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Academic Self-Concept and the Use of Tablet Technologies in Czech and Slovak Schools

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New technologies are being increasingly introduced into classrooms as new tools for learning. This is however often done regardless of any academic evidence concerning their impact. Our objective was to identify differences in Academic Self-Concept in students before and after using tablet technologies in education. A total of 490 students aged 10 to 17 from 10 schools in Slovakia and 12 schools in Czechia were enrolled in a 6-month trial, in which instruction was conducted via tablets and touchscreen boards. Our findings showed that the Academic Self-Concept scores of children, who had below-average Academic Self-Concept scores, improved over the trial. However, initial above-average scores tended to decrease throughout the trial. Incorporating technologies into the educational process does not appear to have the potential to be associated with an increase in Academic Self-Concept in students overall. We believe that those who score low on Academic Self-Concept may benefit from the overall motivating effect of the intervention, and from the chance to experience success in novel educational situations.

Key words: education, self-concept, academic self-concept, tablets

Introduction

Academic research on the effect of using new classroom technologies on student outcomes is still far from comprehensive.

On one hand, there is some evidence to suggest that digital technologies have desirable effects on student outcomes. For example, Jackson, von Eye, Fitzgerald, Zhao, and Witt (2010) studied the effect of Internet, cellular-phone, and computer-game use on academic

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performance and social and overall self-esteem, and found that Internet use leads to higher scores on standardized reading skills tests and higher overall self-esteem. Kucirkova, Messer, and Sheehy (2014; see also Kucirkova & Littleton, 2017) found that reading personalized books with preschool children enhances vocabulary acquisition. Others have explored the use of digital technologies in specific domains, such as mathematics (Sinclair & Baccaglini-Frank, 2016) or the use of digital technologies for autism (Parsons, Yuill, Brosnan, & Good, 2017). Finnish researchers (Salmela-Aro, Muotka, Alho, Hakkarainen, & Lonka, 2016) found that almost half (46%) of the elementary students in their sample felt some degree of cynicism toward school; those students reported that they would be more engaged if socio-digital technologies were used at school.

On the other hand, other experts, parents, and educators have expressed reservations regarding the use of technologies in schools, and suggested that technologies are of no significant benefit to education. A study by Clements (2002) claims the computer has no single effect on mathematics achievement. Others point to the negative impact technology has on children's health (e.g., the lack of physical activity, or its detrimental effect on eyesight), the risk that technology may be overused or misused (e.g., technology addiction or cyber bullying), and potential deterioration in cognitive skills due to excessive technology use from early childhood. Spitzer's Digital Dementia is a notable example of this kind of critique (Spitzer, 2012). A study by Uhls et al. (2014) suggests that screen time may compromise social skills in sixth graders. More recently Ravizza, Uitvlugt, and Fenn (2016) have warned that nonacademic Internet use among students who bring laptops to class was inversely related to class performance; they concluded that class-related Internet use did not benefit classroom performance.

Building on the existing research, this article presents the findings of a research project on the use of tablets in 22 classrooms across the Slovak Republic and the Czech Republic, and their effect on student self-concept.

The outcome measure we opted for is Academic Self-Concept. The rationale behind this was that digital technologies that enable individualized and incremental learning may benefit students by enhancing their perceptions of their own success and motivating them to study. The main objective of the present paper is to explore possible associations between the use of digital technologies (in our case tablets) and Academic Self-Concept in pupils.

Self-concept is defined as 'a person's perceptions of him- or herself formed through experience with and interpretations of one's environment' (Marsh & Shavelson, 1985, p. 107). It is viewed as a dynamic multifaceted and hierarchically organized construct with descriptive as well as evaluative aspects (Zeidner & Schleyer, 1998; Marsh & Shavelson, 1985). Children develop their self-concepts through interaction within their social settings and responding to feedback from others (Zeidner & Schleyer, 1998). As individuals move from childhood to adolescence and adulthood, their self-concept becomes increasingly multifaceted (Marsh & Shavelson, 1985; Guay, Marsh, & Boivin, 2003).

Educational researchers such as Marsh and Shavelson (1985), Bong and Skaalvik (2003) and Chapman (1989) hold the view that there is a separate dimension of self-concept that relates to school performance, known as Academic Self-Concept. This is different from academic performance. Boersma and Chapman (1979, in Chapman, 1989) describe Academic Self-Concept as a relatively stable set of attitudes and affective variables, which reflect one's perception of oneself, self-evaluation, and attitudes related to school-task achievement. Academic Self-Concept relates to the individual's knowledge and perceptions of him/herself in academic achievement situations (Ferla, Valcke, & Cai, 2009); it refers to a person's interest, enjoyment, and perceptions of his or her own competency in a given academic domain (Zhan & Mei, 2013). Academic Self-Concept develops through the individual experiencing success or failure in school tasks, reflecting on the school performance of peers, and being assessed by authority figures (e.g., teachers) and peers (Vágnerová, 2001).

Muijs (1997) analyzed studies on the relationship between school achievement and Academic Self-Concept from various countries and concluded that there is a positive relation between these two phenomena. The positive correlations between Academic Self-Concept and academic achievement (school grades or test scores) indicate that a higher Academic Self-Concept may lead to higher academic achievement (Zhan & Mei, 2013; Chapman, 1989). Other researchers assume there is a reciprocal relation between the two constructs: Academic Self-Concept may both be a result of and affect the individual's academic achievement (Guay et al., 2003; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Ju, Zhang, & Katsiyannis, 2012).

The relationship between academic achievement and Academic Self-Concept has mostly been studied in the general school population. However, Ju et al. (2012) studied this relationship among school students with various types of disabilities and special educational needs. Their findings confirmed that in this group of students, similarly to the general school population, positive self-concept had a significant effect on academic success. When students experience positive feelings of mastery in school, their academic achievement may improve.

Academic Self-Concept positively correlates with external factors in young children (Guay et al., 2003) such as accomplishments, achievement, self-concepts inferred by significant others (Guay et al., 2003), socio-economic background, the number of books at home, time parents spend reading to children, and methods of instruction adopted in schools (Stringer & Heath, 2008).

The most discussed factor relating to Academic Self-Concept is gender differences. Classic studies from the United States of America (Chapman, 1989) consistently confirmed gender differences in global Academic Self-Concept: girls reported higher self-perceptions than boys. More recent studies (Marsh et al., 2015) have not found significant differences in global Academic Self-Concept but have identified differences in specific domains. Cross-sectional and longitudinal studies have revealed that boys report higher self-perceptions of physical ability, physical appearance, and mathematics self-perceptions, while girls report higher verbal self-perceptions (Marsh et al., 2005). Sullivan (2009) analyzed complex data on the Academic Self-Concept of a 1958 cohort and reported gender-stereotyped differences between boys and girls. Sáinz and Eccles (2012) studied gender differences in self-concept in mathematics and computer studies and found a higher Academic Self-Concept in boys than in girls. Similar results were obtained by Jansen, Schroeders, and Lüdtke (2014) for science-related (physics, biology, and chemistry) Academic Self-Concept.

Marsh et al. (2005) described stereotyped gender differences between the verbal and mathematics domains. A Czech study by Skopal, Dolejš, and Suchá (2014) found that there was a slight tendency for mathematics self-concept to decrease in cross-sectional comparison, while verbal and general ability self-concept seemed to be more stable. Academic Self-concept scores were compared among 11, 12, 13, 14, and 15-year-old students ($N = 4117$): the highest mathematics self-concept was recorded in the 11-year-old students, while older students had a lower one. According to Skaalvik and Skaalvik (2004), older students had a higher verbal than mathematics self-concept, regardless of gender. Marsh (in Marsh et al., 2015) later added the internal/external frame of reference model. Based on this theory, achievement in each domain has a positive effect on self-concept in the matching domain (e.g., achievement in mathematics has a positive effect on mathematics self-concept) but a negative effect on self-concept in the non-matching domain (e.g., achievement in mathematics has a negative effect on verbal self-concept).

Could an intervention change Academic Self-Concept scores? Boersma, Chapman, and Battle (1979) compared Academic Self-Concept among children with developmental learning disorders (*N* = 50) and intellectual disabilities (*N* = 18). Following a change in educational setting (full-time remedial placement), these children reported significant improvement in Academic Self-Concept. The introduction of a new method of instruction or an intervention in the school environment had mixed results among the general population, while students with special educational needs or of low socioeconomic status may profit more (Page, 2002). Despite the relative stability of general self-concept, intervention in the educational setting may lead to a significant improvement in Academic Self-Concept, especially in students with special educational needs (see also research by Chiang and Jacobs, 2009, in which academic self-concept was found to improve in students who received software-specific computer-based instruction).

Research Objectives

Our main research objective was to assess the difference in Academic Self-Concept before implementing the tablet project and after several months of using tablets in classrooms. We also intended to measure gender differences in all dimensions of Academic Self-Concept in pre-test measurements, to see whether girls and boys differed in Academic Self-Concept. We were also interested in the comparison of the differences between pre-test and post-test, independently in these two groups. Finally, we wanted to see if Academic Self-Concept would change less or more in those students who had lower initial Academic Self-Concept scores before the program, compared to students with higher initial Academic Self-Concept. Once we had established our objectives, we formulated three research questions:

1) Would the Academic Self-Concept change in students over the duration of our trial?

2a) Would there be a difference in Academic Self-Concept between girls and boys?

2b) Would Academic Self-Concept change after using tablets in school differently in girls and boys?

3) Would changes in academic self-concept and its components differ according to the initial pre-test scores?

Method

Project Description and Protocol

Ten schools from the Slovak Republic (2013/2014) and twelve schools from the Czech Republic (2014/2015) were enrolled in an experimental project, where teaching was conducted using tablets and touchscreen boards. The schools were selected by the two non-profit organizations running the project – EDULAB in Slovakia and its partner organization EDUkační LABOratoř in Czechia. Project managers selected the schools in such a way as to ensure regional representation: the schools were asked to submit a project on how they would use these technologies, and the school with the most feasible project for each region was selected. In each school there was a project class using the technologies. The schools had very diverse academic performances, rural/urban settings, and student economic status. The selection was representative of the most common kinds of schools in the two countries – none of them were elite schools, none were in severely deprived areas, and all were public schools.

Students and teachers enrolled in the project were equipped with Samsung Galaxy Note 10.1 tablets. The tablets have special touchscreens enabling the use of an integrated stylus. They communicate with a 65-inch (165 cm) touchscreen board via Samsung School. In addition, the classrooms were equipped with desktop computers with 24-inch monitors. The projects were launched in the fall of the academic year (2013 for the Slovak project, 2014 for the Czech project).

The project was run by EduLab project managers. Each student had a tablet of their own, and used them in class. The tablets were used every day at school for several school subjects, including the language of instruction (Czech or Slovak), foreign language, and mathematics. The project did not provide specific digital curricula, but encouraged the general use of digital technologies in the classroom and provided participating teachers with resources in the form of educational software, training sessions, on-call support, peer tutoring, and regular tips on subject-relevant applications. Project managers asked teachers to provide regular reports to make sure that the teachers were making a continual effort to integrate the digital technologies into everyday use. Additionally, project managers provided all-round support to classes enrolled in the project: on-site training visits, tips for useful digital content, online support groups, on-call support to fix technical problems, and provided ideas and suggestions.

To ensure impartiality, the research team differed from the project management team. Prior to project commencement we collected initial (pre-test) data via questionnaires administered to students by project coordinators. Our research team member contacted the project coordinators in each school, described the research objectives, explained the procedure, answered any questions, and provided support throughout the administration of the questionnaire. Before the end of the school term (spring) we contacted all the schools again (post-test), collected the second round of data, and then visited all the schools to observe the classes and conduct interviews with the teachers, students, and administrators. The mean time of the tablet trial run (exposure to the tablet) was 6 months.

Participants

The data were collected on students from 10 schools in Slovakia and 12 schools in Czechia. The classes originally contained 726 students in total, in both experimental (tablet use in class) and control (no-tablet use in class) groups. Some students did not take part in the first or second rounds of data collection (due to illness, absence, withdrawal, etc.) or noted down a different identification code making it impossible to match their data; these students were excluded from the data analysis. Our original idea was to recruit a parallel class in the same grade in each school to create a control group that did not use the digital technologies. However, this proved extremely difficult. Firstly, in the smaller schools, there was often only one class in each grade. Where there was more than one class they often failed to meet the condition that tablets should not be used regularly during lessons. This was because the teachers tried to extend the experience to other students and made arrangements for these other classes to use the tablets regularly, despite our attempts to ensure stricter experimental conditions. All students in the control group were thus excluded from our analysis because they ended up using digital classrooms only marginally less than the project class (based on the data from the questionnaires on the frequency of digital technology use given to the students).

Adjusted for excluded students, the final sample for the only group in our test-retest comparison contained 490 students. Gender distribution was as follows: 255 girls aged 10 to 17 (mean age 12.82, $SD = 1.86$) and 235 boys aged 10 to 17 (mean age 12.83, $SD = 1.77$).

Research Ethics

We asked the project coordinators to obtain written informed consent from the parents of all the participating students. All the parents gave their informed consent. The data were collected by their teachers under specific instructions from our team member; we made sure the teachers explained to the students that the questionnaires did not constitute testing of any kind and that the results would be kept completely anonymous. We did not collect names or any other personal information except for age. The teachers were asked to create a code table of student names and to assign a code to each student for the pre-test and then to ensure the students used the same code in the post-test so the pre-test and post-test data could be matched. These tables were retained by the teachers; the research team did not have access to the code tables, and the teachers did not have access to the data tables.

In all our dealings with the teachers and students, we made a special effort to reassure them that our role was not to evaluate the schools or the teachers but to gain insights into how the technologies were used.

Measures

Academic Self-Concept. Participants' Academic Self-Concept was measured before and after completion of the tablet project using the Slovak and Czech versions of the Perception of Ability Scale for Students – PASS (Chapman, 1989; Chapman & Boersma, 1986), published as the Student's Perception of Ability Scale (SPAS; Matějček & Vágnerová, 1992). This self-report instrument is used to measure students' perception of their own abilities, achievements in school subjects, and academic status compared to their classmates (Matějček & Vágnerová, 1992). The items were derived from a pool of 200 items relating to self-perceptions of school performance and attitudes toward school, which were then consulted with teachers, school psychologists, and compared with other self-concept measures. The original instrument had satisfactory structural, reliability, and validity characteristics as well as good discriminant validity between the subscales and cross-cultural stability (Chapman, 1989). The scale was adopted and standardized for the Czechoslovak population in the 1980s (Vágnerová & Matějček, 1992). Czech and Slovak researchers have used SPAS extensively to analyze Academic Self-Concept and school achievement (Žilinčík & Novotný, 2014; Čornák & Popelková, 2008; Skopal, Dolejš, & Suchá, 2014).

The standardized version of the instrument consists of 48 items divided into six subscales, which were originally derived by factor analysis (general abilities, perception of mathematical ability, perception of reading ability, perception of writing ability, perception of spelling ability, and self-confidence in academic ability). The scale is dichotomously structured, making it less sensitive but more suitable for younger participants with lower reading abilities and/or lower reflective and metacognitive skills. In clinical administration, the instrument is aimed at children aged 9 to 14 (Matějček & Vágnerová, 1992); however, for research purposes, it may be used for junior high and older students (Chapman, 1989). Its advantages are that it is easily administered and understood, and has satisfactory validity and reliability (Svoboda, Krejčířová, & Vágnerová, 2009).

Validity and reliability. The construct validity of the instrument was tested by correlating SPAS with personality inventories, school achievement, and teachers' reports using both the US and Czechoslovak versions, and found to be satisfactory. Discriminant validity was obtained by testing the differences between the individual subscales. In the US normative sample (N = 831) the internal consistency of the original instrument was α = .93 (Chapman, 1989). In the Czechoslovak normative sample (N = 300) the internal consistency was between α = .89 and α = .95 depending on age and gender (Matějček & Vágnerová, 1992).

The test-retest method was applied using the original and adapted versions. In the original study (Chapman, 1989), the retest was conducted after four to six weeks (the overall stability coefficient was .83), while in the Czechoslovak sample, the retest was done after two weeks with an overall stability coefficient of between .87 and .93 among the different age groups (Matějček & Vágnerová, 1992). Scales 1 (general abilities) and 6 (self-confidence) had the lowest dependability. These subscales have the highest level of intercorrelation and seem to be most sensitive to changes in external conditions.

The reliability of the instrument is also supported by more recent studies (Orel, Obereignerů, & Mentel, 2016; Obereignerů, Orel, Mentel, & Vohradská, 2017). The reliability test for our sample (N = 490) revealed satisfactory reliability with a Cronbach's α for the individual subscales of between .653 and .905 (Table 1).

The tests were administered online by teachers. Although the measure was originally intended for pen-and-paper data collection, Žilinčík and Novotný (2014), who have extensive experience with it, have stated that it makes no difference to the results if SPAS is administered online or offline. We therefore chose to administer it online in a classroom setting both before and after the tablet project.

Results

As the first step we assessed the normality of data distribution. We used the Shapiro-Wilk test, which showed that the data distribution was different than the normal distribution. On the other hand, skewness and kurtosis suggest that data distribution may be in line with normality criteria. The difference may be related to a relatively large sample (please see Table 2). Based on the results of the Shapiro-Wilk test, we decided to use non-parametric test for further analysis.

Table 1 *Reliability test of SPAS questionnaire*

	pre-test *Cronbach α*	post-test *Cronbach α*
General Ability	.653	.730
Perception of Math Ability	.808	.826
Perception of Reading Ability	.791	.818
Perception of Spelling Ability	.835	.850
Perception of Writing Ability	.807	.826
Self-confidence in Academic Ability	.702	.732
Factor - general abilities	.854	.884
Factor - verbal abilities	.866	.873
SPAS Total Score	.887	.905

Table 2 *Shapiro-Wilk test of normality, skewness and kurtosis of data distribution of SPAS scores*

	pre-test				post-test			
	W	*Sig.*	*Skew.*	*Kurt.*	*W*	*Sig.*	*Skew.*	*Kurt.*
General Ability	.963	.000	.029	-.799	.957	.000	-.027	-.863
Perception of Math Ability	.913	.000	-.473	-.840	.918	.000	-.383	-.979
Perception of Reading Ability	.888	.000	-.763	-.477	.859	.000	-.903	-.287
Perception of Spelling Ability	.911	.000	-.028	-1.400	.904	.000	.008	-1.422
Perception of Writing Ability	.927	.000	-.174	-1.209	.921	.000	-.065	-1.259
Self-confidence in Academic Ability	.959	.000	-.086	-.885	.952	.000	-.149	-.912
Factor - general abilities	.977	.000	-.223	-.753	.976	.000	-.255	-.730
Factor - verbal abilities	.977	.000	-.242	-.700	.977	.000	-.230	-.698
SPAS Total Score	.989	.001	-.240	-.427	.991	.004	-.195	-.383

Table 3 shows the descriptive statistics for the self-concept domains and overall self-concept measures obtained in the pre-test and post-test, and the Wilcoxon test for comparison of the two measurements. The Academic Self-Concept score attainable for the individual dimensions ranged from 0 to 8 points.

Perception of Math Ability slightly decreased across the entire sample throughout the intervention, $z = -2.09$, $p = .036$. However, the effect size was negligible, $r = -.094$. We identified a small change in Perception of Reading Ability, $z = -2.50$, $p = .012$, and found small effect size, $r = -.113$, but the value of the pre-test and post-test medians remained the same. Other changes in self-concept were not significant.

We also looked into potential gender-related links in Perception of Math Ability. Firstly, we wanted to see if these gender differences could be seen under regular classroom conditions (before the tablet project). We compared the data on self-concept domains and overall self-concept measures in the boys and girls obtained before implementation of the tablet project. For comparison we used the Mann-Whitney U test (Table 4).

Gender differences were mainly found in Verbal Abilities. The difference in the Factor Verbal Abilities was significant but with a small effect size, $U = 24704.50$, $z = -3.36$, $p = .001$, $r = -.152$. The girls perceived their Verbal Abilities to be higher (*Mdn* = 15) than the boys did (*Mdn* = 13). This difference was also clear when the different components of Verbal Abilities were compared. The girls had higher perceptions of their Reading Ability (*Mdn* = 7) than the boys did (*Mdn* = 6), and this difference was significant, $U = 25495.50$, $z = -2.89$, $p = .004$, however the effect size was still small, $r = -.131$. The girls also rated themselves better at Writing Ability (*Mdn* = 5) than the boys did (*Mdn* = 4) and this difference was significant and with a small effect size, $U = 24856.00$, $z = -3.29$, $p = .001$, $r = -.148$. The students did not differ significantly

Table 3 *Descriptive statistics for self-concept domains and overall self-concept in pre-test and post-test (N = 490) and in comparison (Wilcoxon test, effect size r)*

	pre-test		post-test				
	Mdn	*IQR*	*Mdn*	*IQR*	*Z*	*Sig. (2-tailed)*	*r*
General Ability	4	3	4	4	-1.79	.073	-.081
Perception of Math Ability	6	3	5	4	-2.09	.036	-.094
Perception of Reading Ability	6	3	6	4	-2.50	.012	-.113
Perception of Spelling Ability	4	6	4	6	-0.60	.546	-.027
Perception of Writing Ability	5	5	4	5	-0.40	.687	-.018
Self-confidence in Academic Ability	4	3	4	3	-0.25	.800	-.011
Factor - general abilities	14	9	14	9	-0.21	.832	-.009
Factor - verbal abilities	14	8	15	9	-0.70	.486	-.031
SPAS Total Score	28	13	28	14	-0.41	.684	-.019

Table 4 *Comparison of Academic Self-Concept (pre-test) between girls (n = 255) and boys (n = 235) (Mann-Whitney U, effect size r)*

	Gender	*Mdn*	*IQR*	*U*	*Z*	*Sig. (2-tailed)*	*r*
General Ability	girls	4	3	28841.00	-0.72	.470	-.033
	boys	4	4				
Perception of Math Ability	girls	5	3	29455.50	-0.33	.743	-.015
	boys	6	3				
Perception of Reading Ability	girls	7	4	25495.50	-2.89	.004	-.131
	boys	6	3				
Perception of Spelling Ability	girls	5	6	27114.00	-1.83	.067	-.083
	boys	3	5				
Perception of Writing Ability	girls	5	4	24856.00	-3.29	.001	-.148
	boys	4	4				
Self-confidence in Academic Ability	girls	4	4	29214.50	-0.48	.630	-.022
	boys	4	3				
Factor - general abilities	girls	13	9	29080.50	-0.56	.573	-.025
	boys	14	8				
Factor - verbal abilities	girls	15	8	24704.50	-3.36	.001	-.152
	boys	13	8				
SPAS Total Score	girls	29	13	27169.00	-1.79	.074	-.081
	boys	27	13				

in General Abilities; although the boys had a somewhat higher self-perception than girls in every dimension. The boys and girls achieved similar results in Perception of Math Ability and other domains.

We were also interested in whether self-concept differed in the boys and girls before and after tablet use. To compare the pre-test and post-test score for each group separately, we performed a Wilcoxon test (Table 5).

We found a very small difference in group of girls in General Ability, which was not significant, but on the borderline of small and negligible effect size, $z = -1.75$, $p = .080$, $r = -.110$. For that reason, we do not consider this difference as significant. Perception of Math Ability changed significantly, but with a small effect size and no difference between pre-test and post-test medians, only in the group of girls, $z = -2.82$, $p = .005$, $r = -.177$. The boys evaluated

Table 5 *Pre- and post-test comparison of each dimension of Academic Self-Concept, factors and total SPAS score in the group of girls and the group of boys separately (Wilcoxon test, effect size r)*

		Girls (n = 255)					Boys (n = 235)				
		Mdn	*IQR*	*Z*	*Sig. (2-tailed)*	*r*	*Mdn*	*IQR*	*Z*	*Sig. (2-tailed)*	*r*
General Ability	pre-test	4	3	-1.75	.080	-.110	4	4	-0.82	.414	-.053
	post-test	4	4				4	4			
Perception of Math Ability	pre-test	5	3	-2.82	.005	-.177	6	3	-0.15	.878	-.010
	post-test	5	4				6	3			
Perception of Reading Ability	pre-test	7	4	-1.33	.183	-.083	6	3	-2.17	.030	-.142
	post-test	7	4				6	3			
Perception of Spelling Ability	pre-test	5	6	-0.93	.355	-.058	3	5	-0.03	.976	-.002
	post-test	5	5				4	5			
Perception of Writing Ability	pre-test	5	4	-0.69	.490	-.043	4	4	-1.33	.182	-.087
	post-test	5	4				4	4			
Self-confidence in Academic Ability	pre-test	4	4	-0.23	.821	-.014	4	3	-0.50	.618	-.033
	post-test	4	4				4	3			
Factor - general abilities	pre-test	13	9	-0.01	.994	-.000	14	8	-0.37	.712	-.024
	post-test	13	10				14	8			
Factor - verbal abilities	pre-test	15	8	-0.98	.329	-.061	13	8	-0.02	.981	-.002
	post-test	16	9				13	8			
SPAS Total Score	pre-test	29	13	-0.54	.587	-.034	27	13	-0.04	.966	-.003
	post-test	28	15				27	14			

their Math Ability to be almost at the same level before and after the experiment. The Perception of Reading Ability slightly changed in the group of boys only. The difference was however only significant, but with a small effect size and no difference between pre-test and post-test medians, $z = -2.17$, $p = .030$, $r = -.142$. In the other domains relating to perception of ability there was no significant change in the girls or the boys before and after the project.

To answer the third research question (Will there be a specific group that seemed to have profited most from using tablets in classroom learning?), we labeled all those who achieved scores of 0 – 3 (under average) on the pre-test in Academic Self-Concept as low scorers, and

Table 6 *Comparison of pre-test and post-test for Academic Self-Concept domains showing students (N = 490) with low and high scores in Academic Self-Concept separately (Wilcoxon test, effect size r)*

		Students with low scores in Acad. Self-Concept					Students with high scores in Acad. Self-Concept				
		n	*Mdn*	*IQR*	*Z*	*r*	*n*	*Mdn*	*IQR*	*Z*	*r*
General Ability	pre-test	212	2	2	-7.23***	-.497	203	6	2	-5.77***	-.405
	post-test		3	3.75				5	3		
Perception of Math Ability	pre-test	118	2	2	-5.23***	-.482	315	7	2	-6.55***	-.370
	post-test		3	3				6	3		
Perception of Reading Ability	pre-test	104	2	2	-5.97***	-.585	345	7	2	-2.50*	-.135
	post-test		3	3.75				7	2		
Perception of Spelling Ability	pre-test	223	1	2	-7.26***	-.486	226	7	1	-6.72***	-.447
	post-test		2	3				6	3		
Perception of Writing Ability	pre-test	173	2	1	-6.95***	-.528	263	7	3	-6.44***	-.397
	post-test		3	3				6	4		
Self-confidence in Academic Ability	pre-test	182	2	2	-6.10***	-.452	232	5	3	-6.78***	-.445
	post-test		3	3				5	4		
SPAS Total Score	pre-test	85	15	6	-4.46***	-.484	214	35	6	-5.26***	-.360
	post-test		18	12				33	10		

*** Wilcoxon test is significant at .001 (2-tailed).
** Wilcoxon test is significant at .01 (2-tailed).
* Wilcoxon test is significant at .05 (2-tailed).

those who scored 5 – 8 (above average) as high scorers. We did this separately for each dimension, so the number of participants differs for each dimension in Table 6. The total score represents the mean score for all dimensions. Table 6 compares the pre-test and post-test scores for each self-concept dimension and the total score (the Wilcoxon test).

Children with a low Academic Self-Concept improved over time in each dimension. The above-average Academic Self-Concept was lower in the post-test measurement compared to the pre-test measurement. This was the case in each domain. The change in self-concept from the pre-test to the post-test indicated that self-concept scores tended to shift toward the mean.

Discussion

The aim of our research was to find out whether Academic Self-Concept changed following the implementation of the tablet project. We did not observe significant changes in self-concept in most of the SPAS domains before and after the tablet project. The only significant, yet very small difference was in the Perception of Math Ability and Reading Ability. Changes in Academic Self-Concept were small; some results may have showed some significance but our interpretation suggests this could have been coincidental. Such interpretations should, however, be further supported by further data that would include a control group.

Similarly to Chapman (1989) and Marsh et al. (2005), we also observed gender differences in specific domains. Girls tended to have a higher self-concept in reading and writing – in verbal skills – than did boys. Higher verbal skill self-perception scores among girls may reflect traditional gender stereotypes in western cultures (Skaalvik & Skaalvik, 2004).

When we divided the children into low-scorer and high-scorer groups and analyzed the data based on this criterion, we observed additional changes in self-concept during the intervention. One interpretation could be that they had misjudged their self-efficacy at the beginning of the academic year, perhaps by being overly optimistic after the summer break. Continuous feedback from teachers (including grades) may alter their perceived self-efficacy during the semester, which would impact their self-concept. This thesis would, however, require further testing.

Let us try to interpret this in the context of introducing technologies into education. Hypothetically, high-scoring students who have a high Academic Self-Concept and good grades do not necessarily require the intervention, and some may be conservative types with low ambiguity tolerance (a change in teaching style may unsettle them despite their positive attitude towards technologies generally). On the other hand, low scorers may benefit more from the overall motivating effect of the change, and from the chance to experience success in novel educational situations. One possible way of interpreting this could also be 'the big fish in a little pond effect (BFLPE)' hypothesis: students who are the most confident technology users (although not necessarily high academic performers) may benefit from an educational change and thus may improve their Academic Self-Concepts (Zeidner & Schleyer, 1998; Huguet et al., 2009). The idea of the stabilizing effect of the intervention would however require data from a control group.

Several researchers (e.g., Chapman & McAlpine, 1987) claim that self-concept is stable. We believe that stability can only be observed within a group in which the distribution of the values measured follows normality criteria. When we focused on students with above-average or under-average values, we found that their self-concept tended to move toward the mean. This means that self-concept does not change at the group level, but its variance tends to decrease with time.

Boersma et al. (1979) observed an improvement in self-concept in children with learning disorders and intellectual disabilities following a change of educational setting. Page (2002) presumes there is a higher probability that change in self-concept will occur among students with specific educational characteristics and needs. Our observations suggest that the academic self-concept among students did not change after the tablet project, either positively or negatively. In this context and based on our observations during data collection it would be worth assessing the impact of tablet technologies on Academic Self-Concept in children with special educational needs.

As for the limitations of the present study, the main instrument contains norms that are not entirely up-to-date. Some items are also formulated in a way that some students may find outdated (cf. Žilinčík & Novotný, 2014). Nonetheless, we still consider it to be the most appropriate measure of Academic Self-Concept available.

It must be said at this point that the researchers did not have complete control over the educational design and the content in each school. Better results could be achieved where there is an opportunity to control the selection of schools, especially if it included schools in which it was possible to guarantee a case/control scenario. This has proven to be extremely difficult to achieve in our case because such setting would interfere with academic arrangements in schools.

Although we originally wanted to collect data in parallel classes that would not be using digital technologies (control groups), this idea failed in practice. Teachers were eager to bring the benefits of innovative technologies to all of their students so they generally used the most interesting applications and digital material in all of the classes they taught, regardless of being assigned to the experimental or control group. For instance we found out that they brought other classes into the experimental class when the original tablet project class was not using them (e.g., during physical education classes), and they let other students work with their tablets. The project seemed to "spill-over" across the entire school. After long discussions we decided not to interfere with this practice; although it tampered with our experimental design it seemed in the best interest of educational objectives.

Our research design allowed us to identify small or no changes in Academic Self-Concept in the whole group, and at the same time we found significant changes in children, who initially had under-average and above-average scores in Academic Self-concept. Because of the absence of a control group, it does not allow us to confirm expressly that using tablets in education would have a specific impact on Academic Self-Concept. Without the control group to our whole sample we cannot compare our results to the following scenarios: 1) a substantial positive change in the control group might imply that our intervention had a negative effect; 2) a substantial negative change in the control group might imply that the intervention had a positive effect (it protected pupils from a substantial decline); 3) comparable effects in both groups might imply that the intervention had no effect.

To address these concerns, in the future it would be advisable to have more control over the selection of schools to ensure full cooperation. It would also be recommended to focus on students with special educational needs (overachievers as well as under-achievers), and observe the specific benefits of using digital technologies for these target groups.

As pointed out by an anonymous reviewer, it would also be interesting to consider if an increase in Academic Self-Concept is always a desirable outcome since it does not necessarily correspond to actual academic performance.

Conclusion

The objective of the paper was to explore differences in Academic Self-Concept before and after the use of tablets in schools, that is, increase student perceptions of being successful. Introducing technologies into the educational process does not seem to have the general potential to improve Academic Self-Concept in students. The main lesson learned is that applying such technology-rich projects does not seem to have the potential to affect the overall Academic Self-Concept. However, our findings suggest that it may have the potential to bridge the divide between children with low self-concept and those who are average to high scorers. Introducing new educational practices may enable low scorers to experience success in domains where they have not experienced success before.

Our previous work (e.g., Masaryk & Sokolová, 2012) showed that introduction of projects using digital technologies into schools can be a positive impulse for pupils and teachers. Yet, in the long run it does not seem to be associated with positive academic effects on the general level. Using such technologies may, however, be a point that lets some students experience success. Projects using digital technologies have thus the potential to be a significant source of motivation and improvement in self-concept in children with special educational needs – for example those with physical or learning disabilities or from economically and socially disadvantaged backgrounds (Lemešová, 2013; Andreánska & Andreánsky, 1981).

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