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EDITORIAL

At the beginning of this new editorial, let us first look back to the 15th International Conference on Efficiency and Responsibility in Education (ERIE 2018) that took place in Prague on June 7 - 8, 2018. First, from the statistical point of view, we had received articles from a diverse variety of higher education institutions from different European and International countries, including India, Kazakhstan, Mexico, Poland, Romania, Russia, Slovakia and Turkey. In the end, a rejection rate reached 30.23%. We are glad that the conference editors and co-editors keep the high standard of the review process and only quality articles were accepted for the conference proceedings. Second, we are glad that the authors presented an interesting variety of topics related to quality in education, new approaches in mathematical education, governmental education policies and the influence of socio-economic factors in education, among others. We are already keen on what new trends and applications will be presented next year during the 16th ERIE conference.

We are pleased that in this new issue of the ERIES Journal we can present you three articles from the University of Hradec Králové, the University of Agriculture in Makurdi, Nigeria and Jan Evangelista Purkyně University in *Ústí* nad Labem. We are grateful that ERIES Journal has again attracted diverse authors from different higher education institutions. It is a commitment for the Editorial board to keep improving the journal quality and to publish interesting research results related to the national and international education.

The first article "Internet Use and Abuse: Connection with Internet Addiction", by Eva Milková and Petra Ambrožová analyses the possible risks of using the Internet by secondary school students. Three aspects entering the educational process of adolescents are discussed in the article: Internet use, school cheating and Internet addictive behaviour. For this purpose, the authors analysed responses from 1,542 students (895 females and 647 males) from secondary schools in the Czech Republic. The students' age varied between 15 and 23 years. The results show that male students indicate a significantly higher tendency to Internet addiction, as well as a significantly higher tendency to Internet abuse. Moreover, students with worse evaluation indicate a significantly higher tendency to Internet addiction as well as a significantly higher tendency to Internet abuse.

The second article "Returning Responsibility to the Home: Outcomes of Background Checks on Low and High Achievers in Middle Basic Mathematics in North Bank Suburb of Makurdi, Nigeria" from authors Joshua Abah Abah, Terungwa James Age and Mercy Onyinyechi Okoronkwo analyses the impact of home involvement on the mathematics achievement of Basic 5 students in North Bank suburb of Makurdi, Benue State, Nigeria. The sample included 73 students along with their parents (guardians) from three mission nursery and primary schools in North Bank. The results reveal that there is a weak positive relationship between home involvement and mathematics achievement. What is more, family and close family members play a vital role in providing guidance for mathematics homework. However, parents in North Bank suburb have shortcomings as mathematics resources providers. Therefore, schools should create a common understanding of how parents could best support their child's mathematics education.

In the third article "Relations between scientific reasoning and culture of problem-solving", the authors Eva Hejnová, Petr Eisenmann, Jiří Cihlář and Jiří Přibyl tried to find out correlations among the three components of the Culture of problem solving (reading comprehension, creativity and ability to use the existing knowledge) and six dimensions of Scientific reasoning (conservation of matter and volume, proportional reasoning, control of variables, probability reasoning, correlation reasoning and hypothetical-deductive reasoning). The analysed sample consisted of 23 students (12 girls and 11 boys) of the 9th grade aged between 14 and 15 years old, all of them from the same primary school. The results show that the ability to use the existing knowledge (a component of the Culture of problem solving) strongly correlates with three dimensions of the Scientific reasoning structure: Proportional reasoning, Control of variables and Probability reasoning. Moreover, the authors investigated that the indicators of the Culture of problem-solving and the Scientific reasoning are not related to school performance either in mathematics or in physics.

By the end of this editorial, we would like to thank all reviewers who contributed to this second issue of 2018, as well as we would also like to thank all authors who have submitted their manuscripts to ERIES Journal. We hope that all our readers will find this issue interesting, and we also hope that ERIES Journal will contribute to the field of efficiency and responsibility in education as it has contributed so far.

Martin Flégl
Executive Editor
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INTERNET USE AND ABUSE: CONNECTION WITH INTERNET ADDICTION

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Highlights

- *The Internet is predominantly used as an individual rather than co-operative aid*
- *Males indicate a significantly higher tendency to Internet abuse*
- *Students with worse evaluation in Czech and Math indicate a significantly higher tendency to Internet abuse*
- *Every fifth respondent is moderately or highly above-average addicted to the Internet*

Abstract

Modern information and communication technologies have progressed quickly. Mobile technology, personal computers and the Internet have become closely linked to human life. However, all these devices and their use bring various pitfalls. Cheating of pupils and students in the school environment has been an interdisciplinary issue linked not only to pedagogy, but also to the whole range of sub-disciplines, like for example social pedagogy or etopedy. The latter disciplines have been significantly interfered by information and communication technologies that bring new forms of illegal school activities. Due to modern technologies we can also trace an increase of inattention of pupils and students and their tendency to distraction during lessons. Signs of Internet addiction among pupils and students can be observed more often. The paper deals with a research focusing on Internet use by secondary school youth and possible risks of using the Internet for them. Three aspects entering the educational process of adolescents are discussed there; Internet use, school cheating and Internet addictive behavior. In addition, a relation between possible risks of Internet use and educational strategies according the Learning Combination Inventory originated by Christine A. Johnston was examined within the research.

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Introduction

Possibilities of mobile learning and collaborative learning have been increased thanks to evolution of mobile technologies and its market penetration through smartphones and tablets, but also due to high acceptance of these technologies among young people. The end of the last century was marked by a rapid technological development and profound changes in many aspects of human activities. Such changes opened plenty of discussions on the role of education as well as the role of information and communication technologies (ICT) in teaching and learning in a new era, and obviously discussions on negative impacts of ICT especially on children and youth (cf. Huang et al., 2010; Ryu and Parsons, 2012; Berjón et al., 2015). With so many social media and communication channels that are used collectively, the Internet can cause various problems. Therefore, it is important to focus on an increasing number of negative aspects of social media that children, and not only them, encounter every day (Davison and Stein, 2014).

The authors of the paper aim at a research focusing on ICT usage by adolescents and its related possible user-risks (cf. Kalibova et al., 2016). The aim is to find out how secondary school students in the Czech Republic use the Internet as a study aid, and to study what are their inclinations to cheating as well as the prevalence of Internet addiction (cf. Kalibova and Milkova, 2016). Moreover, the relationship between educational strategies according the Learning Combination Inventory originated by Christine A. Johnston (Johnston, 1996) and Internet usage was examined within the research. Achieved results are described in the paper.

Adolescence

Adolescence is a period in human life that poses high demands on individuals and belongs to the most difficult periods. Suler (2005) defines four basic areas of needs that are characteristic of the adolescence period, and he describes ways provided by the virtual world to satisfy these needs. One of them is the need to explore one´s own identity and experimenting with it. The virtual arena allows adolescents to answer questions about their own identity even with a high level of anonymity. The need of intimacy, desire to belong somewhere and fellowship are easily satisfiable on the Internet by way of searching and active participation in forming a community. The need of separation from a family is associated with feelings of anxiety and stress that the Internet can reduce or even eliminate. The need to release frustration is also easy in cyberspace.

School Cheating and Plagiarism

School cheating by Donat et al. (2014) is considered to be as one of specific forms of deviant behavior of adolescents. According to the authors, school cheating includes a broad range of activities, such as copying answers from another student´s test, using cribs during an exam, plagiarism, obtaining tests before they are assigned and others.

Plagiarism represents a special chapter of school cheating. Mohan et al. (2015) classify plagiarism as follows:

- Copying of ideas, thoughts (this is a very difficult form of plagiarism to detect, but can cause serious consequences for the offender)
- Copying of texts, pictures, tables from all types of resources

- Copying of oneself (thus coping of one´s own ideas from previous work)
- "Ghost Writing" (we talk about this form of plagiarism when the author does not list another member of the author´s team)
- Mosaic plagiarism (it is a modification of several words in the text that are copied and subsequently published as one´s own text).

The issue of plagiarism is especially up-to-date in connection with so-called "copy-paste" plagiarism, or with a possibility to buy readymade works by other authors.

School Disruption - Cyberloafing

The newly described phenomenon is based on the deliberate use of Internet access for private purposes during work time or lectures that are described in foreign literature as cyberloafing or cyberslacking. In their work Akbulut et al. (2016) include into cyberloafing activities of sending or receiving emails and text messages, browsing on web sites, communication in chat rooms or via social networks, other activities on social networks, online shopping, downloading or playing games for private purposes other than work related.

Yilmaz et al. (2015) says that cyberloafing was originally described only in the context of work environment as counterproductive work behavior. However, with the increasing cases of school disruption due to ICT use, we start speaking about this phenomenon also in the school classroom environment.

According to Griffin (2014) there are principal factors playing an important role within school disruption. These are inability of a student to concentrate on a teacher´s interpretation, the desire for fun, too much demand on a student imposed by a teacher or digital technologies addiction.

Internet Addiction

Already in 1998 Young (1998) stated that Internet addiction becomes a new clinical disease and a phenomenon of postmodern society, and worked with eight criteria of this syndrome:

- Internet use as a means to control mood
- Time spent on the Internet increases in order to achieve the same level of satisfaction
- Repeated effort to cut down Internet use
- Emergence of irritability, depression or frustration in the absence of Internet connection
- Internet connection takes longer than the user perceives
- A user lies to his/her surrounding about the time spent in cyberspace
- A user prefers the Internet to other activities
- Strong commitment to the Internet

Subsequently Young claims that Internet addiction is diagnosed when at least five out of the eight above-mentioned criteria are experienced by an individual.

According to Chou et al. (2015) Internet addiction is mainly characterized by an inability to control Internet use. He claims that the international prevalence scale of Internet addiction varies between 8% to 13% for university students and 1.4% to 17.9% for adolescents.

Internet addiction is influenced by so-called Internet use for entertainment related use. Jeong et al. (2016) states that the entertaining content such as video, music, social networks and games can cause addiction regardless the media type. In this context let us state that the occurrence of Internet addiction is gender-bound. Alpaslan (2015) states a higher incidence in males, mainly due to a higher engagement in playing games online, in cybersex field, in tracking cyberporn materials and online gambling.

Interested readers can find much more information devoted to Internet addiction topic in the paper Kalibova and Milkova, 2016.

Learning Styles

There are various definitions and many typologies of learning styles. Let us introduce at least the following two definitions introduced recently. Hedayati and Foomani (2015) define learning styles as cognitive, affective and psychological characteristics that are relatively stable indicators of how learners perceive, interact and react in a learning environment. Balakrishan and Lay (2016) consider a teaching style as a preferred method of learning an individual that is often associated with their individual performances and may indicate academic success or failure of this individual; it is therefore imperative for teachers to understand students´ learning styles, especially in connection with coming of social media as a potential educational tool.

For the purposes of our research we chose the Learning Combination Inventory originated by Christine A. Johnston (Johnston, 1996), see thereinafter. Her Learning Combination Inventory

differs from other learning style questionnaires (such as Kolb, Honey and Mumford, 1982) by focusing primarily on the learning process (what and how is the student's learning will influenced, as well as how to achieve optimal student´s intellectual development) rather than simply on the learning results (Šimonová and Poulová, 2012).

Materials and Methods

The study carried out in 2015 - 2017 was focused on a long-term research concerning Internet use and abuse including the issue of Internet addiction in education of secondary school youth and its educational strategies according to the Learning Combination Inventory (see Kalibova, 2017).

The main objective was to find out

- how secondary school students Internet usage in lessons and when doing homework;
- how strong is secondary school students' tendency toward misusing Internet;
- what is the level of Internet addiction among contemporary adolescents by using selected criteria;

Furthermore, we were interested whether there is any connection (relationship) between a student's attitude to learning and his/her tendency to Internet abuse and to Internet-related addictive behavior, i.e. we wanted to detect to what extent a concrete student´s preferred learning style might affect a student´s tendency to the mentioned potential risks.

Research sample and its characteristics

For the research purpose we chose secondary schools in the Czech Republic. There were 1542 student respondents from the age group of 15 to 23 year olds (average age =16.99, standard deviation = 4.28), 647 boys and 895 girls.

According to the long-term psychological and pedagogical experience confirming that a mark is highly correlated with the mental capacity of an individual we also examined the respondent's classification in two key subjects - Czech mother tongue as a representative of humanities, and mathematics as a representative of science subjects (see Table 1 and Table 2).

Evaluation	Number of students	%
1 (excellent)	299	19.39
2 (very good)	607	39.96
3 (good)	544	35.28
4 (satisfactory)	88	5.71
5 (fail)	4	0.26

Table 1: Czech language subject evaluation, 2015-2017 (source: own calculation)

Achieved results according to Table 1 are:
Mean = 2.28, Standard deviation = 0.85, whereas M_{boys} = 2.46 and M_{girls} = 2.14.

Evaluation	Number of students	%
1 (excellent)	289	18.74
2 (very good)	509	33.01
3 (good)	532	34.50
4 (satisfactory)	206	13.36
5 (fail)	6	0.39

Table 2: Mathematics subject evaluation, 2015-2017 (source: own calculation)

Achieved results according to Table 2 are:
Mean = 2.44, Standard deviation = 0.95, whereas M_{boys} = 2.50 and M_{girls} = 2.38.

Research methodology

The Learning Combination Inventory (LCI) originated by Johnston (1996) and the Internet Risks Questionnaire were distributed to students. The survey was anonymous (both questionnaires filled in by a respondent were designated with an identification number of a respondent).

Learning Combination Inventory

Using the Learning Combination Inventory (LCI) we determined into what extent is the particular learning pattern – Sequential Processor, Precise Processor, Technical Processor and Confluent Processor characteristic of a respondent. There are 28 items in the LCI questionnaire (see Table 4 thereinafter) indicated as numbers 1, 2,…, 28 (Johnston, 1996).

The patterns can be characterized as follows. (Remark: Next to each pattern there are LCI number indicators corresponding with the given pattern, and the word description of the pattern.)

The Sequential Processor learning pattern student (2, 5, 10, 13, 18, 21, 27) can be characterized as a student who needs clearly formulated instructions, likes verifying theory in practice, works step by step, memorizes correct answers, makes lists, organizes activities, makes plans first of all and then practises.

The Precise Processor learning pattern student (4, 7, 9, 14, 19, 24, 25) requires correct, precise and detailed information, analyzes, asks questions, concentrates on searching his own sources of information and verifies the information. If he explains something, he explains it in details and looks for additional information in books to make himself sure that he is right.

The Technical Processor learning pattern student (1, 6, 11, 15, 17, 22, 26) has a strong and developed logical thinking, considers practical application of information, eliminates unvalued information, uses technical devices. He prefers individual work and oral performance.

The Confluent Processor learning pattern student (3, 8, 12, 16, 20, 23, 28) is able to apply his own ideas, concepts and theories, likes cooperating with creative people, works without stress, likes doing things in new and unusual ways and is often an artistic person. He likes trying new things, starts working first, only then thinks about the method.

Calculating values according to the Lickert scale (1 = never ever, 2 = almost never, 3 = sometimes, 4 = almost always, 5 = always), which was used by a respondent and which was matching a given learning pattern, we could determine a student´s preference to the relevant pattern. The minimum determination of each learning pattern is 7, maximum is 35. Determination between 7 – 17 corresponds to "I avoid this scheme", determination between 25 – 35 corresponds to "I use this scheme first", and determination in the residual range corresponds to "I use this as needed". (Johnston, 1996)

Internet Risks Questionnaire

The Internet Risks Questionnaire (IRQ) itself originated in the course of the author´s PhD study (Kalibova, 2017). Using this questionnaire, we can find out into what extent a respondent uses/abuses the Internet, and how much a respondent is dependent on the Internet. The questionnaire was designed in the form of 43 statements from which a respondent's answers were analyzed according to the Lickert scale (see above).

Obtained data were subjected to a factor analysis. Program Varimax orthogonal (NCSS) was used and according to Cronbach's Alpha (0.86), a critical value |0.30| was selected. Three factors were generated that we marked as F1 Tendencies to Internet addiction, F2 Internet – study aid and F3 Internet abuse. Factor F1 contains 15 statements, F2 contains 13 statements and F3 contains 12 statements (cf. Table 7, Table 8 and Table 9). Three statements, namely "Teachers encourage us to obtain information from the Internet." "The longer I am online the worse mood I find myself in." "I feel that time spent on the Internet is a waste of time", were excluded from previous 43 items since there was no correlation with any of the factors F1, F2, and F3 found.

Statistical survey

Based on D´Agostino Kurtosis test it was determined that all monitored data have a standard distribution, and thus we could use F tests for statistical survey of mutual dependence of individual factors.

Results

In this section let us present the results of both questionnaires and analyze and discuss their individual items. Abbreviations M for arithmetic mean and SD for deviation are used.

Learning Combination Inventory

Processor	M	SD	Median	Min – Max
Sequential Processor	24.59	4.16	25	7 – 35
Precise Processor	21.68	3.46	22	7 – 35
Technical Processor	22.20	4.35	22	7 – 35
Confluent Processor	21.07	4.09	21	7 – 35

Table 3: Results of LCI, 2015-2017 (source: own calculation)

A higher tendency towards the Sequential Processor (see Table 3) corresponds to the fact that traditional forms of learning still prevails in Czech education. This is also apparent from answers shown in Table 4 where the first three places are occupied by responses referring to this learning pattern.

Table 4 represents LCI statements that are put in order according to arithmetic mean M (level of agreement with the statement). In front of each of the statements there is a number corresponding to the LCI item number.

Statement	M	SD
18. I become frustrated if directions are changed while I am working on an assignment.	4.33	0.92
13. I need to have a complete understanding of the directions before I feel comfortable doing an assignment.	3.91	0.91
2. I need clear directions that tell me what the teacher expects before I begin an assignment.	3.88	0.92
28. I like to make up my own way of doing things.	3.80	0.89
5. I feel better about an assignment when I double-check my answers.	3.56	1.16
17. I prefer to build things by myself without anyone´s guidance.	3.47	0.99
26. I like to figure out how things work.	3.37	1.00
9. I prefer to take a paper and pencil test to show what I know.	3.34	1.08
21. I clean up my work area and pit things back where they belong without being told to do so.	3.32	1.17
19. I keep detailed notes so I have the right answers for tests.	3.30	1.06
3. I just enjoy generating lots of unique or creative ideas.	3.30	0.97
10. I keep a neat notebook, desk, or work area.	3.29	1.20
7. I am interested in knowing detailed information about whatever I am studying.	3.27	0.96
1. I would rather build a project than read or write about a subject.	3.23	0.81
14. I find that researching information is my favorite way to learn a subject.	3.21	0.99
4. I memorize lots of facts and details when I study for a test.	3.15	0.98
6. I like to take things apart to see how they work.	3.05	0.92
11. I like to work with hand tools, power tools, and gadgets.	3.03	1.10
22. I enjoy the challenge of fixing or building something.	3.03	1.18
15. I like hands –on assignments where I get to use mechanical/ technical instruments.	3.02	1.16
20. I don´t like having to do my work in the way the teacher says, especially when I have a better idea I would like to try.	2.94	1.00
12. I am willing to risk offering new ideas even in the face of discouragement.	2.87	1.05
16. I become frustrated when I have to wait for the teacher to finish giving directions.	2.84	0.99
25. I ask more questions than most people because I just enjoy knowing things.	2.76	1.07
8. I like to come up with a totally new and different way of doing an assignment instead of doing the same way as everybody else.	2.67	1.02
23. I react quickly to assignments and questions without thinking trough my answers.	2.66	0.91
24. I enjoy researching and writing factual reports.	2.66	0.96
27. I am told by others that I am very organized.	2.31	1.15

Table 4: LCI: Statements order according to mean M, 2015-2017 (source: own calculation)

Using statistical analysis, we acquire statistically significant differences (see Table 5 – Table 8) and hence we can claim:

- Males indicate a significantly higher tendency to the Technical and Confluent Processor, females show significantly higher tendency to the Sequential and Precise Processor.
- Individualized and riskier learning strategies are associated with a higher age.
- The higher tendency to the Sequential Processor, the better evaluation in Czech language (Mathematics resp.). Likewise, the higher tendency to the Precise Processor, the better evaluation in Czech language (Mathematics resp.).

Processor	F-test	M_{boys}	M_{girls}
Sequential Processor	75.95*	23.62	25.30
Precise Processor	16.59*	21.29	21.96
Technical Processor	202.16*	23.81	21.04
Confluent Processor	47.05*	21.84	20.52

Table 5: Interdependence of LCI and gender (*p < 0.05), 2015-2017 (source: own calculation)

Processor	Correlation coefficient
Technical Processor	0.077*
Confluent Processor	0.076*

Table 6: Interdependence of LCI and age (*p < 0.05), 2015-2017 (source: own calculation)

In Table 7 and Table 8 numbers 1, 2, 3, 4, 5 is shown evaluation in the Czech language (Mathematics resp.). This evaluation is normally used in Czech schools and corresponds to the evaluation in the foreign form of A, B, C, D, and F.

Processor	F-test	1	2	3	4	5
Sequential Processor	17.78*	25.37	24.74	24.12	23.52	18.27
Precise Processor	21.74*	22.46	21.81	21.26	21.01	14.83

Table 7: Interdependence of LCI and Czech language (*p < 0.05), 2015-2017 (source: own calculation)

Processor	F-test	1	2	3	4	5
Sequential Processor	10.29*	25.13	24.63	24.51	24.14	17.93
Precise Processor	10.17*	22.01	21.73	21.65	21.29	16.09

Table 8: Interdependence of LCI and Mathematics (*p < 0.05), 2015-2017 (source: own calculation)

Internet Risks Questionnaire

Factor	M	SD	Median	Min – Max
F1 Tendencies to Internet Addiction	39.12	10.04	39	15-75
F2 Internet – study aid	24.55	4.48	25	13-65
F3 Internet Abuse	24.98	7.83	24	12-60

Table 9: Results of IRQ, 2015-2017 (source: own calculation)

Analyzing interdependence of factors F1, F2, and F3 We obtained quite expected correlations (see Table 10):

- The more the Internet is used for study, the higher increase of possibility of Internet addiction and of Internet abuse is there.
- The more Internet abuse occurs, the higher tendency to Internet addiction occurs.

	F1	F2	F3
F1	-	0.30**	0.48**
F2		-	0.28**

Table 10: Interdependence of factors F1, F2, and F3 (p < 0.01), 2015-2017 (source: own calculation)**

Tables 11 to 13 represent questionnaire statements of relevant factors F1, F2 and F3 that are put in order according to arithmetic mean M (level of agreement with the statement).

Statement	M	SD
When I connect to the Internet and it is being loaded, I feel excited.	3.50	1.02
It happens to me that due to the Internet I miss something important (e.g. a meeting, keeping a promise).	3.09	1.09
It happens to me that I procrastinate learning for later due to the Internet.	2.83	1.14
At home I conceal the things I do on the Internet	2.69	1.2
When I am online, I lose the track of time.	2.68	1.15
Even though I have other responsibilities, I postpone them due to the Internet.	2.61	1.17
The computer is my true and intimate friend.	2.47	1.15
When I have a little time off, I automatically connect to the Internet.	2.42	1.3
Thanks to the Internet I get up early in the morning and get connected immediately.	2.39	1.12
When I ban myself to use the Internet just for one day, I cannot stand it and finally get connected.	2.32	1.01
I lie about the question how long I spent online.	2.23	1.02
Thanks to the Internet I have no time for hobbies.	2.03	1.00
I am fed up if I cannot get connected from anywhere.	1.78	0.93
I spend more time on the Internet than with a family or friends.	1.76	0.93
Thanks to the Internet I stay up late till night.	1.52	0.9

Table 11: IRQ: Statements order of factor F1, 2015-2017 (source: own calculation)

Statement	M	SD
I consider the Internet as a source of information which is necessary during secondary school studies.	3.91	0.97
I use electronic sources of information during self-study.	3.80	0.94
I cannot imagine my studies without Internet connection.	3.68	0.92
I also use social networks for learning.	3.44	1.06
I obtain information more often from the Internet than from paper-printed literature.	3.21	1.00
I verify information obtained on the Internet.	3.12	0.63
Information published or posted on the Internet is reliable.	3.11	1.01
We also use the Internet at school during lessons.	2.84	0.82
It is necessary to verify information obtained on the Internet (e.g. with the help of some other paper-printed literature).	2.83	1.05
I share information with classmates about lessons on social networks.	2.72	1.18
We share study materials on social networks.	2.48	1.09
Pedagogues provide us with study material that cannot be found in textbooks (e.g. in the form of freeware materials from the Internet).	2.24	1.09
I consider discussion/chatting with my classmates on social network also as learning.	1.32	0.91

Table 12: IRQ: Statements order of factor F2, 2015-2017 (source: own calculation)

Statement	M	SD
I tell my parents that I use the Internet for learning, but it is not true.	3.41	1.19
I use the Internet during writing a task in order to find out a correct answer.	3.31	1.09
During lessons I communicate on a social network.	3.00	0.99
I am inspired by work published on the Internet when doing my homework.	2.86	0.99
When doing homework or writing an essay "I borrow" a ready-made text from the Internet and I use it in my work.	2.79	1.18
I have downloaded work on the Internet and presented it as my own.	2.62	1.18
I surf on the Internet during lessons.	2.59	1.24
In order to pass my test, I take a photo of the text with my phone. Then I copy it out.	2.21	1.58
I cheat at school through information and communication technologies.	2.18	1.17
We share completed tests on social networks.	2.00	1.07
It has happened to me that someone did an assignment for me in exchange of sending a photo or a video of myself with sexual content.	1.92	1.09
I receive and send emails during lessons.	1.64	0.99

Table 13: IRQ: Statements order of factor F3, 2015-2017 (source: own calculation)

Using statistical analysis, we get the following statistically significant differences (see Table 14 – Table 17) and therefore we can say that:

- Males indicate a significantly higher tendency to Internet abuse as well as students with worse evaluation in Czech language (Mathematics resp.).
- The older the respondents are, the more addictive they become and the higher is the tendency to abuse Internet.

Factor	F-test	M_{boys}	M_{girls}
F1 Tendencies to Internet addiction	15.25*	40.19	38.34
F3 Internet abuse	32.64*	26.20	24.10

Table 14: Interdependence of IRQ and gender (*p < 0.05), 2015-2017 (source: own calculation)

Factor	Correlation coefficient
F1 Tendencies to Internet addiction	0.080**
F3 Internet abuse	0.082**

Table 15: Interdependence of IRQ and age (*p < 0.05), 2015-2017 (source: own calculation)

In Table 16 and Table 17 numbers 1, 2, 3, 4, 5 is shown evaluation in the Czech language (Mathematics resp.). This evaluation is normally used in Czech schools and corresponds to the evaluation in the foreign form of A, B, C, D, and F.

Factor	F-test	1	2	3	4	5
F1 Tendencies to Internet addiction	9.84*	37.09	38.76	40.07	42.44	40.89
F2 Internet – study aid	9.94*	25.13	24.30	24.73	23.51	18.63
F3 Internet abuse	17.44*	23.51	24.35	26.05	28.19	15.91

Table 16: Interdependence of IRQ and Czech language (*p < 0.05), 2015-2017 (source: own calculation)

Factor	F-test	1	2	3	4	5
F1 Tendencies to Internet addiction	2.39*	37.93	39.0	39.50	40.04	40.70
F2 Internet – study aid	6.40*	24.47	24.70	24.60	24.16	19.25
F3 Internet abuse	10.50*	23.71	24.48	25.39	27.11	19.43

Table 17: Interdependence of IRQ and Mathematics (*p < 0.05), 2015-2017 (source: own calculation)

LCI and IRQ interdependence

Table 18 presents found interdependence among IRQ and LCI.

Factor	Sequential Processor	Precise Processor	Technical Processor	Confluent Processor
F1 Tendencies to Internet addiction	- 0.15**	- 0.14**	0.8**	
F2 Internet – study aid	0.09**			0.13**
F3 Internet abuse	- 0.28**	- 0.19**		0.13**

Table 18: LCI and IRQ interdependence (p < 0.01), 2015-2017 (source: own calculation)**

Discussion

Let us discuss achieved results of both questionnaires, partly separately, partly in mutual relation.

Learning Combination Inventory

Acquired statistically significant differences

- Males indicate a significantly higher tendency to the Technical and Confluent Processor, females show significantly higher tendency to the Sequential and Precise Processor.
- Individualized and riskier learning strategies are associated with a higher age.
- The higher tendency to the Sequential Processor, the better evaluation in Czech language (Mathematics resp.). Likewise, the higher tendency to the Precise Processor, the better evaluation in Czech language (Mathematics resp.).

lead us to the following considerations.

Males are more likely to risk, innovate, and often reluctant to learn too much not only due to a low engagement and task-fulfilling orientation, but surely also due to deeper experience of self-realization emerging as a need of being original. As far as females are concerned, the results show the opposite, respectively, females in pursuit of getting and having good school results apply prevalent and learning methods.

With the adolescent age, individualization is rising. This can be caused by the reluctance to stick to established procedures, the decision to take the risks, sometimes even high ones, related to adolescent self-esteem and idealized self-image.

A-students in both subjects are perceived as excellent students who best meet the teacher's idea of successful students, more often they choose the first two strategies based on traditional practices required by traditional schools and these practices bring them the best profit.

Internet Risks Questionnaire

Analyzing IRQ data according F1-Tendencies to Internet addiction we obtained a distressing findings: 20% respondents

show the arithmetic mean of the above 15 given statements higher than 3, which means that every fifth respondent is moderately or highly above-average addicted to the Internet.
The arithmetic mean of more than a half of statements of factor F2-Internet – study aid is above average. It is clear that the Internet has become a common aid in learning and studying. The lowest occurrence of the assertion is the statement "I consider discussion/chatting with my classmates on a social network also as learning." This answer matches with the scale item "never". Although the Internet is used as a learning aid, as shown above, it is predominantly used as an individual rather than co-operative aid. This is actually what the contemporary Czech school still prefers and peer learning is not much developed and supported form of teaching/learning in Czech education.
According to factor F3-Internet abuse statements listed in the Table 13 appear within the Likert scale between items "sometimes" - "often". Respondents admit that they misuse the Internet, but we should mind the fact that the extent to which they do so can be greatly reduced by a respondent in order to minimize their guilt. Males indicate a significantly higher tendency to Internet abuse that is in accordance with Akbulut et al. (2016), see the section Materials and Methods – School Disruption, as well as students with worse evaluation in Czech language (Mathematics resp.).
Among the statements of factor F3 there are three statements focused on school disruption by means of Internet use: "During lessons I communicate on a social network", "I surf on the Internet during lessons" and "I receive and send emails during lessons." (cf. Griffin, 2014, section Materials and Methods – School Disruption). The nine other statements focus on cheating and plagiarism. Respondents mostly agreed with statements concerning drawing inspiration and copying work published on the Internet while writing their own work. They mostly draw inspiration on Internet portals sharing papers and assignments, and then from Wikipedia's online encyclopedia. They often only copy a text without evaluating the information critically. Statistical results concerning interdependence of the three statements belonging to school disruption according to gender show that a significant difference can be seen only in the statement "I receive and send emails during lessons", namely that females send and receive emails during lessons more often than males. Obviously, such a conclusion matches natural talkative women's behavior (see Kalibova et al., 2016).

LCI and IRQ interdependence

Students who prefer the Sequential Processor learning pattern and students who prefer the Precise Processor learning pattern are students who favor clear instructions, precise and detailed information. They respect the traditional concept of teaching/learning at school in which it is the teacher who has a decisive and determining role. Students who prefer the Sequential Processor learning pattern, uses the Internet as a study aid. Students who prefer the Precise Processor learning pattern, prefer studying books. None of these students show a tendency to Internet addiction or Internet abuse.
Students who prefer the Technical Processor learning pattern have a strong logical thinking and eliminate inappropriate information. Such type of a student uses the Internet as a learning aid, does not abuse it, but tends to become Internet addicted.
Students who prefer the Confluent Processor learning pattern use the Internet as a learning aid, however, although there was no risk of becoming Internet addicted found, these students abuse the Internet at school.

Based on results gained in Table 18 let us describe in a simple well-arranged form a typology of students (see Table 19).

Student type	Learning type	Internet – study aid	Internet addiction	Internet abuse
A	Sequential Processor	✓	×	×
B	Precise Processor	×	×	×
C	Technical Processor	✓	✓	×
D	Confluent Processor	✓	×	✓

Table 19: Typology of a student

Conclusion

The paper deals with issues of selected types of Internet risk behavior in the context of using the Internet as an educational aid. The target group are secondary school students. The discussed topic responds to the rapid increase in implementation efforts in the use of information and communication technologies in education and describes also the mutual relation between the student's educational strategy and the tendency to Internet abuse and to Internet addiction.
From the results of our research it can be concluded that contemporary secondary school youth in the Czech Republic does not significantly differ from their peers abroad. Statistical survey made for factors F1 and F3 according to a gender and two selected fundamental subjects show in all cases a statistically significant difference between monitored variables, namely that males indicate a significantly higher tendency to Internet addiction as well as a significantly higher tendency to Internet abuse. Moreover, students with worse evaluation indicate a significantly higher tendency to Internet addiction as well as a significantly higher tendency to Internet abuse.
The Internet provides a user with a broad and varied range of uses, one of which is undoubtedly the possibility of new types of communication. The role of women and men is represented in our culture by certain traits of behavior. Adolescents get acquainted with these traits, and in some sense they are also assumed to active communication with each other face to face. This seems to be more difficult for adolescent men than women, and the use of the Internet in communication (with all its features - such as anonymity) effectively reduces young men´s anxieties. Males indicate a significantly higher tendency to cheating and plagiarism, whereas tendency to school disruption is comparable with females. According to Mares (2007: 189) "Sex of pupils has nothing to do with cheating especially at the beginning of school attendance". Gradually, these are the boys who prevail in cheating. This trend might be explained by the fact that girls tend to stick to the rules and are more aware of the possible consequences of breaking the rules.
Alarming results are in the field of Internet addiction, with almost 20% of respondents showing signs of already developed Internet addiction. It is obvious that it is high time to focus on effective prevention of the above-described types of risk behaviors on the Internet that adolescents encounter in the educational process. Primary prevention should be addressed to both parents of adolescents as well as schools and school facilities.

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RETURNING RESPONSIBILITY TO THE HOME: OUTCOMES OF BACKGROUND CHECKS ON LOW AND HIGH ACHIEVERS IN MIDDLE BASIC MATHEMATICS IN NORTH BANK SUBURB OF MAKURDI, NIGERIA

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Highlights

- *There is a relationship between home involvement and mathematics achievement*
- *Family members and close family members play a vital role in providing guidance for mathematics home work*
- *Parents of pupils in North Bank suburb have shortcomings as mathematics resources providers*

Abstract

This study is a correlational survey of the impact of home involvement on the mathematics achievement of Basic 5 pupils in North Bank suburb of Makurdi, Benue State, Nigeria. The study is the outcome of the first phase of a local intervention programme targeted at encouraging homes in the suburb to actively support the mathematics education of children at the Basic Education level. The participants of the study comprise 73 Basic 5 pupils along with their parents across three basic schools in the suburb. The mathematics achievement scores of the pupils for the First Term of the 2016/2017 Academic Session were correlated with home involvement scores generated from the adopted Parental Involvement Questionnaire. The correlational analysis established a weak positive relationship (r = 0.0177, p = 0.9241; and r = 0.174, p = 0.2884) between home involvement and mathematics achievement. Further interaction with pupils revealed that outside pupils' parents, certain friends, members of extended family and neighbours play vital roles, ranging from re-teaching class work at home to providing guidance for mathematics homework.

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Introduction

The home is the first social institution of the child. It is where the child first learned the essentials of life such as language, relationships and societal norms and values. The home is the fundamental unit of human society. So, if education is considered as the conscious effort of the society to communicate its culture, science and technology to its young ones, then it is reasonable to see the home as both the first school and the sole beneficiary of other educational endeavours. This implies that the home is an indispensable stakeholder in the education of the child, particularly in the area of mathematics.

One of the renditions of the term "home" indicates that it is one's own dwelling place; the house in which one lives; especially the house in which one lives with his family; and the habitual abode of one's family (CrumpledApp, 2015). Such definitions often lead many to think the term "family" is synonymous with "home". Across much of Africa, particularly in Nigeria, both terms are used interchangeably, considering the fact that extended family practices are common. A child staying hundreds of kilometers from his birth place normally considers the relatives he or she is staying with as family and as such his or her home. Glaringly, in this setting, the duties of a parent and a guardian are one and the same. It is, thus, common for schools to address end-of-term correspondence with the salutation "Dear Parent/Guardian".

Evidently, the home and the school are partners in the growth and development of the child. It used to be normal to accuse the home when children behave out of tune in the public. Awareness of this sense of responsibility has continued to keep the home on its toes to instill in the child the right values and morals right from a very tender age. Such informal training yields outcomes that are often considered as future determinants of progress in areas such as job, marriage and civic responsibility. The traditional African child is trained to protect and preserve the image of his or her family wherever he or she goes to in life. But over the years, the dominance of formal education over home training is beginning to dampen the significance of this socio-cultural perspective to education. Many homes misinterpreted emphasis on early childhood education to imply a relief of the burden of providing the core parental support in the upbringing of their children.

With the cost of schooling skyrocketing across Nigeria, homes that could send their wards to good schools kept pushing for real value while continuously relinquishing their traditional roles as the base of children's education. The outcome of this societal pressure on schools is a lopsided educational system that keeps grappling with monumental challenges, most of which are attributable to the host society. Misinformation about the fundamental issues emerging from the loss of collective responsibility has led to educational policies that attempt to control teachers through conceptualizing them as mere technicians who require taming and has resulted in several restructuring that were actually done to teachers rather than with teachers (Lingard, Hayes & Mills, 2003). The sure path to growth and success in this regard is a co-ordinated participation beginning with the support of parents and the communities to schools by preventing student absence and motivating students to learn, do their homework and use their time effectively (Bibiire & Omojokun, 2016).

An area that requires active participation of the home is the mathematics education of children. Mathematics as a subject is essential for children to appreciate the beauty of nature, think logically and make sound judgment (Iji, Abah & Anyor, 2018). The home should show some concern and willingness to act in order to correct accumulated myths about the difficulty of mathematics as a school subject and avoid the influence of faulty foundations in mathematics that may impede children's future development. With adequate support from the home, pupils can be encouraged to master the automatic procedures, skillful manipulations and the sense of logic that mathematics is known for (Iji, Abah & Anyor, 2017).

There seem to be abundant researches into the need for school-home partnership in mathematics education as affirmed by Cai (2003), but very few are domestic enough to consider the existing societal dynamics of the current era. Jackson and Remillard (2005) for instance, examined how African-American mothers from low-income neighbourhood of the United States conceptualized their roles in their children's mathematics learning with their findings identifying challenges that are due in part to stereotypes held by practitioners about the families they serve in low-income urban schools. The incidences of social and economic variables on education of poor communities are well documented in available literature (Jimenez Bandala & Andrade, 2017; Husak & Hudeckova, 2017; and Safrankova & Zaptopkova, 2017). A local study by Agada (2017) also threw more light on the short-comings of dwellers of slum communities in Makurdi, Benue State, Nigeria, in terms of provision of support in the mathematics education of children. The emerging trend observable from the local community and the incessant cries of local school administrators about the lackadaisical attitude of homes towards mathematics in particular, formed the basis for this study. Specifically, this study is a fact finding survey of the relationship of pupils' home background to their academic achievements in middle basic mathematics, with respect to the peculiarity of the North Bank suburb of Makurdi, Nigeria.

The Role of the Home in Mathematics Education

One of the reasons the whole world is attracted to the educational system of Finland is the sense of responsibility shared by all stakeholders in the upbringing of children. Coughlan (2016) reports that one of the most striking facts about Finnish schools is that their students have fewer hours of instruction and observe long summer holidays, apportioning bigger roles to the home. The Finnish system adopts a holistic approach to education with parents wanting a family-friendly approach that also holds high respect for teachers. Coughlan (2016) adds that the Finnish school system is inseparable from the culture which it serves. In this sense, children's education is continuous based on the full involvement of the home and the outcome is a fine balance between quantity and quality.

Homes and families have the direct and lasting impact on children's mathematics learning and development of social competence. When parents are involved, pupils achieve more, exhibit more positive attitudes and behaviour, and feel more comfortable in new settings (Adams & Baronberg, 2011). One of the best things parents can do to improve their children's mathematics literacy is to regularly expose them to practical applications of mathematics at home which can help them develop mathematical reasoning (Kormanik, 2012). The home can help pupils merge what they observe, discover and learn outside the classroom with the theoretical and abstract mathematics they learn in school. Such practical mathematics is readily available in the estimation of resources at home, the use of money for daily expenditure, available games in the community and even in the cultural practices of the society (Abah, 2017; Abah, 2016).

Apart from normal activities in the home, parents and guardians can work with children's school teachers to facilitate their children's mathematics learning. Hartog and Brosnan (2008) identify two reasons why parents-teachers collaborations are likely to be the most profitable. First, children generally want to please both their parents and their teachers. If they see that mathematics is important to both their parents and their teachers, they will consider it important for themselves too. Second, extending mathematical concepts from the classroom to the home will establish the idea that mathematics is not just a school subject, but an everyday subject that makes life more interesting and understandable. Hartog and Brosnon (2008) suggested that teachers can provide assistance in:

i. Setting up a system of home study;
ii. Helping parents understand the sequencing of mathematical skill development;
iii. Suggesting materials and activities that are entertaining and suitable for their child's level and which can be done in a reasonable amount of time;
iv. Providing clear guidelines on how to use materials;
v. Giving feedback on the successes and failures of home activities; and
vi. Knowing when to stop working with a child on an activity so that a good working relationship is maintained.

Generally, emphasis on the role of the home in mathematics education of children dwells on the need for parents and guardians to give more time to children, providing them a supportive environment at home, encouraging their mathematics learning and discussing with them about their problems in the subject. Parents are to keep watch on the children's activities, help improve their study habits and maintain a positive disposition while advising them. Even for parents who themselves found mathematics difficult, there should be a decisive effort to set aside such distaste, avoid talking negatively about the subject, and seek collaboration to instill the love of mathematics in their children (Brown, 2016).

Some Empirical Studies

Generalizations about the significance of parents' involvement in mathematics education are often rooted in empirical research findings. These studies, though from very diverse demographic backgrounds, are unanimous in affirming that active participation of homes is always favourable to the overall progress of children in academic work. The studies highlighted are only representative of the available literature in this subject. In a Canadian study, Leferre *et al.* (2009) attested that children's numerical competence in Kindergarten is highly predictive of their acquisition of mathematics in later levels of education, suggesting that experiences at home before schooling are important in understanding how numeracy develops. The researchers correlated the mathematical skills of 146 children in Kindergarten, Grade 1 and Grade 2 with the frequency with which parents reported informal activities that have quantitative components such as games, shopping and cooking. The findings of the study showed a relation between parents' reports of their children's participation in mathematics-related activities and the children's mathematical outcomes.

Similarly, Lore, Wang and Buckley (2016) reported a favourable empirical evidence for cultivating a collaborative, home-school relationship aimed at improving the mathematics performance of catholic school first grade students by training parents as providers of at-home numeracy support. The participants included 60 parents from diverse racial backgrounds from two urban catholic schools. The result revealed that students who received the parent-child home numeracy intervention made large and statistically significant gains in their mathematics achievement, measured by a standardized test, as compared to the control group.

A small-scale study by Rockliffe (2001) explored some of the major influences affecting parental participation in mathematics education and examined the changing nature of the role adopted by parents as their children moved up through the school grades. The study observed that the nature, style and strategies adopted by the parents were influenced by factors relating directly to the parents' own mathematical experiences. In contrast to the range of parental responses, the study reported that teachers tended to view the parents as a homogenous group, generally lacking confidence and expertise in mathematics. The outcome of Rockliffe's work points to a high need for more inclusive school practices for encouraging active participation by parents in mathematics education for the overall benefit of the children.

Another survey by Bicknell (2006) evaluated New Zealand parents' roles as motivators, resource providers, monitors, mathematics content advisers and mathematics learning advisers. In the study, 18 students (2girls, 12 boys) from a Year-6 pullout programme, 10 Year-6 students (2girls, 8 boys) from regular classes in two different schools and 5 Year-8 (2 girls, 3 boys) from a full time special class for gifted students, were isolated to examine parental roles in their mathematics achievement. Responses to questionnaire and interviews shows that overall, parents in the study have strong positive attitude about parental involvement. They showed a strong acceptance for the important role that mathematics plays in the children's futures. The parents also rightly recognized the teacher as a key factor in the children's interest, excitement, fascination and appreciation for mathematics.

In a similar vein, Berkowitz *et al*. (2015) in a randomized field experiment of 587 first-graders, tested on educational intervention designed to promote interactions between children and parents relating to mathematics. The researchers predicted that increasing mathematical activities at home would increase children's mathematical achievement at school. The intervention which involved short numerical story problems delivered through an iPad app, significantly increased children's mathematics achievement across the school year compared to a reading (control) group, especially for children whose parents are habitually anxious about mathematics.

The emerging paradigms and suggestions of these and other studies in their class point to the fact that parental involvement is a process that required school leaders, teachers, students and significant others in the school community to make efforts through consultation, planning and reflection (Bicknell, 2006).

The current study is a brain-child of several calls to refine home intervention programmes that appeal to the socio-economic diversity of homes and the possibility of transforming ordinary out-of-school activities into rich mathematics learning experience for children. A unique feature of the present study is its encompassing dimension which attempts to compare home parameters of high mathematics achievers to that of low achievers. The audacity to confront North Bank suburb dwellers with the friendliness of school-home partnership introduces techniques and approaches that are novel in this part of the world.

Research Questions

The following questions guided this study:

i. To what extent are homes in North Bank suburb of Makurdi, Nigeria, involved in the mathematics education of pupils at the Middle Basic level?
ii. What is the relationship between home involvement and mathematics achievement of low-achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria?
iii. What is the relationship between home involvement and mathematics achievement of high-achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.

Research Hypotheses

The following hypotheses were tested at 0.05 level of significance

i. There is no significant difference between high and low achievers in the level of home involvement in the mathematics education of pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.
ii. There is no significant relationship between home involvement and mathematics achievement of low-achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.
iii. There is no significant relationship between home involvement and mathematics achievement of high-achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.

Materials and Methods

This study is the outcome of the first phase of a local intervention programme targeted at encouraging homes in the North Bank suburb of Makurdi township to actively support the mathematics education of children at the Basic Education level. The school-home partnership for mathematics education (SHPME) project seek to first identify the existing structure of home involvement in mathematics education in the community before providing intervention training and support materials to families identified as critically in need of help. A similar scheme could be found in the descriptions by Lore, Wang and Buckley (2016).

The design adopted for this study is the ex post facto research design. The pre-existing groups in this study are high mathematics achievers and low mathematics achievers. They are compared on achievement in Middle Basic Mathematics as dependent variables on the basic home involvement in mathematics learning. The ex post facto research design compares two or more groups of individuals with similar backgrounds who were exposed to different conditions as a result of their natural histories (Psychwiski.com 2016).

The participants in this study 73 Primary 5 (Basic 5) pupils along with their parents/guardians. The pupils are purposively drawn from 3 Mission Nursery and Primary schools in North Bank suburb of Makurdi, Benue State, Nigeria. Mission schools, which are educational institutions owned and managed by religious missions or churches, were considered appropriate for the kick-off of the SHPME based on their affordability in terms of fees charged and their high level of absorption of children from diverse socio-economic background in the local community. Primary 5 was selected for the study because it is a pivotal stage of the Nigerian 9-Year Basic Education system from where pupils are at liberty to transit to the Upper Basic level (Junior Secondary School). Also, pupils in Primary 5 are expected to be able to communicate their feelings about their home conditions during interaction with teachers and researchers.

The procedure for the study involves four distinct stages. The first stage is the recording of the pupils' examination scores in mathematics for the First Term of the 2016/2017 Academic Session. This is handled purely by the partnering schools to establish a measure of academic achievement for each pupil. The second stage involves the ranking of the end-of-term mathematics scores of all the pupils in the selected class of each participating school. The essence of the ranking is to divide the class into two categories, namely high achievers and low achievers, based on pupils' scores. The end of term scores is the overall measure of academic achievement which is summed from scores from all mode of assessment used in the term.

Table 1 shows the descriptive statistics of mathematics scores of pupils in the two categories. The difference in the mathematics scores of pupils in the two categories is significant ($p < 0.0001$) as established from a preliminary *t*-test of the two categories of scores.

Statistic	Math Score of Pupils in Top Categories	Math Score of Pupils in Bottom Category
Data size (n)	39	34
Mean	67.487	37.971
Error	1.817	1.833
SD	11.348	10.690
Skewness	-0.120	-0.164
Kurtosis	-1.254	-1.310
Anderson-Darling Normality test *p*-value	0.4743	0.6255

Table 1: Descriptive Statistics of the Two Categories of Pupils

The third stage of the study involves interactions with pupils to obtain general background information of home conditions in relation to the learning of mathematics. This interaction was co-ordinated by the researchers in collaboration with the schools' head teachers and Primary 5 mathematics teachers. In the fourth stage, parents were sent the second instrument through their wards to fill and return to the mathematics teachers.

Two separate instruments were used for data collection in this study. The first is a researcher designed structured-interview used in the interaction with the participating pupils. The short interview comprises questions like "Do you like mathematics?" Depending on the pupils answer, the follow up question would demand a reason. Other items on the interview template are "Do you normally practice mathematics at home?"; "Who normally assist you in studying mathematics at home?" (to indicate relationship); "How does the person (name or indicated relationship) assist you?"; "Are you doing well in mathematics in school?"; and "What do you think will make you perform better?"

The second instrument used for data collection in this study is a full adoption of the Parental Involvement Questionnaire (PIQ) designed and validated in the work of Cai (2003). The reported reliability coefficient of the PIQ is 0.89. The PIQ is a 23-item self-reported questionnaire meant to elicit responses from parents on the extent of their roles in the mathematics education of their children.

Table 2 shows the description of the five parental roles and their general descriptions. The items are rated on a four-point Likert-type scale with strongly Agree = 4, Agree = 3, Disagree = 2 and Strongly Disagree = 1. Conversely negatively worded items are reverse-coded. The benchmark of acceptance is 2.50 implying that a mean below 2.50 indicate rejection (low parental involvement) while a mean of 2.50 and above indicated parent acceptance (high parental involvement).

S/N	Parental Role	No of items on PIQ	Description
1	Motivator	5	Parents provide emotional support for pipils' learning
2	Resource Provider	4	Parents play the role of resource provider at home by providing an appropriate place to study, relevant reference books, and/or access to the library
3	Monitor	5	Parents monitor their children's learning and progress at home
4	Mathematics content Adviser	4	Parents provide advice to their children on mathematics content
5	Mathematics learning counselor	5	Parents understand their children's current situation learning difficulties, potential, needs and demands and provide appropriate support to help their children overcome learning difficulties.

Table 2: Brief Description of Parental Roles

The method of data analysis for this study involves the use of means, standard deviation and correlation analysis to answer research questions and the use of the *t*-test of significance of correlation to test the stated hypotheses at 0.05 level of significance. Extracts of the pupils' interview were also used to interpret the extent homes are involved in the mathematics education of their children, using qualitative data deduction techniques (Abakpa, Agbo-Egwu & Abah, 2017).

Results

The results of this study are presented according to the research questions and hypotheses.

Research Question One

To what extent are homes in North Bank suburb of Makurdi, Nigeria, involved in the mathematics education of pupils at the Middle Basic level?

The results in Table 3 shows that, for pupils in the bottom category, there is low parental involvement with respect to item 1, item 7, item 9 and item 20. This implies that parents of pupils in the bottom category have problems supporting their children who are having difficulties in school mathematics. The parents of pupils in this category do not take their children to the library and lack in their houses variety of games, puzzles and activities that encourage the development of their children's mathematics skills. Likewise, they are not aware of the approaches used to teach mathematics in their children's schools. However, this category parents score high on all other items of the PIQ.

The results displayed in Table 4 indicate that parents of pupils in the top category are not aware of the approaches used to teach mathematics in their children's school (Item 20) and certainly lack mathematical games and puzzles in their houses (Item 9). Similarly, the parents of pupils in this category do not take their children to the Library (item 7). This category of parents also score low on item 1 of the PIQ. They however score high on the remaining items of the PIQ.

Considering that parents of pupils in both the bottom and top categories default on the same items of the PIQ, a comparison of the level of their involvement in terms of the five (5) parental roles is necessary.

S/No.	PIQ Statement	Mean	SD	Remarks (Level of Parental Involvement)
1	Statement 1	2.32	0.94	Low
2	Statement 2	3.09	0.79	High
3	Statement 3	3.05	0.81	High
4	Statement 4	3.44	0.66	High
5	*Statement 5	2.85	0.82	High
6	Statement 6	2.71	0.84	High
7	Statement 7	2.05	0.78	Low
8	Statement 8	2.82	0.87	High
9	Statement 9	2.32	0.84	Low
10	Statement 10	3.00	0.89	High
11	*Statement 11	2.58	0.82	High
12	Statement 12	2.85	0.82	High
13	Statement 13	2.59	0.82	High
14	Statement 14	2.62	0.95	High
15	Statement 15	2.79	0.88	High
16	Statement 16	2.65	0.79	High
17	Statement 17	2.79	0.88	High
18	Statement 18	2.82	1.00	High
19	*Statement 19	2.65	0.81	High
20	Statement 20	2.41	0.78	Low
21	Statement 21	2.67	0.88	High
22	Statement 22	2.97	0.80	High
23	Statement 23	2.79	0.91	high

Reverse-Coded

Table 3: Parental Involvement scores for Pupils in the Bottom Category

S/No.	PIQ Statement	Mean	SD	Remarks (Level of Parental Involvement)
1	Statement 1	2.26	0.85	Low
2	Statement 2	3.15	0.71	High
3	Statement 3	3.13	0.54	High
4	Statement 4	3.31	0.57	High
5	*Statement 5	2.85	0.81	High
6	Statement 6	2.92	0.66	High
7	Statement 7	1.90	0.64	Low
8	Statement 8	2.79	0.86	High
9	Statement 9	2.28	0.79	Low
10	Statement 10	3.00	0.96	High
11	*Statement 11	2.64	0.81	High
12	Statement 19	3.03	0.58	High
13	Statement13	2.59	0.85	High
14	Statement 14	2.69	0.92	High
15	Statement 15	2.61	0.78	High
16	Statement 16	2.54	0.97	High
17	Statement 17	2.79	0.86	High
18	Statement 18	2.95	0.83	High
19	*Statement 19	2.64	0.81	High
20	Statement 20	2.33	0.81	Low
21	Statement 21	2.82	0.64	High
22	Statement 22	3.03	0.71	High
23	Statement 23	2.90	0.63	High

Reverse-Coded

Table 4: Parental Involvement Score for Pupils in the Top Category

The comparison in Table 5 shows that parents of pupils in the Bottom category are slightly better motivators, resource providers and mathematics content advisers than the parents of pupils in the Top category. On the other hand, parents of pupils in the Top category are better monitors and mathematics learning counselor than the parents of pupils of Bottom category. Ultimately, with a grand mean of 2.732, homes of high achieving pupils are more involved in the mathematics education of their children than homes of low achieving pupils (grand mean = 2.724). The strength of these difference and relationship are tested in the hypotheses of this study.

S/No.	Parental Role	Cluster Mean of PIQ Scores of Parents of Pupils in Bottom Category	Cluster Mean of PIQ Scores of Parents of Pupils in Top Category
1	Motivator	2.95	2.94
2	Resource Provider	2.48	2.47
3	Monitor	2.73	2.79
4	Mathematics Content Advisor	2.76	2.72
5	Mathematics Learning Counselor	2.70	2.74
	Grand Mean	2.724	2.732

Table 5: Mean parental Involvement in the Five Key Parental Roles

Out of all the pupils interviewed in this study, only three (3) answered “No” to the question “Do you like mathematics?” When asked why, one of the students replied “I don’t like mathematics because it is too hard for me to understand”. In the same vein, another student said”… because mathematics is a hard subject”. The third student added “because mathematics is a hard subject and I always find it difficult to understand”.

The pupils who accepted that they like mathematics gave reasons relating to future careers in Engineering, Accounting, Medicine, and other science-based disciplines. Some of the pupils actually opined that mathematics is simple and interesting. One of such pupils replied “because mathematics is a universal subject”. Another pupil in this category said “because mathematics is very easy for me to solve”. A pupil emphasized that “mathematics is a requisite subject which you must pass before gaining admission into the university”.

When asked the question “Do you normally practice mathematics at home?” 23.3% of the pupils interviewed in this study answered “No”, with the remaining 76.7% answering “Yes”. Among the pupils that practice mathematics at home, the response to the prompt “who normally assist you in studying mathematics at home?” include “friend”, “a sister”, “neighbor”, “father”, “uncle”, “cousin brother”, “brother” and “mother”. A pupil (Math score = 82, position = 2nd) whose father normally assists in studying mathematics explained thus:

> My father normally teaches me at home every day after the school hour. He uses good example and I follow the method he taught me.

Another pupil (Math score = 86, Position = 1st) explained that his sister normally assist him in practicing mathematics at home. According to this pupil:

> She normally asked me if there is any homework and if there is any, she teach me how to answer the question.

A pupil (Math score = 40, position = 15) who replied that her neighbor assist him in studying mathematics at home explained: “I do ask her to explain and also to re-solve my class work for me”. One of the pupils (Math score = 70, position = 4th) who said her cousin brother normally assists her in studying mathematics at home reiterated thus: “He will ask me to solve the homework then he will later do the correction for me”.

One of the pupils (Math score = 81, position = 1st) said his cousin brother help him by solving his homework on the board in the house. Another pupil (Math score = 40, Position = 21st) relate that his friend normally follow his mathematics note to teach him at home. A pupil (Math score = 70, Position = 4th) whose brother usually assist in studying mathematics at home has this to say:

> Whenever I solved any exercise from my textbook, I always show him for corrections. Sometimes I do give him some mathematics questions from my workbook to solve for me.

A pupil (Math score = 68, Position = 9th) who is normally assisted by her brother explained how:

> Whenever I come back from school, he will collect my mathematics book, then he will repeat the class work on a piece of paper and ask me to re-solve it. Then later, he will do the correction for me.

Another pupil (Math score = 70, Position = 4th) explained that her uncle usually help her to solve mathematics questions that she was unable to solve. A pupil (Math score = 23, position = 30th) whose father normally assist in studying mathematics at home explained thus: "If I'm confused in any of the questions, I meet him and he explain details for me to understand".
In the same vein, a pupil (Math score = 52, Position= 12th) usually assisted by his sister, explained thus:

> She normally cross-check my notebook when I come home from school and ask me to repeat whatever my teacher taught me in the school.

When asked about strategies that could make them perform better in mathematics, the pupils pointed out extra home lessons, repeated practice, getting more mathematics textbooks and focusing more on what their teacher is teaching. One of the pupils (Math score = 44, position = 16th) who earlier replied "I don't have anybody at home to assist me", ended his interview with "If I have someone around me to be assisting me I will perform better".

Research Question Two

What is the relationship between home involvement and mathematics achievement of Low-achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.

Variables	No. of pairs	r	SE of r	Remarks
Home Involvement	34	0.017	0.0177	Weak positive correlation
Mathematics Achievement				

Table 6: Correlation between Home Involvement (PIQ scores) and Mathematics Achievement (Math scores) of Pupils in the Bottom Category

The results in Table 6 indicate that there is a weak positive relationship (r = 0.017) between home involvement and mathematics achievement of low-achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.

Research Question Three

What is the relationship between home involvement and mathematics achievement of high-achieving pupils at the middle Basic level in North Bank suburb of Makurdi, Nigeria?

Variables	No. of pairs	r	SE of r	Remarks
Home Involvement	39	0.174	0.162	Weak positive correlation
Mathematics Achievement				

Table 7: Correlation between Home Involvement (PIQ scores) and Mathematics Achievement (Math scores) of Pupils in the Top Category

The result in Table 7 show that there is a weak positive relationship (r = 0.174) between home involvement and mathematics achievement of high achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.

Research Hypothesis One

There is no significant difference between the level of home involvement in the mathematics education of low-achieving pupils and the level of home involvement in the mathematics education of high-achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.

Groups	N	Mean	SD	t.	t-critical	p-value
Low Achievers	34	2.731	0.293			
				0.113	1.9994	0.9102*
High Achievers	39	2.746	0.332			

** Not significant at α = 0.05*

Table 8: Unpaired t-test of Home Involvement (PIQ Scores) of Low and High Achieving Pupils

The results in Table 8 indicate that there is no significant difference between the level of home involvement in the mathematics education of low-achieving pupils and the level of home involvement in the mathematics education of high achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria. This is because the t-value 0.113 is less than the t-critical value, 1.994. Likewise, the p-value of 0.9102 is not significant at 0.05 level of significance.

Research Hypothesis Two

There is no significant relationship between home involvement and mathematics achievement of Low achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.

Variables	No of pairs	r	SE of r	p-value
Home Involvement	34	0.17	0.177	0.9241*
Mathematics Achievement				

** Not significant at α = 0.05*

Table 9: t-test of Correlation Coefficient between Home Involvement (PIQ scores) and Mathematics Achievement (Math Scores) of Pupils in the Bottom Category.

The results in Table 9 indicate that the p-value 0.9241 is not significant at 0.05 level of significance. Therefore, there is no significant relationship between home involvement and mathematics achievement of low-achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.

Research Hypothesis Three

There is no significant relationship between home involvement and mathematics achievement of High achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.

Variables	No of pairs	r	SE of r	p-value
Home Involvement	39	0.174	0.162	0.2884*
Mathematics Achievement				

** Not significant at α = 0.05*

Table 10: t-test of correlation coefficient between Home Involvement (PIQ scores) and Mathematics Achievement (Math scores) of Pupils in the Top Category

The results in Table 10 show that the *p*-value (0.2884) is not significant at 0.05 level of significance. Therefore, there is no significant relationship between home involvement and mathematics achievement of high-achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria.

Discussions

The outcome of this study reveals a systematic pattern of parents involvement in the mathematics education of their children, particularly at the Middle Basic level in North Bank suburb of Makurdi, Nigeria. Basically, the results in Table 3 and 4 affirm that parents and homes are adequately involved the mathematics education of Basic 5 pupils in the study area. This outcome supports the findings of Bicknell (2006). However, parents of pupils in both the high-achieving and low-achieving categories fare less in specific areas of supporting pupils who are having difficulties in school mathematics, taking their children to the public library and providing activities that encourage the development of their children's mathematics skills. Both categories of parents are not aware of the approaches used to teach mathematics in their children's school, suggesting a gap in the school-home relationship of pupil's mathematics education. These key findings reveal shortcomings on the part of the parents to turn everyday occurrences and household tasks into lessons that not only help pupils with their mathematical reasoning skills and sense of applied mathematics, but prepare them for adulthood (Kormanik, 2012). The observed gap in the school-home relationship with respect to the teaching and learning of mathematics may be due to schools and parents having a different understanding of what home involvement should look like. One of the best ways to structure this relationship is through involving parents in their children's home work and employing targeted parent involvement to solve a particular problem – such as poor attendance or behaviour at school (Dervarics & O'Brien, 2011). In this regard, Basic schools can subscribe to the under-listed responsibilities in creating a partnership that can have a significant impact on pupils' achievement. Basic schools should:

i. Recognize that all parents, regardless of income, education or cultural background, are involved in their children's learning and want their children to do well in mathematics;
ii. Survey parents and the schools' teachers to understand their perspective on parent involvement. Investigate how parents want to be involved and how teachers want parents to be involved.
iii. Work to create a common understanding of how parents could best support their child's mathematics education and how teachers could communicate with parents. This might be accomplished through discussions, flyers, meetings or other strategies.
iv. Identify barriers to achievement within schools. Can parents help address these challenges? If so, how?
v. Give teachers training on how to develop homework assignments that involve parents.
vi. Regularly involve parents in their child's homework and report on the results of doing so.

(Dervarics & O'Brien, 2011)

Considering the five key parental roles of parents of pupils in North Bank suburb, Table 5 indicates a low level of parents' involvement as mathematics resource provider for their wards. The cluster mean of 2.48 for parents of pupils in the Bottom category and the cluster mean of 2.47 for parents of pupils in the Top category both fall short of the benchmark mean of 2.50. this point to the fact that parents across all categories of mathematics learner at the Middle Basic level in North Bank suburb need to do more in making their homes conducive for learning mathematics. This entails making out time to take their children to the library and fostering a positive study culture at home. Parents can encourage their children's school work and providing books, mathematical equipment and a supportive home environment.

The extracts from pupils' responses to interview prompts from their mathematics teachers demonstrate that effective home engagement in the mathematics education of children gets the most out of their schooling. In line with the observations of Kwesi (2015), the pupils' responses reflect that parents, teachers and children consider mathematics as a hallmark of future success. These Basic 5 pupils could relate the importance of mathematics to their future career. Their responses revealed that home involvement in mathematics education is a collective affair in this part of the world, with members of the extended family, friends and neighbours playing vital roles. Such roles range from re-teaching class work at home to providing guidance for mathematics homework and exercises (Ulrychova, 2016).

This study also observed a weak positive relationship ($r = 0.017$) between home involvement and mathematics achievement of low achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria. A similar outcome ($r = 0.174$) was obtained for High achieving pupils at the Middle Basic level in North Bank suburb of Makurdi, Nigeria. However, it is noteworthy that although this similarity points to a unique characteristic of homes in the suburb (Jimenez Bandala & Andrade, 2017; Husak & Hudeckova, 2017; and Petr Safrankova & Zaptopkova, 2017), the relationship is comparatively stronger for high achieving pupils. This finding is in tandem with the outcome of the work of Jackson and Remillard (2005) who observed that challenges in home involvement are due in part to the stereotypes held by schools in low income suburbs. The existing dynamics of homes in slum communities of Makurdi, such as the North Bank suburb, implies that home support in mathematics education of pupils is at best haphazard (Agada, 2017). The non-significance of the difference between the level of home involvement in the mathematics education of pupils across both low and high achieving categories points to homogeneity in home support practices in North Bank suburb. Similar outcomes shown in Table 9 and 10, lend more weight to this line of thought and support the view of Rockliffe (2001) that some parents as a homogenous group, generally lack confidence and expertise in harnessing the mathematics potentials of their children.

Conclusion

This study has attempted to verify the relationship between home involvement and mathematics achievement of pupils across both low and high achieving pupil – categories in North Bank suburb of Makurdi, Benue State, Nigeria. The survey of 73 Basic 5 pupils along with their parents across three (3) Middle Basic Schools in North Bank suburb establishes a weak positive relationship between home involvement and mathematics achievement that is homogenous to both achievement categories. Further interaction with the pupils reveals that apart from parents, other members of the extended family, friends and neigbours play vital roles in the mathematics education of children. The study also revealed that among the five key parental roles, parents of pupils in North Bank suburb have shortcomings as mathematics resources providers. This implies that they often default in providing a nice learning environment at home for their children to study mathematics. These homes lack variety of games, puzzles and activities that encourage the development of children's mathematics skills. They also failed in buying mathematics related books for the children and in taking their wards to the library.

Based on the findings of this study, the local School Home Partnership for Mathematics Education (SHPME) project intend to strategize with local schools in the North Bank suburb to develop an intervention programme for pupils already identified as seriously in need of home support. These efforts will be targeted at repositioning Basic schools in the study area to develop a working relationship with homes for the benefit of the children. Future studies in the course of this researcher-sponsored intervention will consider the viability of various approaches for educating both schools and homes on the mathematics education of children.

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RELATIONS BETWEEN SCIENTIFIC REASONING, CULTURE OF PROBLEM SOLVING AND PUPIL´S SCHOOL PERFORMANCE

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Highlights

- *The ability to use the existing knowledge correlates strongly to the three dimensions of Scientific reasoning (proportional reasoning, control of variables and probability reasoning)*
- *It wasn't proved any correlation between the creativity and the dimensions of Scientific reasoning*
- *Individual components of the Culture of problem solving and individual dimensions of Scientific reasoning largely do not correlate with school performance either in mathematics or in physics*

Abstract

The article reports the results of a study, the main aim of which was to find out correlations among the three components of the Culture of problem solving (reading comprehension, creativity and ability to use the existing knowledge) and six dimensions of Scientific reasoning (conservation of matter and volume, proportional reasoning, control of variables, probability reasoning, correlation reasoning and hypothetical-deductive reasoning). Further, we present the correlations among individual components of the Culture of problem solving and individual dimensions of Scientific reasoning with pupils' school performance in mathematics and physics. We conducted our survey among 23 pupils aged between 14–15 years in the Ústí nad Labem Region. The results have shown that one component of the Culture of problem solving – the ability to use the existing knowledge – strongly correlates with three dimensions of the Scientific reasoning structure: proportional reasoning, control of variables and probability reasoning. However, no correlation was proved between the creativity and the dimensions of Scientific reasoning. We have found out also that the indicators of the Culture of problem solving and the Scientific reasoning largely do not correlate with school performance either in mathematics or in physics.

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Introduction

The paper is one of the outcomes of the research project concerning with developing culture of solving problems in school mathematics. It deals with mutual relations between the Culture of problem solving (CPS) and Scientific reasoning (SR). The paper is an extension of the contribution (Eisenmann et al., 2017), which was presented at the conference ERIE 2017. This article reports more detailed the results of a study, the aim of which was to find out correlations among the three components of the Culture of problem solving (reading comprehension, creativity and ability to use the existing knowledge) and six dimensions of Scientific reasoning (conservation of matter and volume, proportional reasoning, control of variables, probability reasoning, correlation reasoning and hypothetical-deductive reasoning).

The constructs CPS and SR aim at assessment of pupils' abilities to solve problems, which we believe are significantly developed in mathematics and physics. Therefore we explore also correlations among pupil's school performance in these subjects and both constructs that we present also in this paper. In the section Results and discussion (see Tables 1, 2, 3, 4 and 5) we bring out the description of correlations among all pairs of examined components of CPS and dimensions of SR and report also correlations of these indicators of CPS and SR with school performance in mathematics and physics. In more detail we comment possible reasons of stronger or weaker relations among them.

The Culture of problem solving

In our research, we have been engaged in the area of problem solving for a long time (Novotná et al., 2014; Novotná, Eisenmann and Přibyl, 2015). In order to be able to describe a pupil's ability to solve mathematical problems, we have introduced the so-called Culture of problem solving construct within the research mentioned above. The phrase 'culture of problem solving' can be found in several pieces of work (e.g. Clarke, Goos and Morony; 2007; Reiss and Törner, 2007), where the word culture is not strictly defined and can be understood as a more cultivated approach to the studied phenomenon. Such authors as Clarke, Goos and Morony (2007) link the word culture to the word inquiry – culture of inquiry. When forming the phrase CPS, the word culture was understood from us as a system of various meanings, activities and patterns of behaviour that can be met with in problem solving at schools.

When composing the components of the structure, we drew on previous works (e.g. Herl et al., 1999; Schoenfeld, 1982; Szetela, 1987; Szetela and Nicol, 1992, Wu and Adams, 2006), among which the work of Wu and Adams (2006) was the most relevant. Their problem-solving profile, conceived as a tool for changing a pupil's ability to solve problems, focuses on two components of the structure we developed: Reading/Extracting all information from the question and Mathematics concepts, mathematization and reasoning.

The composition of CPS is described in detail in (Eisenmann et al., 2015). This structure consists of four components: intelligence, reading comprehension, creativity and ability to use the existing knowledge.

There are no doubts about the indispensability of including *intelligence* (I) in the structure of CPS. As Wenke, Frensch and Funke (2005) state, from the inception of the concept of 'intelligence', the ability to solve problems has featured prominently in virtually every definition of human intelligence. In addition, intelligence has often been viewed as one of the best predictors of the problem-solving ability.

The second component is *reading comprehension* (RC). Obviously, this is one of the key competences without which successful problem solving would be impossible, as pointed out by a number of authors (Pape, 2004; Schoenfeld, 1992) and verified by Hite (2009). The inclusion of this component is based on Pólya's four stages of solving a problem (Pólya, 2004). The first stage is understanding the problem. The basis of solving any problem is to understand its structure connected with the ability to read the assignment of the problem with comprehension. This means that having read the assignment, the solver is able to grasp the relations in the problem, identify the initial and output variables of the problem and handle the input data in an appropriate way.

The third component is *creativity* (C). The key role of creativity in problem solving is discussed by Bahar and Maker (2011) or Sriraman (2005). Nadjafikhah, Yaftian and Bakhshalizadeh (2012) speak of creative problem solving. "At the school level, creativity in mathematics is generally related to problem solving and or problem posing." (Nadjafikhah, Yaftian and Bakhshalizadeh, 2012: 290). Chamberlin and Moon (2005: 38) state that "Creativity refers to the domain-specific thinking processes used by mathematicians when engaged in non-routine problem solving."

The fourth component is the *ability to use the existing knowledge* (UK). This ability has been considered as a prerequisite to successful solving of non-routine problems. Whilst solving such kinds of problems, the knowledge itself is not sufficient; the solver must also be able to use it.

With respect to an individual pupil, we find the use of CPS in teaching important in three areas.

1. Knowing pupil's CPS may help the teacher select appropriate problems the pupil will be able to solve successfully.
2. It may help eliminate a pupil's weaknesses that may be an obstacle to solving problems.
3. Knowing pupil's CPS may help the teacher decide which heuristic strategies should be used and in being aware of the depth in which these strategies can be handed over to the pupil.

Scientific reasoning

Research on scientific reasoning has its roots in the early studies on cognitive development of 'formal reasoning' (Inhelder and Piaget, 1958; Piaget, 1965) and 'critical thinking' (Hawkins and Pea, 1987). What exactly constitutes scientific reasoning is complex issue, therefore there are many definitions of scientific reasoning. Lawson (1982, 2005) suggests that scientific reasoning has a structure that follows from hypothetic-deductive nature of science that includes such aspects as proportional reasoning, control of variables, probability reasoning, correlation reasoning and process of drawing inferences from initial premises, which is linked with inductive and deductive reasoning. Scientific reasoning involves application of the methods of scientific inquiry to reasoning or problem-solving situations, for example systematically exploring a problem, formulating and testing hypotheses and evaluating experimental outcomes. According Opitz, Heene and Fischer (2017: 81), the differences between conceptualizations of scientific reasoning that exist are in:

1. the skills they include,
2. if there is a general, uniform scientific reasoning ability or rather more differentiated dimensions of scientific reasoning, and
3. if they assume scientific reasoning to be domain general or domain specific.

With regard to our research, in the next text we will aim specifically at measuring of scientific reasoning and therefore we will deal with the operational definition of scientific reasoning. It includes the necessary skills that support scientific inquiry such as control of variables, hypothetical-deductive reasoning, causal and correlational reasoning, proportions and ratios deductive and inductive reasoning, and probabilistic reasoning (Han, 2013). This is not a complete list because scientific reasoning is multifaceted and other skills could be included but these ones are commonly agreed-upon skills that are needed for students to conduct scientific inquiry.

For assessment of scientific reasoning the following dimensions can be used (Han, 2013):

- Control of Variables
- Proportions and Ratios
- Probability
- Correlational Reasoning
- Deductive Reasoning
- Inductive reasoning
- Causal Reasoning
- Hypothetical-Deductive Reasoning

In our study we used the Lawson Classroom Test of Scientific Reasoning (LCTSR) (Lawson, 1978) that was designed to examine six dimensions including conservation of matter and volume, proportional reasoning, control of variables, probability reasoning, correlation reasoning and hypothetical-deductive reasoning. These skills are important components of the broadly defined scientific reasoning ability. In our study we restrict only to these chosen dimensions and scientific reasoning we define operationally in terms of students' ability in handling questions of these six skill dimensions.

Scientific inquiry is considered the core component of STEM education (Science, Technology, Engineering and Math), therefore the scientific reasoning skills are emphasized in science education. The development of these skills, however, cannot be separated from prior knowledge and the learning of content because of their tightly linking, how research have shown for example in physics education (Coletta and Phillips, 2005). Childrens' reasoning skills are interesting not only for researchers but also for teachers who can determine the best methods for improving learning and instruction in science education (Zimmerman, 2007). Some research (e.g. Papáček, 2010) shown that particularly inquiry-based science instruction can promote scientific reasoning abilities. However, creative thinking and inquiry learning can be promoted in any classroom, not only in science.

The relation between CPS and SR

Much research has been carried out to find out how scientific reasoning relates to other areas of learning. For example Shayer and Adey (1993) argue that instruction in scientific reasoning has a permanent impact on general learning ability. They carried out a study comparing students who received scientific reasoning-based teaching with those who did not. They showed that the reasoning-based group (at age of 16) outperformed the control group on tests not only in Science but also in English and Mathematics.

The P21 (Partnership for 21st Century Skills – a group of corporations who partnered with the U.S. Department of Education in 2002) has created a framework that identifies the key skills for success, the so called '21st Century skills'. These include, among others, creativity, critical thinking and problem solving. Scientific reasoning skills are good tools for the purpose of the development of these key skills. As CPS includes reading comprehension and creativity in its structure, we suppose that a relation exists between CPS and SR and this is the point we wish to focus on in our contribution.

Objectives

We endeavour to find potential correlations between individual CPS components and SR dimensions by means of appropriate research with pupils. This contribution describes the first pilot research the aim of which, in particular, is to formulate first hypotheses concerning correlations between individual CPS components and SR dimensions. As it is possible to expect, with high probability, that intelligence (the first CPS component) has a relation to all above-mentioned SR dimensions, we have narrowed our pilot research to the testing of the three remaining CPS components. The secondary task of the pilot research is to carry out the mapping of any possible relations between individual SR dimensions. We explore also correlations among pupil's school performance in mathematics and physics and both constructs that we present in this paper.

Materials and methods

The following subsections focus on the art of measuring both the constructs and the description of the sample.

Culture of problem solving

As far as RC is concerned, the pupils were set a short text of 15 lines. Afterwards, their task was to answer correctly 9 questions (from 4-item multiple-choice possibilities they were selecting one correct answer). The aggregate of all points has formed the total score. The test is built on the same principle as the one used in the PISA research.

In our study*, C* was understood in the context of divergent thinking. In accordance with Sternberg (2005), we do not perceive creativity as a single attribute but a set of attributes, and with respect to the study we selected a set of strategies to focus on. The creativity level was measured by Guilford's Alternative Uses Test, which measures the following four dimensions:

- Fluency – how many relevant uses the pupil proposes;
- Originality – how unusual these uses are;
- Flexibility – how many areas the answers refer to;
- Elaboration – quality and number of details in the answer.

The pupils proposed as many 'uses of common objects' as possible. What is important here is how logical and practicable the answers were. Qualitative evaluation of each dimension was translated into points and the total score indicating an index of creativity. The higher the index, the more creative the pupil is assessed to be.

The pupils' UK was assessed on the basis of a set of problems developed by the research team. Dyads of problems were used for this written testing – the first problem to find out whether a pupil has a particular piece of knowledge and the other to find out whether the pupil can use or apply it. The more frequent is the situation in which the pupil has the required knowledge and can use it at the same time (i.e. both the tasks of the given dyad are solved correctly), the higher is the score he will achieve in the area of this component.

Example of a dyad:

a) Solve the equation: $6x + 4x + 2x = 18$

b) There are three vessels of water. Each of them has a different volume and in total they contain 19.5 litres of water. The largest vessel contains twice as much water as the medium one and the medium vessel contains four times more water than the smallest one. How many litres of water are in each of the vessels?

All three above-named CPS components have been tested during the course of a single 45-minute teaching unit. The section of the test focused on RC lasted 14 minutes, C section was expected to be completed in 7 minutes, and the third section, which concentrated on UK lasted 14 minutes as well. All tested pupils were working independently, they were not allowed to use either calculators or any other technological devices. All parts of the test were then evaluated by the authors of the contribution themselves.

Scientific reasoning

Scientific reasoning was tested by LCTSR (Lawson, 1978) which has gained the largest popularity among researchers and teachers. Since its initial development, the test has undergone several revisions. We used the Czech version (Dvořáková, 2016) of the current version of LCTSR released in 2000 and according to Han (2013) we carried out small corrections in items 8a and 8b.

LCTSR is a 24-item, two-tier test which involve a series of multiple-choice questions. Each of the two-tier items (from the total number of 12 pairs) consists of a question with some possible answers followed by a second question giving possible reasons for the response to the first question. The reasoning options are often based on student misconceptions that were discovered via free response tests and interviews (Driver et al., 2003; Stepans, 2003).

LCTSR assesses students' reasoning abilities in six dimensions including conservation of matter (items 1, 2) and volume (CONSER) (items 3, 4), proportional reasoning (PROPOR) (items 5, 6, 7, 8), control of variables (VARIABL) (items 9, 10, 1, 12, 13, 14), probability reasoning (PROBAB) (items 15, 16, 17, 18), correlation reasoning (CORREL) (items 19, 20) and hypothetical-deductive reasoning (HYPDED) (items 21, 22, 23, 24).

The items have an increasing difficulty. With regard to the evaluation of the test, for tasks 1 through to 22 the points are awarded only when both the related tasks are resolved correctly. Only tasks 23 and 24 are independent and for that reason they are also evaluated independently.

Example of the two-tier item (9 and 10)

9. At the right are drawings (see Figure 1) of three strings hanging from a bar. The three strings have metal weights attached to their ends. String 1 and String 3 are the same length. String 2 is shorter. A 10 unit weight is attached to the end of String 1. A 10 unit weight is also attached to the end of String 2. A 5 unit weight is attached to the end String 3. The strings (and attached weights) can be swung back and forth and the time it takes to make a swing can be timed.

Suppose you want to find out whether the length of the string has an effect on the time it takes to swing back and forth. Which strings would you use to find out?

a. only one string
b. all three strings
c. 2 and 3

d. 1 and 3
e. 1 and 2

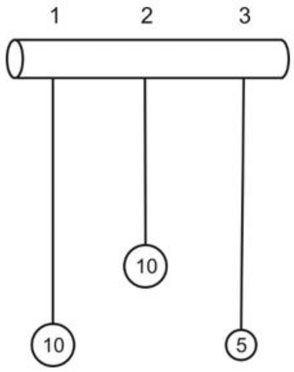

Figure 1: Picture from the item 9 (source: Dvořáková, 2016)

10. because
   a. you must use the longest strings.
   b. you must compare strings with both light and heavy weights.
   c. only the lenghts differ.
   d. to make all possible comparisons.
   e. the weights differ.

In our study we aimed at the ninth grade of primary school because Han (2013) found out that LCTSR worked well just with 9th graders. The pupils were solving the task during one teaching unit. At first they were briefly instructed by their teacher and then they received approx. 30 minutes for the solution of the test. They worked independently and were not allowed to use either calculators or tables. The test was evaluated by the authors of this paper.

Sample

Altogether 23 pupils (12 girls and 11 boys) from one class of the ninth grade aged between 14–15, from one primary school in Teplice took part in our pilot study. Describing the pupils' school performance, they can be characterized as common learners, representing above average class in the Czech Republic. Such evaluation has been backed up by two sources: the grade in mathematics and physics in the 2015/2016 school report and the evaluation of their mathematics and physics teacher. The arithmetic mean of the grade achieved in mathematics is 2.0 with standard deviation of 0.52, in physics 2.1 with standard deviation of 0.54.

Statistical evaluation

On account of type variables we used Spearman's rank correlation coefficients to measure the strength of relationship between two variables. The calculation was realized by STATISTICA 12.0 (StatSoft, Inc.).

Results and discussion

At first we explored correlations between RC, C and UK components of CPS. The results can be seen in Table 1.

Pairs of components	N	Spearman *R*	R^2	*p*-level
RC & UK	20	0.0917	0.0084	0.7003
RC & C	20	0.3324	0.1105	0.1520
UK & C	19	– 0.2472	0.0611	0.3074

Table 1: Spearman correlation coefficients for components of CPS construct (source: own calculation)

With none of the pairs it is possible to reject a null hypothesis that correlation coefficient is zero at the 5% level of significance. The components RC, C and UK are independent. It is surprising that the correlation coefficient between RC and C is positive, whereas between UK and C is negative.

Similarly the correlations between dimensions of SR were explored. The results can be seen in Table 2. Marked correlations are significant at $p < 0.05000$ (bold types in the table).

Pairs of dimensions	N	Spearman *R*	R^2	*p*-level
CONSER & PROPOR	**18**	**0.6509**	**0.4237**	**0.0034**
CONSER & VARIABL	18	0.4086	0.1670	0.0921
CONSER & PROBABL	**18**	**0.5135**	**0.2636**	**0.0292**
CONSER & CORREL	18	– 0.0627	0.0039	0.8045
CONSER & HYPDED	18	0.2970	0.0882	0.2313
PROPOR & VARIABL	**18**	**0.6165**	**0.3801**	**0.0064**
PROPOR & PROBABL	**18**	**0.5426**	**0.2944**	**0.0199**
PROPOR & CORREL	18	0.0119	0.0001	0.9625
PROPOR & HYPDED	18	0.3935	0.1548	0.1061
VARIABL & PROBABL	**18**	**0.5044**	**0.2544**	**0.0327**
VARIABL & CORREL	18	0.3195	0.1020	0.1962
VARIABL & HYPDED	18	0.0890	0.0079	0.7253
PROBABL & CORREL	18	0.2845	0.0809	0.2524
PROBABL & HYPDED	18	0.0433	0.0018	0.8644
CORREL & HYPDED	18	– 0.0112	0.0001	0.9646

Table 2: Spearman correlation coefficients for dimensions of SR (source: own calculation)

Although the sample size is not so extent, we find five pairs of strongly correlated dimensions, in which we can reject the null hypothesis at the 5% level of significance (bold types in the table). Therefore, four dimensions correlate together (CONSER, PROPOR, VARIABL a PROBAB), with the remaining two dimensions (CORREL a HYPDED) no correlation with any further dimension has been revealed.

The main target of our research, however, was to investigate correlations between the SR dimensions and the CPS components. The results can be seen in Table 3.

Pairs of dimensions	N	Spearman *R*	R^2	*p*-level
RC & CONSER	16	0.2222	0.0493	0.4081
RC & PROPOR	16	0.2505	0.0627	0.3492
RC & VARIABL	16	0.4497	0.2022	0.0804
RC & PROBABL	16	0.2139	0.0457	0.4261
RC & CORREL	16	– 0.0139	0.0001	0.9592
RC & HYPDED	16	– 0.4837	0.2340	0.0576
UK & CONSER	15	0.4735	0.2242	0.0745
UK & PROPOR	**15**	**0.8142**	**0.6630**	**0.0002**
UK & VARIABL	**15**	**0.5741**	**0.3296**	**0.0251**
UK & PROBABL	**15**	**0.5413**	**0.293**	**0.0371**
UK & CORREL	15	– 0.1572	0.0247	0.5757
UK & HYPDED	15	0.2048	0.0419	0.4640
C & CONSER	15	0.3527	0.1244	0.1971
C & PROPOR	15	0.1311	0.0171	0.6413
C & VARIABL	15	0.0271	0.0007	0.9233
C & PROBABL	15	0.0611	0.0037	0.8287
C & CORREL	15	0.2050	0.0420	0.4633
C & HYPDED	15	0.1395	0.0194	0.6199

Table 3: Spearman correlation coefficients for components of CPS construct and dimensions of SR (source: own calculation)

Three strongly correlating pairs can be observed here, where we reject the null hypothesis at the 5% level of significance (bold types in the table). With the UK component of CPS three dimensions of SR correlate like this – PROPOR, VARIABL a PROBAB. In addition, three other pairs have been found which correlate in a weaker manner; here the null hypothesis can be rejected at the 10% level of significance.

The correlation coefficients show that there is a narrow relationship between the first four dimensions of SR (excluding CONSER and VARIABL). The understanding of the conservation of mass

and volume (CONSER) and proportional reasoning (PROPOR) are basic skills that children usually develop at a fairly young age. The abilities of the control of variables (VARIABL) and understanding probability (PROBAB) start to develop more significantly at the end of primary school and the process continues throughout the first years of secondary school (Han, 2013). Individual dimensions of SR are not independent, but they create a hierarchy, which means that the successful solution of tasks from the higher dimension supposes the mastering of tasks from the lower dimensions. Based on the discovery of strong correlations between the first four dimensions, we assume that their good mastering creates the necessary background for the successful development of reasoning skills in the area of higher dimensions for this age category (at the end of primary school).
In our research we have noticed only weak correlations between CORREL and the previous four dimensions, which are not, however, statistically significant. This finding could be connected with the fact that only a one pair-item is devoted to this dimension; thus pupils can get either two points or no point at all.
The hypothetical-deductive reasoning (HYPDED) is the most complicated ability in the LCTSR, which represents the last stage of formal reasoning. This dimension is developed in particular during the students' stay at secondary school. Among the pupils of the ninth grade, its level is still very low and for that reason we did not come across a narrower correlation with other dimensions in our research.
As mentioned above, the first four dimensions of SR (CONSER, PROPOR, VARIABL, PROBAB) correlate together (with the majority of pairs correlating in a very strong way) and they therefore create the necessary background for the development of other, higher dimensions. In our research we have also found out that three of the dimensions (PROPOR, VARIABL a PROBAB) at the same time strongly correlate with UK (with UK also correlating slightly with the lowest dimension CONSER). On the basis of these findings we assume that the mastering of UK among students at the end of primary school is tightly linked with the development of more general skills at the level of the first four dimensions. We therefore think that dimensions PROPOR, VARIABL, PROBAB and component UK are important for the further development of learners in the STEM area.
Similarly, also foreign research points to the necessity to develop not only content understanding, but also scientific reasoning (Bao et. al., 2009). Positive correlations between student scientific reasoning abilities and measures of students' gains in learning science content have been reported also by Coletta and Phillips (2005). These findings support the consensus of the science education community on the need for students to develop an adequate level of scientific reasoning skills together with a solid foundation of content knowledge.
With regard to the weekly correlating pairs, our research suggests the link between RC and VARIABL. This fact can be explained by the dimension's being represented in the test by the biggest number of tasks (altogether 6) that belong to the most demanding ones in terms of reader's comprehension (the texts of these tasks were relatively extensive and demanded understanding of more complex texts).
A negative correlation appeared between RC and HYPDED. The tasks from the area of HYPDED are the most difficult ones and in addition to that quite demanding in terms of RC. The results of our research suggest that the better the reading skills pupils have, the lower level they achieve in the area of HYPDED. This may point to the fact that children have a quite well developed reading comprehension at the monitored age, but in the area of HYPDED the level is quite low.
No stronger relationship has appeared between C from CPS and SR dimensions, which is a considerably surprising finding rather than what we would expect here.
We can observe all the above-mentioned relations between the SR dimensions and the CPS components well-arranged in Figure 2. The arrows suggest relations between observed dimensions and components that correlate at the 5% level of significance.

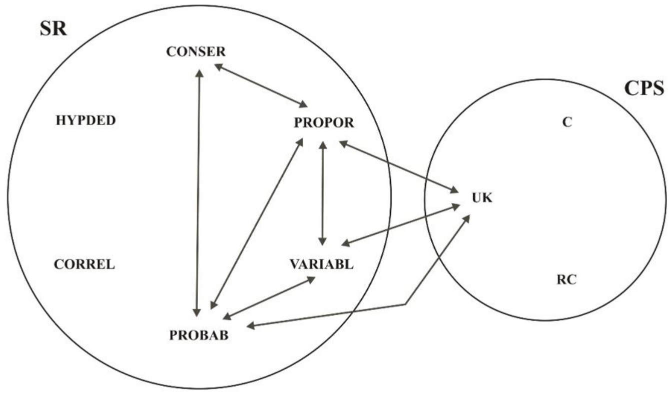

Figure 2: The scheme showing relations between SR dimensions and CPS components (source: own drawing)

Finally we explore how do individual components of CPS and individual dimensions of SR correlate with pupils' school performance in mathematics and physics. These subjects were selected for the study as they are the subjects in which abilities included in CPS and SR are significantly developed. On the basis previously conducted research (Shayer and Adey, 1993) we expected that some correlations would show.
In the Czech Republic, lower secondary school pupils are evaluated by grades 1 to 5 on a school report. Grade 1 corresponds to the best performance, 5 describes insufficient performance, failure. In Table 4 we present relative frequency of grades 1 to 5 in mathematics and physics in the studied sample of pupils.

Grade	Math	Physics
	Rel. freq. (%)	Rel. freq. (%)
1	13.04	8.70
2	73.92	69.57
3	13.04	21.74
4	0	0
5	0	0

Table 4: Relative frequency of grades 1 to 5 in mathematics and physics (source: own calculation)

Table 4 shows that pupils' school grades in physics are worse than in mathematics. However, there is no pupil having grade 4 or grade 5.
The correlations between the components of CPS, the dimensions of SR and pupils' school performance in mathematics and physics are presented in Table 5.
Mostly negative correlation coefficients in Table 5, that are, however, in most cases below the level of significance, suggest the indirect nature of the investigated dependences, that is the better the pupil performs in CPS, respectively in SR, the lower (i.e. better) grade he gains. Only grades in physics significantly correlate with the component C of CPS and the dimension CONSER of SR (bold types in the table 5). These results were quite surprising for us. That is why we investigated the correlation between the grades from mathematics and physics, where we would expect a stronger dependence quite rightly, as these two subjects are closely related to their focus and content.

However, even in this case only a very weak, statistically insignificant, correlation was shown. We believe that this fact is related to the size of the research sample and it should therefore be the subject of further research with a substantially a larger set of pupils.

Pair of Variables	N	Spearman R	R^2	p-level
MATH & RC	21	0.1092	0.0119	0.6376
MATH & UK	20	– 0.0032	0.0000	0.9893
MATH & C	20	0.0298	0.0009	0.9007
PHYS & RC	21	– 0.3791	0.1437	0.09013
PHYS & UK	20	– 0.0392	0.0015	0.8696
PHYS & C	**20**	**– 0.5243**	**0.2749**	**0.0176**
MATH & CONSER	18	– 0.2249	0.0506	0.3695
MATH & PROPOR	18	– 0.4020	0.1616	0.0982
MATH & VARIABL	18	– 0.1443	0.0208	0.5677
MATH & PROBABL	18	– 0.1956	0.0383	0.4366
MATH & CORREL	18	0.0000	0.0000	1.0000
MATH & HYPDED	18	– 0.0712	0.0051	0.7789
PHYS & CONSER	**18**	**– 0.6035**	**0.3642**	**0.0080**
PHYS & PROPOR	18	– 0.2495	0.0622	0.3181
PHYS & VARIABL	18	– 0.4095	0.1677	0.0915
PHYS & PROBABL	18	– 0.3159	0.0998	0.2016
PHYS & CORREL	18	– 0.4140	0.1714	0.0876
PHYS & HYPDED	18	0.0233	0.0005	0.9269

Table 5: Spearman correlation coefficients for the components of CPS, the SR dimensions and pupils' school performances (source: own calculation)

Conclusion

The results given in the previous chapter prove the legitimacy of the idea of exploring mutual relations between individual components of CPS and SR indicators and indicated the limits of our study, especially with respect to the investigation of dependence between individual CPS and SR indicators and pupil´s school performance in mathematics and physics. In the sufficiently wide research ($N = 200$) we will try to verify whether one of the components of CPS, the ability to use the existing knowledge, really correlates so strongly to the three dimensions of SR – proportional reasoning, control of variables and probability reasoning, as it has been shown by the pilot study described in this paper. The aim of the subsequent research will be to verify the influence intelligence as the fourth component of CPS on individual dimensions of SR and in addition to that to confirm or disconfirm a relatively surprising result of the pilot research that creativity does not correlate with SR dimensions. Among the subjects that we will take as a basis for the assessment of pupil' school performance we will include another key subject, namely mother tongue (Czech). On a sufficient larger research sample we want to verify again the dependence or the independence of individual components of CPS and individual dimensions of SR with pupil´s school performance in mathematics and physics. By means of demonstrating relations between both the constructs a path might be opened for teaching practice. It might show how to enable teachers to remove obstacles in pupils' problem solving more effectively, in particular with respect to courses in mathematics and physics.

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