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The Tendency and Preferred Purposes of Use of Technology by Boys and Girls, and the Production of a Successful Product in an Experimental Inquiry-based Learning Setting with the Use of Digital Technologies

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ABSTRACT

Although there is discussion of gender equality in science and experimental tasks, it might be different in a non-traditional learning environment, such in an inquiry-based learning arrangement. It's structure of this teaching method differs from a traditional lesson in that they are perceived as more flexible and have a product as an outcome. The influence of gender, children's preference in using, and the level of use of digital technology on the outcome will to be analysed in this alternative learning arrangement. 101 primary school children were taught in an inquiry-based learning setting using digital tools to solve an architectural problem. During the experimental phase, the created product was tested in an experiment. The question is whether gender, pupil's general purpose in using and frequency of technology has an impact on this lesson's outcome. There was no significant correlation between gender and a successful outcome, but there was a correlation between frequent use of digital tools and a successful achievement in the lesson. There was no significant relationship between gender and the different uses to which technology was put, nor between pupils' purpose in using it and a successful final outcome in the experiment in an inquiry learning setting. This means that inquiry-based learning, even in a science-based lesson, is suitable for boys and girls equally and frequent use of technology is linked to improved student achievement.

Keywords: gender studies, media in education, elementary education, improving classroom teaching, teaching strategies

INTRODUCTION

The memorandum of the European Commission (2000) focuses on ICT-based facilities, using technology, foreign languages, business and social competencies in order to achieve lifelong learning among the community. It needs to be analysed whether the first key skill, namely using digital technology contributes to achieving this declared aim in explorative learning arrangements such as inquiry-based learning, as measured by the pupil's outcome at school. Girls' and boys' benefit from the advantages of digital technology may not be equal, a technology gender gap has been observed by Graham, Fuertes, Egdell and Raeside (2016, p. 2). The same conclusions can be found worldwide, according to the International Telecommunications Union or ITU (2016, p. 2), the global internet user gender gap grew from 11% in 2013 to 12% in 2016. This inequality can

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also be found among students, where ICT has the highest mean difference in A-level results for each gender of all 35 subjects (Department for Education and Skills, 2007, p. 42). Therefore, the UNCTAD (2014) called the empowerment of women as entrepreneurs and for more equality in ICT related areas. As there has been an ongoing debate regarding girls' and boys' different use of digital technology in terms of both purpose and frequency of use, it is important to consider the effects of this on the student's learning achievement in this paper. The lesson used for this analysis is based around a scientific experiment, gathering knowledge about gravity, stability and structure in school. It has been discussed for many years whether gender also plays a part in science results. OECD (2018, p. 2) noticed that boys and girls are not equally likely to plan a career that involves science, although they would have the capacity and skills to do so. As a result of these conclusions institutions, such as the WISE campaign (2017), have tried to attract more women to choose scientific studies over others at university. Despite, these discussions, conferences and campaigns for equality found that among eight-graders in the US males continued to outperform females in the International Mathematics and Science Study (TIMSS) in 2007, which was also the case in 2003, 1999 and 1995 (Gonzales, Williams, Jocelyn, Roey, Kastberg & Brenwald, 2009). Although gender differences in science performance tend to be small and show the least difference of all measured means in the PISA in OECD (2018, p. 5) study, it is still the case that in 33 OECD countries boys are more likely to be top performers than girls. These and other challenges are faced by educators in preparing pupils for learning and living in the dynamic information environment of today. At the core of what teaching needs to deliver is a knowledge of how to learn from a variety of sources of information. Schools must give children opportunities to practise this in every subject in the curriculum. In order to see the connection between what they are learning in school and the world outside, they need to develop research competencies and cooperative learning strategies. Pupils should be prepared to make reasonable decisions, develop expertise and learn throughout their lives in the complex information society. These fundamental challenges for educators made them turn to inquiry in subjects across the curriculum. Inquiry that is created by the teacher and the pupils enables the latter to gain deep understanding of a specific topic through a wide range of resources. This process which changes the culture of a school into that of a collaborative research community is called inquiry-based learning (Kuhlthau, Maniotes & Caspari, 2015, p. 3). Its structure is completely different to traditional learning setting, where memorisation, oral recitiation and task-based learning is more important than learning by discovery or project work (Beck, 2009). The influence of gender on the use of digital tools has not been analysed wildly enough in alternative learning settings, such as inquiry-based learning arrangements. On one hand, due to its open structure it increased girls' performance in mathematics compared to that of boys' (Cooper, Karen & Biggs, 2015). On the other hand, a research investigation carried out by Lamoureux, Beheshi, Cole, Abuhimed, and AlGhamdi (2014, p. 4) showed that while seeking information during inquiry-based learning in history teenage girls' responses were described as less accurate than those of teenage boys. Nevertheless, Laursen, Hassi, Kogan, and Weston (2014) found this research-based learning, which usually favours males, to be equally suitable for both sexes, in particular for females' learning results. In school life, there are so many factors involved that an answer to this question cannot be predicted for children of primary school age.

There are also many other variables that influence pupils' successful learning outcome. As mentioned before, gender, the frequency of use of technology and its different kinds of preferred uses were chosen as independent variables in this paper. Their influence in an inquiry-based learning setting with digital technology on pupil's learning achievement will be analysed in detail. Therefore, the research questions are:

RQ1: Is there a correlation between pupils' gender and the production of a successful final outcome in the experiment in an inquiry learning setting with digital technologies?

RQ2: Is there a correlation between pupils' frequency of use of digital tools and producing a successful final outcome in the experiment in an inquiry-based learning setting with digital technologies?

RQ3: Is there a relation between pupils' gender and the different purposes for which they are using technology in general?

RQ4: Is there a relation between pupils' different preferences of purposes to which they put technology in general and using digital technology to produce a successful final outcome in the experiment in an inquiry learning setting?

The aim of this research project is to find this aforementioned gender gap regarding the successful pupil's outcome in an inquiry-based learning setting using digital resources during the process. Furthermore, it needs to be investigated whether the general use of digital tools or how they are using these tools influences the outcome of a successful product at the end of the treatment session. Whether the preferred purpose of using digital technology differs between boys and girls also needs to be analysed for this reason. After computing correlations between these variables, it will be clear if there is a gender gap in inquiry-based learning sessions using digital technology in a science-based lesson in primary school. The importance of online resources in schools and how this is influenced by gender will be discussed, along with whether inquiry-based lessons in combination with digital technology opens or closes the gender gap in science.

THEORY

The influence of gender in a science-based lesson and its successful learning outcome in an alternative learning environment called inquiry-based learning has not been analysed at all in primary school and this is the aim of this research.

Inquiry-based Learning in Primary Schools

The OECD (2018) states that inquiry-based learning is a combination of project-based learning and experimental learning, where students work independently in groups, pose questions, observe, draw conclusions and describe the outcome to others. PISA's preface sounds like a description of inquiry-based learning:

"More important, science is not only the domain of scientists. In the context of massive information flows and rapid change, everyone now needs to be able to 'think like a scientist': to be able to weigh evidence and come to a conclusion; to understand that scientific 'truth' may change over time, as new discoveries are made, and as humans develop a greater understanding of natural forces and of technology's capacities and limitations" (OECD, 2018, p. 2).

Unlike in traditional education, inquiry-based learning puts the student in the centre and both the teacher and the student are equal discussion partners. Ross (2003, p. 1) stated that "in the Socratic method, the classroom experience is a shared dialogue between teacher and students in which both are responsible for pushing the dialogue forward through questioning". The National Research Council (1996, p. 121) developed the National Science Education Standards that represent the consensus of the science education community and research on the role of inquiry-based learning in science. They propose that pupils in K-12 science classrooms develop the underlying process of inquiry and the skills necessary perform it. These are designing and conducting investigations, identifying and posing questions, analysing data and evidence, using models and explanations, and communicating outcomes. Harlen (2013, p. 23) quotes that students do not have to discover every detail for themselves and they can get help, especially when they are struggling or stopped working. Some teachers might think it is also a mistake to give students some information on the topic but this is not the case because some guided help can speed up the process and help them to focus on the aimed learning goal. His model embodies a constructivist view of learning. Students come to new experiences with ideas formed from earlier experience. They have open minds and develop their ideas by inductive reasoning about what they observe but they can use digital or offline resources. The process of inquiry is essentially about the use of data which may be found in a range of ways beyond action on objects or from secondary sources such as the media and the internet. Furthermore, this model shows that it is important to help pupils to develop conceptual understanding and the skills of inquiry and investigation. Inquiry-based learning school activities can be found in Europe, for example in the Pollen project, where twelve participating countries explained their approach to teaching inquiry-based learning in science and offered some teaching tools for primary school teachers, as well as guidelines for adapting or designing units of study (Worth, Duque & Saltiel, 2009, p. 10). Their methods of investigation included engaging, formulating questions, planning and designing, implementing, organising and analysing data, drawing conclusions, discussing, cooperating, sharing, communicating with other audiences and reflecting. What these approaches have in common is, that students build their understanding of the world around them from their experiences. Pupils have ideas, theories and explanations of how the world works, and even if they are not scientifically correct they work for them. Words, experiments and explanations alone have little power, as pupils tend to stick to their original ideas (Konicek & Watson, 1990, p. 682). What is worse according to Mehalik, Doppelt and Schuun (2008, p. 72), children who are not often asked for their opinion are especially reluctant to admit errors in thinking. Pupils only draw new conclusions by testing their hypotheses and realising the error themselves. No costly equipment is needed, nor special well-organised field trips, but rather inquiry-based learning arrangements. Sub-terms, such as scripted inquiry, have risen. This method provides a frame, that guides the sequencing of how an experiment is carried out and how it is used to gather data as in the style of a cookbook. It imposes large limitations. According to Wurdinger (2016, p. 22-25) experimental lessons, where the teacher states facts and tells pupils how they will be able to see this result for themselves is akin to the traditional method and very different from inquiry-based learning. Observational lessons, where pupils observe and the teacher asks questions, might be meaningful but not for those with little experience. Project-based learning is a model that organises learning around projects based on challenging questions that involve pupils in design, problem-solving, decision making or investigative activities. Thus problem-based learning and experimental learning tends to be more teacher-directed and more extrinsically motivating and can be seen as a part of inquiry-based learning but this method is more than just carrying out a project or conducting an experiment. (Yoon, H.G, Joung, Y.J, & Kim, M. 2011. The Challenges of Science Inquiry Teaching for Pre-Service Teachers in Elementary Classrooms. Research Science Education, 42, 589-608) Yoon , Joung and Kim (2011) stressed that inquiry-based learning is about developing pupils' own ideas and curiosity, guiding them in designing experiments for their hypotheses and scaffolding pupil's data discussion and interpretation. According to the evaluation of Bertsch, Kapelari and Unterbruner (2014, p. 25), inquiry-based learning in science education in primary schools can be a very productive way to promote conceptual understanding. Furthermore, investigating the characteristics of scientific experiments and ideas in general can also help promote this understanding.

Gender Influence on Learning Achievement in ICT and Science at School

Assessing the gender gap in learning achievement in ICT is difficult in primary school due to the lack of standardised tests in this age group. What has been found by the Department for Education and Skills (2007, p. 11) is that the different subject choices made by boys and girls in secondary schools should cause concern because they have significant long-term outcomes in terms of subsequent career choices. Despite this, there is no call for single sex education because systematic reviews have failed to identify consistent findings of a positive impact. Although girls find it easier to succeed in school settings, this is not always the case for science and ICT. In the latter subject, the gender gap for passing A-Levels is 2.8, the highest of all subjects, whereas it is 1.9 for Physics, 1.1 for Chemistry, 1.3 for other sciences, 2.6 for psychology or -1.5 for home economics (Department for Education and Skills, 2007, p. 37). Unlike the TERCE data (UNESCO, 2016, p. 17), which showed no clear gender advantage in science, in PISA assessments (OECD, 2016) male learners outperformed female learners in several Latin American countries in 2012. Even though US eighth-graders continued higher performance in science in 2007, 2003, 1999 and 1995; in the International Mathematics and Science Study, the gap narrowed in 2007 among the fourth graders (Gonzales et al., 2009). In Germany, results from the OECD (2018, p. 2) in the year 2015 the outcomes were similar and not that surprising in science as they haven't much changed since 2012. Although the latest assessment focused on science and it did not reveal many new insights. The preface, states:

"From taking a painkiller to determining what is a 'balanced' meal, from drinking pasteurised milk to deciding whether or not to buy a hybrid car, science is ubiquitous in our lives. And science is not just test tubes and the periodic table; it is the basis of nearly every tool we use – from a simple can opener to the most advanced space explorer." (OECD, 2018, p. 2)

Despite this important message, fewer pupils are interested in science and fewer girls choose this area for their future career, even though it offers well-paid jobs. It should be noted that female engineers in Germany state their job perspective 10% better in contrast to other jobs (Statista, 2017). The motivation of Singapore's young people is highly evident in the latest PISA assessment with successful scores in science, but in Japan, ranked directly below, it is the opposite. As in Germany and the Netherlands pupils are not really motivated by science topics. Achievement is mainly influenced by social-economic background and gender. Pupils living in educated families scored higher than pupils in disadvantaged areas. The dilemma for educational policy in Germany is that the effect of discipline and good teaching on school achievement is high but the effect of school organisation, where the government has some influence is weak. Despite various campaigns there is also a persistent lack of girls' interest in science and maths (OECD, 2018, p. 7). This aligns with the IEA's international study in 2003 of trends in student achievement which also found another interesting aspect in this field. It showed that children with large numbers of books at home have a higher achievement in science and mathematics in both fourth and eighth grade. For example, families with more than 200 books at home were found in Australia, Hungary, Estonia and Sweden. In Egypt, Ghana, Botswana, Iran, the Philippines, Morocco, Indonesia and South Africa more than 30% of the families had 10 books or fewer at home and this had a negative impact on their learning achievement. Parents were also questioned about study aids such as a computer and a desk. Having them at home was also associated with higher student achievement in mathematics and science (Mullis, Martin, Gonzalez & Chrostowski, 2004, p. 134). Building on this outcome, PIRLS in 2001 developed an Index of Home Educational Resources based on children's and parents' information on the number of books, the number of children's books, and the availability of educational aids. For each child these four items were a computer, books of their own, a study desk for own use and access to a daily newspaper. Most countries had their students at the middle level of available resources but the most striking differences were at the low and high levels. The latter included countries such as Norway, Iceland, Sweden, the Netherlands, the Canadian province of British Colombia, Denmark and Scotland. They could also find a link between student achievement and the number of books at the fourth grade. All except Norway had average reading achievement above the average on the PIRLS international reading scale (Mullis, Martin, Kennedy & Foy, 2007, p. 111). That is why the Department for Education and Skills (2007, p. 11) in the UK introduced the National Literacy and Numeracy Strategies. Apparently, this had an influence on the gender gap by improving the attainment of boys in English and girls in Maths in primary school. The gap persists in the same way that the small gender difference in verbal reasoning tests does not predict or explain the large gender difference found in languages and other humanity subjects, it is also essential to analyse the relationship between gender and learning achievement in this paper.

Inquiry-based Learning in Science with Digital Technology and Learning Achievement

During inquiry-based learning students have been shown to be effective in connecting new and old knowledge. Edelson, Gordin, and Pea (1999, p. 439) refer to this as bridging activities. In their 6-week project pupils assembled a library of structured activities and open-ended investigation topics, and interpreted visualisations of global warming. Helpful links and personalised IT tools made it easier for learners to understand the settings. Furthermore, they found it was easier to manipulate and create data and summary statistics with max, min and mean. By providing this programme, the demand on the teacher and existing classroom resources reduced. Digital technology can also help to raise learning achievement. Guidelines for integrating content and process together in the design of learning activities to improve students' outcomes in inquiry science can be found in Edelson (2001). He gives an example of a technology-supported unit designed with the Learning-for-Use model, in which students take an active part in an open-ended Earth-Science-investigation. The question is whether digital technology in inquiry-based lessons leads to a higher learning achievement. There is evidence by Kirschner, Sweller, and Clark (2006) stating that this learning method in general disadvantages weaker performing students, whereas Hmelo-Silver, Duncan, and Chinn (2007) responded to their literature review and found inquiry-based instruction to be successful in reducing the achievement gap experienced by urban African-American boys, fostering better engagement and better performance compared to traditional lessons. This review is consistent with the quantitative study of Geier et al. (2008, p. 932). They found that inquiry science groups using digital technologies achieved higher scores in standardised test outcomes than their peers. Little is known about whether the way we use computers might also influence pupil's outcome. This is in contrast to the relationship between computer use and learning achievement which, although sometimes controversial, is much analysed. Roy, Taylor and Chi (2003) examined computer-related gender differences. There was no significant knowledge improvement from pre- to post-test in middle school, but the online group was superior to the library group in supporting students search for target-specific information. Nevertheless, they found that boys retrieved more task-relevant information on an online query than girls. Imhof, Vollmeyer, and Beierlein (2007) analysed the effects of gender on computer behaviour. They found that male students spend more time at the computer for personal purposes and outperform females at a computer task. Even though the overall picture shows a consistent gender effect on confidence in how to use the computer, the study shows that the gender gap is closing as far as ICT confidence and computer access at university is concerned. Nevertheless, a positive attitude towards digital technologies and science is helpful for a successful learning outcome in an inquiry-based learning setting using digital technology. Over a five-year time, span, Gibson's and Chase's (2002) surveys suggested that participants in inquiry-based science camps maintained a more positive attitude towards science, and a higher interest in careers in that area, compared to those who applied but were not selected for this activity. This longitudinal long-term impact shows the importance of inquiry-based learning and teaching. Juliani (2014, p. 125- 135) makes it clear how inquiry and student achievement are connected and how this method is linked to the common core standards. Additionally, he shares successful experiences from teachers, who talk about their strategies and challenges in these projects with young learners, using the inquiry-driven learning model. Nevertheless, it should be analysed whether this method appeals to, and is beneficial to, both sexes. Schaumburg (2004) gathered data on the increase in students' outcomes and results revealed that both sexes had benefited from explicit instruction at the same speed. However, without this help, boys outperformed girls quite considerably in tests on computer topics. As inquiry-based learning does not include specific instructions from the teacher on how to get through the experimental phase, there might be a disadvantage to girls in teaching using this method. The connection between learning achievement and inquiry-learning and frequency of use of or preferred uses of digital technology will be analysed in the next part.

Gender and Digital Technology Preferences (Frequency of Use and Preferences)

The ITU (2016) found that a gender divide continues to exist in most countries. While the rate of internet use for women in each of the US and Canada is at least 50%, making it a necessary part of life for female Northern Americans, this is not true for Europe and particularly in the poor countries of the world. The reason for this has not been determined yet, but the United Nations Development Fund for Women (2000, p. 142) detected some aspects which affect access and the use of internet and ICTs. Women have lower levels of literacy worldwide, and women and girls have lower levels of education and make up most of the population in rural areas in many developing regions. Women's workloads of income generation, domestic and community management activities mean that they often don't have free time to learn about and use ICT. Digital technology and its content are overwhelmingly designed by men, in the English language, and don't necessarily reflect the perspectives and interests of women or girls. Finally, restrictions on travel to cyber-cafés or on the interaction with the opposite sex, and preconceptions about the ability of women or girls to manipulate and understand technology, contribute to reducing women's or girl's use of ICT. This low confidence greatly affects its use and aligns with current studies. Broos' (2005, p. 27) results present a gender divide in ICT attitudes and indicate a positive relationship between those and ICT experience. Women have more negative opinions towards computers and the internet than their counterparts in general. Men were found to have less computer anxiety. This might be since respondents who have used computers for a longer period and have a higher self-perception of experience show less technophobia. This opinion is persistent in girls and when they become teenagers as the percentage to study technology out of all subjects is 12% compared to 29% for boys (Department for Education and Skills, 2007, p. 43). That is why this paper analyses whether more frequent use leads to better learning achievement when using digital tools in the classroom. Moreover, girls' and boys' preferences and how they use these tools need to be examined too. The European Commission (2009, p. 10) stated that the fact that technological development is conducted by mostly middle-aged male engineers and software developers results in the needs of the rest of the society not being properly addressed. Making this group more heterogeneous might enhance the quality of ICT developments in terms of user acceptance and new customer groups. According to the Initiative D21 (2017, p. 30), men and women are as efficient searching the web for information but men use calculation and business programmes, online transaction apps, and internet call features more often than their counterparts. Women in general post more content on social platforms. Similar results can be found in younger participants because boys tend to spend more time to enter queries and to scan and filter the hits while girls clicked on search results less often and browsed more deeply (Roy & Chi, 2003). Impact of gender and age on performing search tasks online, 2012). Some studies considered gender as an influence on ICT, but it was still not sufficiently reflected within the field of design from a feminist point of view according to Huff's and Cooper's (2002, p. 4) findings. Interestingly, programmes that needed commands, a joystick with time pressure and eye-hand coordination were classified as boys' games, whereas girls' games were conversational or goal-based and looked like tools for learning. Their study shows that programmes designed for children of either gender looked just like those designed specifically for boys. This confirmed the assumption that gender-based stereotypes can unintentionally influence the design of software. For this reason, according to Cassell and Jenkins (1998, p. 19) some US computer-game companies have employed only female designers, since they are more sensitive to the needs of their same female users. That explains why there has also been an attempt to design a concept based on research results that include age-based or female specific demands and preferences. The case study by Buchmüller, Joost, Bessing and Stein (2011, p. 756) deals with the unequal distribution of access to ICT, which separates the society into users and non-users. This divide is caused by social factors like age, local infrastructure, gender and education. Their concept shows how to attempt to enhance social equality and inclusion. In relation to gender, they found out that young female participants used ICT essentially for entertainment and communication with their friends. They used it more for organisational or emotional connectedness and were more concerned about care for others, while boys used it in a more self-referential way. The concept of availability was critical for women, while men stated not having issues being out of reach of others wanting to help them or communicate with them. Women were interested in more diverse topics such as privacy, friendship, children, housekeeping, health, fitness, beauty, emotions, style, travelling and wellness, whereas men were generally more concerned with professional life, entertainment and health. Women's lives were full of challenges in coordinating different life spaces as well as mediating between other people's needs and their own. They often regarded ICT from the perspective of daily functioning and assumed fewer technical limits, while men showed a higher rate of technical differentiation and were more qualified in technical details. Similar results can be found in children because girls tend to use the internet for communication, have more than one profile on social networks and are more aware of the risks of frequent playing whereas boys tend to play more than two computer games regularly and share less photographs than their counterparts (Zumarova, 2015, p. 786). The predominance of males in computer engineers and software developers leads to a homogeneity, which has serious consequences for the technological progress and innovation according to Cox and Blake (1991, p. 50). Therefore, this paper will analyse whether there are any different preferences or differences in the frequency of use of digital technologies by boys and girls; before addressing the links between inquiry-based learning using ICT and learning achievement. A description of how the study has been carried out is in the next paragraph.

METHOD

In order to address sample bias, all schools and 101 primary school children at the age of 10 years were randomly chosen from 9 Austrian primary schools. The treatment phase was an inquiry-learning lesson of two hours based on a science topic. Pupils had to pose their own research question, a hypothesis and had to design a model to carry out their experiment. By using digital technologies, they were able to investigate their science topic, gathering information about gravity, structure and architecture. The aim was to build a construction that should link two objects and withstand a specific given aim of 500g. The success of the experiment, was rated on an ordinal scale with grades that would relate to 'pass' or 'not pass' by the researchers. Boys and girls used digital tools to gather information in order to solve their problem and build a bridge. The responsible person teaching the class took photos of the testing phase in order to have proof of all pupils' results of the conducted experiments. The teachers were also given a proper introduction, presentation and further reading about the method inquiry-based learning. Additionally, they could discuss their ideas, the given model of the session or concerns with the researchers. Therefore, all 101 pupils in a primary school were exposed to the same treatment. There was no pre-test or control group because they intention was to get more information about the influence of gender or the frequent use of digital tools while conducting an experiment. After their lesson, they were given a questionnaire of how often they use digital technologies and for what kind of purpose. This is how the researchers investigated the effects of technology on their results. The children and teachers were told that the focus lies on inquiry-based learning and the data was split afterwards according to the pupils' gender.

RESULTS

Calculated descriptive statistics for all students are listed in **Table 1**, which presents the valid frequency and percentage of how often pupils use digital tools at home or anywhere else in general. Although 44% of them rarely use them, 31% are monthly, 18% are weekly and 7% are daily users. Girls and boys are broadly equally distributed in the sample of 101 participants (53% female, 47% male), as are the types of digital resources used (37% tablet, 20% personal computer, 11% smart phone, 32% laptop).

Table 1. General Use

General Use					
		Frequency	Percent	Valid %	Cumulative %
Valid	every day	7	6.9	7.0	7.0
	weekly	18	17.8	18.0	25.0
	monthly	31	30.7	31.0	56.0
	<monthly	44	43.6	44.0	100.0
	Total	100	99.0	100.0	
Missing	System	1	1.0		
Total		101	100.0		

When asked about their preferences in the use of digital technologies, children could choose between multiple answers and 40% ticked "play", 28% "post", 22% "read" and 18% "chat", whereas 22% answered "other" and named programming, watching YouTube, tutorials and music. The outcome of the lesson was analysed using photos of the experiments and rated on the level of successful outcome. The outcome was classified into five values: great (the bridge could withstand more than expected), good (withstood amount expected), satisfactory (withstood with difficulties), not good (bent), not sufficient (experiment didn't work at all or was not sufficient to test it). 9% of the participants were graded as great, 3% as good, 21% as satisfactory, 33% as not good and 35% as not sufficient. Therefore, expressed as a dichotomous answer, 65% of pupils created successful bridges, whereas 35% did not. This is how variables were defined whether the test was successful for the research question and for the correlation tests.

Before testing the hypotheses, the reliability, validity and objectivity of this study need to be addressed. The reliability measures the internal consistency of the outcome. The Spearman-Brown Coefficient for equal length is used for a two-item test and is a more appropriate measure of reliability in this case. The dimension successful test gives $\alpha = 0.70$, which indicates an acceptable internal consistency for this scale with this specific sample. The validity of the study was met due to the fact that the researchers were not involved in the choice of the sample and the distribution of control groups was randomised. The objectivity was met because the project was carried out by teachers and the researchers remained distanced. The next step is to test the distribution of the sample.

Table 2 presents the results of the tests of normality, namely the Kolmogorov-Smirninov Test and the Shapiro-Wilk Test.

Table 2. Tests of Normality

Tests of Normality							
	Sex	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Test1	Girl	.412	53	.000	.607	53	.000
	Boy	.425	48	.000	.595	48	.000
Test successful	Girl	.213	53	.000	.832	53	.000
	Boy	.258	48	.000	.815	48	.000
GPplay	Girl	.402	53	.000	.615	53	.000
	Boy	.382	48	.000	.627	48	.000
GPpost	Girl	.450	53	.000	.564	53	.000
	Boy	.456	48	.000	.556	48	.000
GPread	Girl	.441	53	.000	.577	53	.000
	Boy	.521	48	.000	.389	48	.000
GPchat	Girl	.486	53	.000	.498	53	.000
	Boy	.513	48	.000	.421	48	.000
GPother	Girl	.486	53	.000	.498	53	.000
	Boy	.476	48	.000	.520	48	.000

a. Lilliefors Significance Correction

The tests analysing the normality in all variables on the data of boys and girls show that all subsets are not normally distributed.

The first research question addresses the relationship between gender and a successful test outcome.

RQ1: Is there a correlation between pupils' gender and the production of a successful final outcome in the experiment in an inquiry learning setting with digital technologies?

In order to test the first research question, a test on correlation will be carried out.

Table 3. Correlation Gender and Successful Outcome

Correlations				
			Sex	Test successful
Sig. (2-tailed)..810Spearman's rho	Sex	Correlation Coefficient	1.000	.024
		N	101	101
		Correlation Coefficient	.024	1.000
	Test successful	Sig. (2-tailed)	.810	.
		N	101	101

The data show, that there is no significant correlation between the successful result of the lesson and the gender of the sample group (r_s=.024, p = .81). Therefore, the hypothesis "There is no correlation between pupil's gender and the production of a successful final outcome in the experiment in an inquiry learning setting with digital technologies" cannot be rejected.

The second research question focuses on the relationship between pupils' general use of digital technology and a successful outcome in the lesson. Students could tick "less than a month", "monthly" "weekly" and "daily", when assessing frequency of use of technology.

RQ2: Is there a correlation between pupils' frequency of use of digital tools and producing a successful final outcome in the experiment in an inquiry-based learning setting with digital technologies?

Table 4. Correlation General Use and Successful Outcome

Correlations				
			Test successful	**General Use**
Sig. (2-tailed)..011Spearman's rho	Test successful	Correlation Coefficient	1.000	.253*
		N	101	100
	General Use	Correlation Coefficient	.253*	1.000
		Sig. (2-tailed)	.011	.
		N	100	100

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4 presents the correlation between pupils' frequent general usage of digital tools and a successful final product during an inquiry-based learning session using digital technology. For this sample, children that use digital tools at home or anywhere else every day were more likely to build a successful bridge that met the experiment's criteria and their own expectations, expressed in their hypotheses. As the children were all the same age, this variable was controlled and the reason for the correlation is another one, than age related. Therefore, the hypothesis "There is no correlation between pupils' frequency of use of digital tools and ability to use a successful final outcome in the experiment in an inquiry-based learning setting with digital technologies" can be rejected. The relationship can be regarded as a weak and positive Spearman's correlation (r_s=.025, p = .01). This means for this treatment group, the more often pupils used digital tools in general, the better the final product in an inquiry-based learning lesson with digital resources in school. As there was no significant result between gender and a successful outcome in the first research question, producing a successful construction in this alternative teaching method is not gendered specific. Boys and girls can equally achieve a good result in inquiry-based learning lessons using digital tools when they use them more often in general. Therefore, it is possible that frequent users of digital tools are able to solve a problem better with digital tools because they are used to it or know how to use it. A correlation can not show the reason why there is a link but even though it can not be explored in this paper, it is evident that this positive frequent use applies to both girls and boys equally.

The third research question addresses the relationship between pupils' general purpose of technology and their gender. In the questionnaire to complete the phrase 'When I use digital resources I…', they could tick any or all of the following: 'play', 'post', 'read' or 'chat'. They were also given the option to add other ideas under the 'other' section.

RQ3: Is there a relation between pupils' gender and the different purposes for which they are using technology in general?

Table 5. Pupils' general purpose of technology

		Sex			
		Girl		Boy	
	Count	**Column N %**	**Count**	**Column N %**	**GPall**
38.5% 2041.7%	GPpost	15	28.8%	13	27.1%
	GPread	16	30.8%	6	12.5%
	GPchat	11	21.2%	7	14.6%
	GPother	11	21.2%	11	22.9%

Table 6. Pearson Chi-Square Test on general purpose and gender

Pearson Chi-Square Tests		
		Sex
GPall	Chi-square	5.775
	df	5
	Sig.	.329

The answers to this question were presented in a multiple-choice format on pupils' questionnaires. They could tick more than one box. Therefore, it was necessary to enter the data for multiple response questions each item in turn. After defining multiple response sets, a frequency chart table could be compiled, as above. The following table gives the Chi-squared calculation which shows that the p-value is not significant ($\chi(5) = 5.775$, $p = 0.32$). The hypothesis "There is no relation between pupils' gender and the different purposes for which they are using technology in general" cannot be rejected. Boys and girls in this treatment group were equal in their preferences to use digital tools to write, chat, post and read. Some pupils added that they were also programming, watching tutorials or music e.g. on Youtube.

The fourth research question addresses the relationship between pupils' different preferences in the use of technology and a pupil's successful outcome.

RQ4: Is there a relation between pupils' different preferences in the purpose to which they put technology in general and using digital technology to produce a successful final outcome in the experiment in an inquiry learning setting?

Table 7. Experimental final outcome and pupils' different preferences

		Experimental final outcome			
		Not successful		**Successful**	
	Count	**Column N %**	**Count**	**Column N %**	**GPall**
34.3% 2843.1%	GPpost	9	25.7%	19	29.2%
	GPread	7	20.0%	15	23.1%
	GPchat	10	28.6%	8	12.3%
	GPother	4	11.4%	18	27.7%

Table 8. Pearson Chi-Square Test on outcome and preferences

Pearson Chi-Square Tests		
		test1
GPall	Chi-square	8.581
	df	5
	Sig.	.127

As mentioned above, the answering format was a multiple-choice questionnaire and students could tick more than one answer. This kind of data is quite limited in terms of the range of tests to which it can be subjected, and the items "purpose of technology" need to be defined as a multiple response set first. Pupils' outcomes needed to be defined either as successful, which included all stages of a working construction, or not successful, which meant that the construction failed the test. This was necessary as otherwise some combinations had fewer than five counts in the Chi-square table, and therefore it was not possible to measure a statistically significant outcome. The above table shows the frequency of occurrence for each combination and the Chi-square table below shows the significance for the test. The hypothesis "There is no relation between pupils' different preferences of purposes to which they put technology in general and using digital technology to produce a successful final outcome in the experiment in an inquiry learning setting" cannot be rejected. Looking at the frequencies, most successful pupils play on their digital tools, although this relation is not statistically significant. There is no significance reported in the Chi-square table between the frequencies in the chart above for this age group during an inquiry-based learning lesson with digital technologies ($\chi(5) = 8.581$, $p = .127$). This means that in this sample group pupils in this age group can achieve a successful outcome irrespective of whether they are and it doesn't depend on whether children are playing, posting, chatting, reading, programming or simply watching YouTube in their spare time on digital resources in this age group as simply using technology in general for them represents learning.

DISCUSSION

Gender equality is receiving significant attention from the education community. The difference in learning achievement of boys and girls in science using digital technologies has been discussed widely in international studies (ITU, 2016; OECD, 2016, 2018; UNCTAD, 2014). The first part of this paper compares definitions of inquiry-based learning and clarifies the distinctions as compared to other terms which have wrongly been used interchangeably with exploratory, project- or problem-based learning. The gender gap in science and digital technology has remained stable over successive A-level (Department for Education and Skills, 2007) and PISA (OECD, 2018) assessments, which needs to be tackled. Considering that this gap extends to pupil's preferences towards learning and their future careers, it is necessary to try to close it. In this paper the topic of science in school, teachers' beliefs in how to teach the subject, inquiry-based learning and its links to gender and digital technology have been addressed. The second part focuses on the method of the teacher, while the third part deals with interpretation of the outcomes. It is important to investigate inquiry-based learning with digital technologies (two aspects that increase the gender gap) in primary schools, because studies in this area seem to be relatively sparse. The results didn't report any gender inequality in this non-traditional teaching method. There was no significant relation between gender and either a successful learning achievement (r_s=.024, p = .81) or different purposes of technology use ($\chi(5) = 5.775$, p = 0.32) in this inquiry-based learning lesson. There was also no significant relation between a successful outcome when using digital technologies at school and pupils' preferred use of on these tools ($\chi(5) = 8.581$, p = .127) for this treatment group. Nevertheless, there was a significant, although low correlation between frequent use of digital technology and a successful learning achievement (r_s=.025, p = .01) in this sample. This successful learning outcome is not dependent on gender but the level of frequency of use of digital tools. This means that every boy or girl can produce a satisfactory outcome in class as long as she or he spends time on them. In this sample, it was not necessary for pupils to perform sophisticated activities on digital resources. Simply writing, posting, chatting and reading online over a longer time span contributed equally to an improved learning outcome. Therefore, the more often pupils used digital tools, the more easily they were able to use it for their research, the more decisively they gathered scientific information, the more efficient they were in exploring and the better the learning achievement at the end of the lesson. Teachers should be aware of pupils' individual differences in order to improve their learning outcome by implementing inquiry-based learning sessions and digital tools. This could, in fact, reduce the gender gap and help to better establish women in fields other than languages and social sciences. Even though new gender gaps are opening such as the dominance of women in fields of biology, medicine, dentistry, agriculture and humanities (Osborne, Simon & Collins, 2003, p. 1064) certain stereotypes are still prevailing such as the under-representation of women in the fields of mathematics, physical science and computing. This paper's findings are very promising with regard to the potential benefits from implementing this method in schools, and if applied in mathematics or physics, girls and boys might equally benefit from its advantages. Nevertheless, active participation for both girls and boys requires equality in ICT access, knowledge and use. In order to achieve a women-friendly ICT sector, schools need to encourage girls to use digital technologies in and outside school and should also promote employment in the IT sector for girls. In this way the quality in this field can be increased and ICT content can be made attractive to girls.

CONCLUSIONS

The results show that daily us of digital tools can impact the way children solve their problems inquiry-based learning. This could be because they find the information quicker on the internet or simply because they know what they are looking for in the search engine. Young (2002) stated that with the help of digital tools pupils can easily browse through e-books, newspapers and sample papers within a couple of minutes and get all the information they need. Another reason could be that computer supported learning makes learning more meaningful and encourages pupils to make more efforts, which can be shown in a study in Finland (Hakkarainen, K. et al., 2000). Further studies are needed to analyse whether inquiry-based learning can facilitate positive attitudes towards science and the learning of science, which poses a major problem in the gender gap. As OECD (2018, p. 7) noticed, girls lack confidence in science and Finland is the only one out of 72 countries where girls are the top performers in science. Cronin-Jones' (1991) case study indicates that not only students' but also teachers' beliefs should be considered within context. For example, if teachers assume that science is a body of factual content and students do not have the necessary skills for independent learning, this does not align with inquiry-based learning principles and therefore this will not work in the classroom. This thinking automatically leads to teaching practices that are at variance with the intended aim of the lesson. In contrast, when teachers, fostered a discovery-orientated approach to learning, students considered it as positive and desirable. So only teachers who regard inquiry-based learning to be a successful method and internalise its ideas and ideals will experience successful learning. Shrinking the gender gap requires new teaching methods, such as inquiry-based learning settings, and much efforts by parents and educators to eliminate typical stereotypes in girls and boys. The intention of this work was to show that children need to be exposed to digital tools in order to enhance teaching and learning process. They can help both, girls and boys, to accelerate, enrich and deepen their skills. The next goal of this work is to analyse the outcomes of a following study from a socio-cultural perspective which focuses on practices and material conditions. It is important to understand what technology bounded practices mean for education and learning in the digital age. The focus of it should be on a description and explanation on what these practices look like, how teachers can identify them and what their emergence means for schools with low-experienced teachers in digital tools or poorly-equipped schools.

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