majority of these respondents – as many as 889 (80.1%) – were women; thus, men accounted for one fifth (221 [19.9%]). The interview involved 20 pupils in Zielona Góra and neighbouring towns (10 people were selected in each type of institution corresponding to the stage of education).

One of the detailed questions was designed to establish the results of using ICT, which helped specify the wide field of new media impact.

<sup>1</sup> The teachers listed a total of 23 subjects taught by them, both general education subjects and those from the educational and professional spheres.

<sup>2</sup> The stages of education in Poland at the time of the research were divided into 1) integrated primary school (ages 7–10, with one teacher teaching all the subjects); 2) primary school (ages 11–13); 3) junior high school (ages 14–16 [*gimnazjum*]); and 4) high school (ages 17–20).

The author identified five basic spheres of this influence (co-occurring variables), indicating the following results (effects): 1) improving reflexes and manual coordination; 2) developing creativity and cooperation skills; 3) increasing the speed of searching, selecting and valuing information; 4) increasing the ability to concentrate and ignore distracting stimuli; and 5) causing chaos and information 'confusion'. The results presented in the article – concerning the first sphere of influence – addressed the question of to what extent (according to pupils and students) the use of ICT tools in practice improves reflexes and manual coordination. Therefore, a co-occurring specific variable was distinguished: the frequency distribution of the effects of children and teenagers using ICT tools on improving reflexes and manual coordination. The declarations of pupils and teachers were the indicator for this variable. The respondents selected and specified only relevant answers from the above-mentioned five areas, and ordered them from most to least important. As a result, a hierarchy of the importance of ICT impacts was created. In relation to the correlation problem, the author identified a relationship between pupils' opinions and teachers' observations and identified the factors differentiating the two groups' views on the issue.

### **Interpretation and discussion of the results**

The closed question establishing what ICT gives children and teenagers (in terms of effects) was answered by 2,456 (97.8%) pupils and 1,061 (95.6%) teachers. For these groups, the author counted and graphed the frequency distributions of the effects of ICT use by children and teenagers in particular spheres of influence (listed above), thus illustrating their importance for the research. The author attempted to establish to what extent the ICT tools used in practice have an impact on improving the reflexes and manual coordination in children and teenagers, according to the respondents. The results are presented in Table 1.

**Table 1. Frequency distribution of pupils' and teachers' opinions on the effects of ICT use by children and teenagers in improving reflexes and manual coordination [quantity distribution by numerical and percentage values]**

ICT use improves reflexes and manual coordination (*)		Level of importance (hierarchy of effects importance)						Total
		0 (none)	1 (the most important)	2	3	4	5 (the least important)	
<b>Pupils' opinions</b>								
numerical quantity	N	248	473	439	556	539	201	2456
	%	10.1	19.3	17.9	22.6	21.9	8.2	100.0
weighted quantity	N	0	473	351	334	216	40	1414
	%	0.0	33.5	24.8	23.6	15.3	2.8	100.0
<b>Teachers' opinions</b>								
numerical quantity	N	315	270	200	157	85	34	1061
	%	29.7	25.4	18.9	14.8	8.0	3.2	100.0
weighted quantity	N	0	270	160	94	34	7	565
	%	0.0	47.8	28.3	16.7	6.0	1.2	100.0

(\*) Because the scale used for the calculations and interpretations is linear and ranges from 0 to 5, the numbers obtained at a given level of importance were given appropriate weights: level 0 = weight 0; 5 = 0.2; 4 = 0.4; 3 = 0.6; 2 = 0.8; and 1 = 1.0.

### Pupils' opinions

The frequency distribution established by the pupils' self-assessment and showing the hierarchy of importance of ICT for improving reflexes and manual coordination reveals an irregular pattern with fairly similar numerical quantities ranked at particular levels of importance (except the fifth one). There was a clear downward tendency in weighted quantities (starting from 473, through 351, 334 and 216, to 40). According to the children and teenagers, the use of ICT tools has a significant impact on

improving reflexes and manual coordination. Almost one fourth (22.6%) of the pupils placed a high significance (third level of importance) on this sphere of new media impact – the highest numerical quantity in this category. Slightly fewer respondents (539 [21.9%]) said that the use of digital instruments is of little importance for improving reflexes and manual skills (fourth level of importance). One in five pupils (19.3%), by marking the first place in the hierarchy of influence importance, believed that using new technologies has the greatest effect on the development of reflexes and manual skills. Another 439 (17.9%) pupils, i.e. those indicating the second level of importance, saw a very strong impact of media on practicing reflexes and manual coordination. Only 201 (8.2%) children and teenagers assigned the lowest weight to the role of ICT in developing manual skills and reflexes; this was the least significant impact (weighted value: 2.8%). The picture is completed by the level with the weight of zero, established by counting those respondents who gave no weight to this category (by not voting). Thus, one learns that one in ten pupils (315 [10.1%]) did not notice any influence of ICT on the development of reflexes and manual coordination.

One can therefore conclude that pupils attached a high importance to the impact of computer tools in the sphere of reflexes and manual coordination. In their opinion, the use of ICT instruments (especially manually operated input devices) has an extensive impact on the refinement of the precision of hand and finger movements. Such exercises, supported by modern digital techniques, help form reflexes and develop the ability to quickly orient oneself in a given situation and to respond adequately (above all, spontaneously) to it.

In order to take a broader view of the effects of ICT use by children and teenagers, attention was paid to the factors that differentiate it: gender, type of educational institution (stage of education) and place (environment) where children and teenagers studied. The statistical analysis demonstrated whether these variables significantly differentiated the phenomena under study. The results are presented in Table 2.

**Table 2. Pupils' opinions on the effects of using ICT tools by children and teenagers on reflexes and manual coordination – as differential factors**

Results of the chi-square test: Effects of using ICT tools by children and teenagers on reflexes and manual coordination		
Differential factors (sociodemographic data of students)		
Gender	Type of educational institution(stage of education)	Place (environment) of learning
$\chi^2 = 70.94 > \chi^2_{(\alpha=0,01; df=5)} = 15.09$ $p = 6.51883E-14$ $H_0$ rejected	$\chi^2 = 119.94 > \chi^2_{(\alpha=0,01; df=15)} = 30.58$ $p = 1.94484E-18$ $H_0$ rejected	$\chi^2 = 53.06 > \chi^2_{(\alpha=0,01; df=20)} = 37.57$ $p = 7.95437E-05$ $H_0$ rejected

The calculations showed statistically significant differences in three cases – between the effects of ICT on children and teenagers in improving reflexes and manual coordination and gender, stage of education and place of learning. The detailed distributions of the quantities<sup>3</sup> revealed the following findings.

- (1) Primarily boys considered improvements in reflexes and manual coordination to be a result of new media use. The frequency distribution of ICT effects (reflexes and manual coordination, by gender) illustrates this well, for example, in the distribution of quantities established at the first (highest) level of importance. In this group, there were 312 (25.6%) boys compared to 161 (13.0%) girls, that is, twice as many. Thus, it can be stated that the boys gave more weight to computer tools' impact on reflexes and manual coordination than the girls. The boys were more appreciative of the use of ICT instruments, especially manual input devices, and saw them making a more significant influence (a wider range of impacts) on improving the precision of hand and finger movements and on developing the ability to orient oneself quickly in a given situation and to react accordingly.
- (2) The picture of quantities (reflexes and manual coordination, by educational stage) is unambiguous in its message: the higher the educational level, the lower the weights assigned by pupils for this category of ICT impacts. As exemplified by the course of the first level of importance,

<sup>3</sup> Due to the word count, these are not presented in this article.

it is easy to see how the most weight (the most important influence) given to this sphere by those in the early educational stages – i.e. 122 (33.7%) votes from children in early education and 152 (21.4%) from pupils in primary school – decreased in subsequently older pupils, amounting to 120 (16.2%) votes from pupils in junior high school and 79 (12.3%) from those in high school. This differentiation definitively determines this trend.

- (3) The numerical distribution (reflexes and manual coordination, by place of learning) had an irregular pattern. It is noticeable that pupils from villages (up to 10,000 inhabitants) and small towns (10,000–25,000) gave the most weight (the most important impacts) to this sphere of the effects of using ICT. The lowest weight in the importance hierarchy of new media was given by those living in medium-sized towns (25,000–100,000). These trends may be illustrated by the numbers of pupils who ranked this effect at the first (highest) level of importance: 150 (18.3%) from the countryside, 119 (22.7%) from villages, 77 (20.3%) from small towns, 66 (14.9%) from medium-sized towns and 61 (20.8%) from cities (over 100,000 inhabitants).

### Teachers' observations

The frequency distribution established on the basis of teachers' observations about the effects of ICT use by children and teenagers on developing reflexes and manual coordination shows a regular, steadily downward trend, which is clearly illustrated by both numerical and weighted quantities. This rule also applies to the zero level (with the highest quantities), showing votes from 315 (29.7%) respondents. This large group of teachers, almost one third, did not assign any weight to this category of ICT effects, and declared it insignificant and to have no major impact on children's and teenagers' development. When viewed as a whole, teachers rated the effects of implementing new media on improving reflexes and manual skills as very important – the largest group of respondents, i.e. almost one fourth (25.4%), ranked it at the first level of importance. On the other hand, one in five



(18.8%) teachers noticed a substantial role of using computer technology in shaping and developing children's and teenagers' reflexes and manual skills. Further quantities at lower levels were as follows: 157 (14.8%) teachers claimed that the use of ICT instruments had a major impact on improving children's and teenagers' reflexes and manual coordination, while 85 (14.4%) thought that this impact was low (not very important) and only 34 (3.2%) indicated it as the least important.

In revealing their convictions about the effects of computer tools being used by children and teenagers, teachers maintained that such tools have a major impact on developing reflexes and manual skills. They were convinced that regular exercises done in a digital environment through manually operated input devices have a very significant influence on the development of hand and finger motor skills. They believe that such exercises largely speed up reaction time to changing environmental conditions. According to the teachers, daily work with ICT instruments improves children's and teenagers' dexterity with tools in general. They recognise that hand–eye coordination and manual dexterity are skills that have a very strong impact on a pupil's proper functioning.

When analysing the teachers' opinions, the author paid attention to the factors that differentiated the phenomenon under study: gender, type of educational institution, place where the teachers worked and the teachers' professional rank. These differential variables were statistically analysed, and the test results are presented in Table 3.

**Table 3. Teachers' opinions on the effects of using ICT tools by children and teenagers on reflexes and manual coordination – as differential factors**

Results of the chi-square test: Effects of using ICT tools by children and teenagers on reflexes and manual coordination			
Differential factors (sociodemographic data of teachers)			
Gender	Type of educational institution (stage of education)	Place (environment) of learning	Rank in professional advancement
$\chi^2 = 16.89 > \chi^2_{(a=0,01; df=5)} = 15.09$ $p = 0.004722421$ $H_0$ rejected	$\chi^2 = 19.89 < \chi^2_{(a=0,01; df=15)} = 30.58$ $p = 0.176014097$ no grounds for rejecting $H_0$	$\chi^2 = 20.22 < \chi^2_{(a=0,01; df=20)} = 37.57$ $p = 0.444487877$ no grounds for rejecting $H_0$	$\chi^2 = 9.42 < \chi^2_{(a=0,01; df=15)} = 30.58$ $p = 0.854299502$ no grounds for rejecting $H_0$

The calculations showed significant statistical differences in one case. The detailed numerical distribution of teachers' views on the effects of ICT on children's and teenagers' reflexes and manual coordination in the function of the differential variable 'gender' reveals that women gave slightly more importance to this sphere of media impact than men. The difference is at a low level, but it clearly indicates a dependence between these characteristics. At the two highest levels of importance, indicating very high and highest levels of ICT impact, 46.2% of the women outnumbered 36.9% of the men. The zero level, meaning no impact, was selected by 28.5% of women and 34.6% of men. This means that in the study group of teachers, the women were more convinced than the men about the correspondingly greater range of consequences of computer tools used by children and teenagers, maintaining that these tools have a more significant impact on forming and improving manual dexterity and reflexes. Thus, women, by placing more weight on this sphere of ICT effects, reported a bigger role of regular exercises conducted by pupils in a digital environment (through, for example, manually operated input devices) and a more significant impact on the development of hand and finger motor skills. They probably notice a role of computer games in this, which, in their opinion, children and teenagers use to the greatest extent (see Baron-Polańczyk, 2021a, p. 447). In women's positive opinions, games sharpen the senses, create reflexes and perceptiveness and improve concentration and reaction speed towards changes, among other things (Christ & Szmigiel, 2016, pp. 81–87; Helms et al., 2015, p. 59; Siemieniecki, 2021, p. 170–177; Wang et al., 2022).

### **Correlation between pupils' and teachers' opinions**

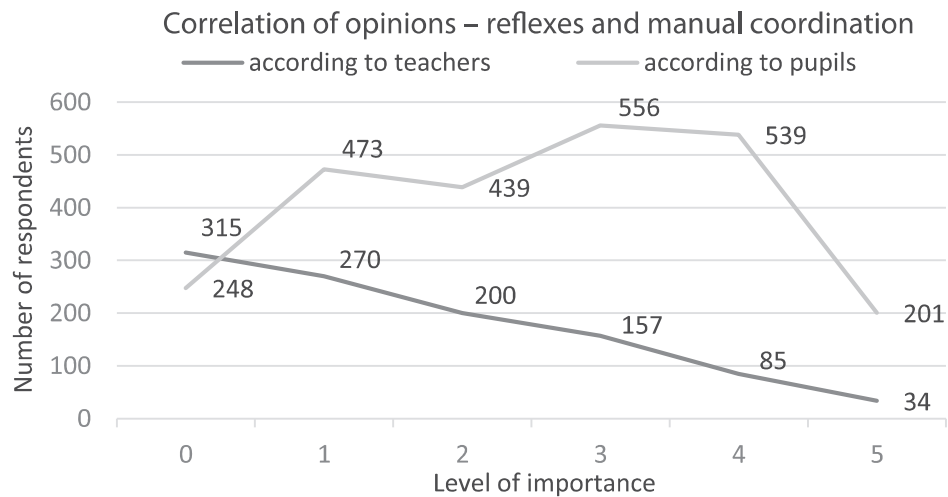
In order to better illustrate the importance hierarchy of the impact of new technologies, the results from the five analysed areas were compared. Data on the impact of children's and teenagers' use of ICT is captured globally. Overall, the category of change labelled as 'reflexes and manual coordination' ranked third among pupils (with a weighted value

of 1,414 and a zero weight of 248), who declared it a significant effect of ICT use. Teachers ranked this area in second place (with a weighted value of 565 and a zero weight of 315), maintaining that pragmatic implementation of new technology by children and teenagers has a very significant impact on improving reflexes and manual coordination. Thus, both pupils and teachers pointed out this area of media impact and attached great importance to ICT as stimulating tools.

The analysis indicated a possible relationship between the examined variables, i.e. between the opinions of pupils and the views of teachers as to how ICT impacts children's and teenagers' manual coordination. Statistical methods were also used to establish this relationship, which is a general methodological assumption in the context of dependence research problems. The coefficient of determination ( $r^2$ ) and Pearson's correlation coefficient ( $r$ ) were used to calculate the strength of the relationship between the two (coexisting) variables (Ferguson & Takane, 2016, pp. 142–143). The values of the coefficients were 1) coefficient of determination –  $r^2 = 8.25682E-05$  and 2) correlation coefficient –  $r = -0.009086705$ .

The Pearson's correlation coefficient was negative, indicating a decreasing regression line; thus, the correlation was negative and it expressed opposing changes in both variables (Pilch & Bauman, 2010, p. 133). The negative value means that the pupils' self-assessment – in relation to the selected category of ICT impact area – decreased as the number of teachers' opinions in this area increased. It should be emphasised that the data used to calculate these correlations in this (overview) research only points to the coexistence of the values of variables. The values may coexist, even though one does not cause the other (King & Minium, 2020, pp. 186–188).

**Figure 1. The correlation between pupils' opinions and teachers' observations about the effects of children's and teenagers' ICT use on improving reflexes and manual coordination**



By interpreting (determining the degree of dependence) the value of the Pearson's correlation coefficient (approximately  $r = -0.009$ ), one can state that the correlation between the pupils' and the teachers' opinions was 'weak' (Guilford, 1964, p. 157) or 'faint' (Góralski, 1987, p. 38). Thus, the phrase 'weak, negative correlation' can be used to describe the correlation found for the established levels of significance (hierarchy of importance) of ICT effects in this category (outlined by different opinions of pupils and teachers). What stands out in Figure 1 is the marked non-answers (level 0), given by as many as 315 (29.7%) teachers.

In relation to the problem under study and the results, it is worth emphasising that the literature reveals a specific dichotomy of opinions (polarisation of positions) on the influence of computer games and ICT in general on children's and teenagers' development. Numerous representatives of the older generation in particular have a negative attitude towards computer games and are convinced of their harmful influence (in physical and psychological terms). On the other hand, positive the aspects of gaming, confirmed by numerous studies, are gaining popularity: players gain knowledge about cooperation and competition, social behaviour and teamwork (for example, massively multiplayer online role-playing

games). Popular games are frequently based on impersonating a member of real or a fictional society, thus developing social competence, and the interaction between players is based on communication, often in English or using a special slang. On the other hand, arcade games require the player to have reflexes, manual coordination and concentration. Players must foresee events, make decisions quickly, concentrate and think logically. These skills are also supported by classic logical games: chess, bridge or solitaire. It is also worth mentioning the positive aspects of physical exercise in games (especially VR games or dance simulators, which require more coordination and a sense of rhythm). The issue of improving reflexes and manual coordination by using ICT tools is closely related to the conditions of safe and hygienic work at an ergonomically designed computer workstation equipped with appropriate input/output devices and high-quality hard/software (Cho et al., 2012).

## Summary

The analysis of the literature and the data collected from 2,456 pupils and 1,061 teachers allow for the following conclusions.

(1) Based the frequency distribution of the effects of ICT use by children and teenagers in the five areas of ICT impacts, an aggregated hierarchy of their importance was established (according to the order of pupils' and teachers' opinions), in which the category of reflexes and manual coordination was attributed as follows:

- Pupils gave it a high weight (third place, weighted value – 1,414). Children and teenagers therefore believe that the use of ICT tools and exercises supported by modern digital technology, have a significant impact on improving their reflexes and manual coordination. They think that daily use of digital instruments (especially manually operated input devices) results in, and to a large extent improves, the precision of their hand and finger movement.

- Teachers gave it a very high weight (second place, weighted value – 565). In particular, the first three levels of importance, as ranked, were selected by the majority of the teachers (59.1%), as they considered ICT tools used by children and teenagers to result in improved reflexes and manual coordination (increasing their competency to a large, very large or the highest extent). Teachers are convinced that regular exercises carried out in a digital environment through manually operated input devices have a very significant impact on the development of pupils' hand and finger motor skills.

(2) The correlation between pupils' opinions and teachers' observations on the effects of ICT use by children and teenagers on improving reflexes and manual coordination was weak ( $r @ -0.009$ ) and negative, and it expressed opposite changes in both variables.

(3) The analysis showed that among the many differentiating factors analysed, statistically significant differences existed in four cases: between the ICT effects on children and teenagers in terms of improving reflexes and manual coordination and gender, educational stage, place of learning and the gender of teachers. The following findings were established:

- When it comes to the effects of ICT use, boys noted them more often than girls, primarily in the improvement of reflexes and manual coordination. They much appreciated manually operated input devices (according to the high level of differentiation), perceiving their more significant impact on improving hand and finger movements precision and on developing the ability to orient oneself quickly in a given situation and to react appropriately to it.
- The numerical distribution in the function of the type of institution (stage of learning) showed a downward trend (the importance of ICT effects decreases with the educational level), as the higher the educational stage, the lower the weights given by pupils were.
- The results in particular areas and the numerical distribution in the function of the place of learning (town size) showed an irregular pattern.



The highest weights (the most significant influence) for the effects of ICT use on improving reflexes and manual coordination were given by pupils from villages (up to 10,000) and small towns (10,000–25,000). The lowest weight in the hierarchy of new media impacts was given by pupils from medium-sized towns (25,000–100,000 inhabitants).

- The results in particular areas and the numerical distribution in the function of the gender of teachers allows for the conclusion that women gave slightly more weight (significance) to media impact on the development of reflexes and manual coordination in children than men. The women were more convinced of the correspondingly greater range of consequences of computer tools, maintaining that they have a more significant impact on the creation of reflexes and perceptiveness and on the formation of hand and finger motor skills.

In general, pupils and teachers ranked the category 'reflexes and manual coordination' at a high level of importance for ICT effects (selecting high and very high importance, respectively). On the other hand, the research (establishing a correlation) points to a divergence of opinions between pupils and teachers as to the extent of ICT impact on reflexes and manual coordination. It revealed slightly different views on the subject (as evidenced by the low degree of negative correlation) and showed a slight 'separation' between the children and teenagers' world ('us') and the teachers' world ('them'), which is important in the context of recognising pupils' needs and understanding the reasons why they use new media on a daily basis (Baron-Polańczyk, 2018, 2021b). Given the empirical recognition of the differences between pupils' and teachers' opinions, the educational indications for the idea of constructivism as well as the consequences stemming from it for educational practice, one may doubt whether the teachers in the study were 'constructivist' enough for the ICT era. The differences in the beliefs of educators and pupils gained particular importance during the COVID-19 pandemic (Donoso et al., 2020; Ptaszek et al., 2020), when the educational process was dependent on the effective use of remote work tools – the manifestation of information competency that determined the learning process (construction of knowledge).

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