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Are heavy users of computer games and social media more computer literate?

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Abstract

Adolescents spend a substantial part of their leisure time with playing games and using social media such as Facebook. The present paper examines the link between adolescents' computer and Internet activities and computer literacy (defined as the ability to work with a computer efficiently). A cross-sectional study with $N = 200$ adolescents, aged 17 on average, was conducted. Hierarchical regression analyses showed that an increase in time spent playing games on a PC/MAC was related to higher scores on practical and theoretical computer knowledge. Moreover, practical computer knowledge was higher for adolescents who liked playing shooters, fantasy games, or Facebook-games. Frequency of social media use was associated with higher scores in practical computer knowledge. A bootstrap analysis indicated that this relationship was mediated by a decrease in computer anxiety, not by more positive attitudes towards the computer. Gender yielded substantial main effects on the media literacy variables but the associations between the computer and Internet activities and the literacy aspects were similar for boys and girls. This study is expected to encourage future longitudinal research on adolescents' incidental learning during leisure time computer and Internet activities.

Keywords: media in education; secondary education

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1. Introduction

Literacy in information and computer technologies (ICT) is a key competence today. Using the computer efficiently contributes to citizens' options for participating in modern societies (e.g., Papacharissi, 2002). From a financial perspective, a country's economic growth depends on a qualified workforce, and "to be employable in 2020, graduates must be technologically literate […]" (World Economic Forum, 2011, p. 7). Adolescents spend much of their daily leisure time with the computer, often playing computer games or communicating through social networking sites. The affective and cognitive consequences of these activities have been a matter of ongoing debate in the social sciences as well as in the general public. The goal of the present research is to examine the link between adolescents' computer and Internet activities, including the use of social networking sites and popular video games such as first-person-shooters, and adolescents' computer literacy. It was predicted that recreational computer use is related to higher computer literacy and that decreased computer anxiety and more positive attitudes towards the computer may be in part responsible for this relationship.

1.1 Computer literacy

In the last decades, the notion of literacy has been transferred from its original domain of reading and writing to audiovisual (mass) media such as the TV (media literacy) and to computers (computer literacy). Computer literacy has been defined as the "knowledge, skills, and attitudes needed by all citizens to be able to deal with computer technology in their daily life" (Tsai, 2002, p.69; cf. Dominick, Friedman, & Hoffmann-Goetz, 2009; Poynton, 2005). Computer literacy entails the capability to handle tasks that users are faced with on a daily basis, for example "the ability to use several applications (usually Microsoft Word, Microsoft Internet

Explorer and Microsoft Excel) for certain tasks“ (Taylor, Goede, & Steyn, 2011, p. 29). According to our approach, computer literacy is one component of a more broadly defined *digital literacy* which – in addition to computer literacy – involves the ability to make sense of graphs, pictures, and moving images on a screen (visual literacy; e.g., Elkins, 2010) and to find and analyze information using the computers and the web (information literacy; cf. Ryan & Capra, 2001). Moreover, digital literacy (but not computer literacy) involves the ability to take up a critical position to the things presented on the computer but also to be able to enjoy computer-based entertainment and interactions, similar to conceptualizations of media literacy (e.g., Groeben, 2002; Potter, 2011). In sum, the concept of computer literacy as it is defined here does not entail all competencies that appear desirable when people interact with the computer; it is rather focused on the ability to work with a computer efficiently.

The present research is based on the approach by Richter, Naumann, and colleagues (Naumann, Richter, & Groeben, 2001; Richter, Naumann, & Groeben, 2000; 2001; Richter, Naumann, & Horz, 2010), who distinguish theoretical (declarative) and practical (procedural) knowledge of the computer as the two key components of computer literacy. This approach is particularly appealing, as it comes with a reliable computer literacy inventory which has been employed in a number of studies on computer-based learning and communication (e.g., Gauss & Urbas, 2003; Koch, Müller & Sieverding, 2008; Mäkitalo-Siegl, Kohnle & Fischer, 2011; Wecker, Kohnlet & Fischer, 2007; Wittwer, Nückles & Renkl, 2008). The theoretical knowledge (“know what”) is assessed with the help of multiple-choice items that ask for the meaning of common ICT abbreviations and terms such as “IP-address”, “Trojan” or “Kernel” (see Appendix A for sample items). The practical knowledge (“know how”) consists of multiple-choice items as well. Each item starts with a scenario – e.g., the computer mouse is defunct and you want to end the program you were working with – and the respondents need to choose which of four behavioral options would be the best in that situation (see Appendix B for sample items).

1.2 Computer literacy and adolescent home computer use

Part of the computer knowledge is likely obtained in educational settings such as informatics school classes. However, another part of adolescents' computer knowledge is likely obtained in out-of-school contexts. Previous theory and research on reading and writing literacy indicated that students' leisure activities such as keeping diaries or reading novels are associated with better language skills (e.g. Hull & Schultz, 2001; Mar, Djikic, & Oatley, 2008; Stanovich, 1993). For the field of computer literacy, we assume that the acquisition of computer knowledge is often unintentional and takes place during recreational computer use. Such instances of incidental learning (e.g., Marsick & Watkins, 2001; Marsick, Watkins, & Lovin, 2010) are expected to increase the declarative knowledge, i.e., after fixing the internet to go on Facebook adolescents know what an IP-address is (as well as PPPee, PADI, etc.). Even more so, however, we assume that informal computer use contributes to practical computer knowledge, i.e., knowing how to 'fix the internet' by switching the modem's power on and off. We propose that home computer use does not only provide the opportunity to make literacy-relevant experiences, it may also decrease computer anxiety i.e., the discomfort or fear when using the computer or when thinking about using the computer (cf. Chua, Chen, & Wong, 1999; Simonson, Maurer, Montag-Torardi, & Whitaker, 1987). A low level of computer anxiety has been conceived as a facet of computer literacy in and of itself, and computer anxiety was negatively related to both theoretical and practical computer knowledge (i.e., Richter et al., 2010). Thus, we hypothesize that a reduction of computer anxiety can be one link between computer use in informal settings and computer literacy. In addition to reduced anxiety, more positive attitudes towards the computer can serve as a mediator between computer experience and computer literacy. Levine and Donitsa-Schmidt (1998) found support for a model that placed computer attitudes and computer confidence as mediating variables of the positive association between computer ownership, computer use at school, and frequency of use on the one hand, and perceived computer knowledge on the other.

Previous research in this field was inclined to examine computer use and computer experience on a broad level. For example, practical and theoretical computer knowledge were positively related to the amount of computer and internet use, the number of desktop and internet appliances used, as well as the years of previous computer experience (Richter et al., 2010, for similar results on *perceived* computer knowledge see for example Geissler & Horridge, 1993). Likewise, a number of studies found a negative relationship between the frequency of computer use and computer anxiety (e.g., Korobili, Togia, & Malliari, 2010; see Chua, et al., 1999, for meta-analytic findings). What is missing thus far is a fine-grained analysis of different computer-based activities. Most computer users – and adolescents in particular – engage in a broad range of computerized activities, including coursework for school, watching videos on youtube, or playing first-person shooter video games. The present research seeks to identify which computer and Internet activities are associated with computer literacy.

Adolescents spend much of their daily leisure time with the computer. Their favorite computer activities are communicating through online chats and social networking sites, playing video games, and watching videos online (Rideout, Foehr, & Roberts, 2010). Previous studies showed that some of these favorite activities are linked to adolescent problem behavior. Playing violent video games was related to externalizing problems, (i.e., aggression and delinquency; Anderson & Bushman, 2001; Holtz & Appel, 2011), and communicating online was found to be related to internalizing problems (i.e., depression and loneliness, Van den Eijnden, Meerkerk, Vermulst, Sijkerman, & Engels, 2008). However, e-communication may as well have the potential to contribute to adolescents' dealing with issues of identity, intimacy, and sexuality and therefore may contribute to healthy adolescent development (see Valkenburg & Peter, 2011, for an overview). Whereas video games were further related to cognitive problems in attention and memory in some studies (e.g., Dworak, Schierl, Bruns, & Strüder, 2007; Maass, Klöpper, Michel, & Lohaus, 2011) others pointed at the benefits of action video game play for attention and visuospatial tasks (e.g., Green & Bavelier, 2003, 2006; cf. Greenfield, 2009).

1.3 Summary, study overview, and predictions

The present research is based on the assumption that the frequency of adolescents' leisure time computer use is positively associated with adolescents' computer literacy, particularly practical computer literacy. The aim of the present research was to examine, which particular activities were related to computer literacy. To this end, a cross-sectional study was developed that asked for adolescents' computer activities, including their engagement with social media. We expected that using social media extensively provides opportunities to develop practical computer literacy, resulting in a positive relationship between both variables. We also hypothesized that the amount of social media use was inversely related to computer anxiety which serves as a potential mediator of the social media use-practical literacy relationship. As a second potential mediator, attitudes towards the computer were examined. Moreover, we assessed computer gaming and differentiated playing on a home computer, a console, or a cell phone. Whereas playing on the computer was expected to provide opportunities to develop practical computer literacy, yielding a positive relationship with practical literacy, this should not be case for playing on a console or playing with a phone. Finally, our aim was to examine which computer game genres were related to adolescents' computer anxiety, computer attitudes, and computer literacy. As the latter variables as well as the computer activities are subject to potential gender differences (e.g., Ünlüsoy, de Haan, Leseman, & van Kruistum, 2010; Holtz & Appel, 2011; Rideout et al., 2010; Tsai & Tsai, 2010), gender was a matter of additional concern.

The present study extends previous findings as it a) specified the contribution of different computer activities, including a distinction of different video game genres, b) examined computer literacy with the help of ability test items (as opposed to self-reported competence), c) investigated anxiety and attitudes as mediating variables, and d) tested our model on a mixed sample of adolescents rather than a sample of undergraduates.

2. Method

2.1 Participants

Participants were 200 adolescents aged 16 to 19 years (*M* = 17.34, *SD* = 0.96), 116 or 58% of them were female. The participants were recruited in final year or next-to-final year classes at secondary schools in Austria. Participation was voluntary and included informed consent.

2.2 Computer Use Measures

Time spent with the computer and time spent with video games. The participants were asked about how much time they spent with the computer on an average day and free spaces for the hours and minutes were provided. The time spent with the computer ranged from 10 minutes to 960 minutes (16 hours) a day, *M* = 231.28 minutes; *SD* = 176.30.[1] The subsequent three questions focused on video games and asked for the average daily time spent playing with a computer, a video game console, or a mobile phone, respectively. For each hardware device, free spaces for the hours and minutes to fill in were provided. Participants played more with PC/MACs (*M* = 63.58 minutes, *SD* = 98.45) than with video game consoles (*M* = 9.65 minutes, *SD* = 23.33) or with a mobile phones (*M* = 6.95 minutes, *SD* = 18.82).

Games played. The participants were asked to note their five favorite video games. These open answers were subsequently assigned to 11 genre categories, which were based on earlier research (Lucas & Sherry, 2004; Holtz & Appel, 2011) and recent developments on the video games market. For each genre, we scored whether or not one or more of the favorite games fell into this category. Details on the genres, including their popularity in the present study, are shown in Table 1.

<Table 1>

Further computer and internet activities. A second set of questions asked for the frequency of using the computer for different other purposes on a five-point scale (1 = never; 5 = very often). The activities asked for were *using the computer at school* (*M* = 4.04, *SD* = 1.08); *doing school-related work at home* (*M* = 4.22, *SD* = 0.88); *programming* (*M* = 2.03, *SD* = 1.20); using *social media* (e.g., online communities and chats, *M* = 4.29, *SD* = 0.98), writing and reading *e-mails* (*M* = 3.61, *SD* = 1.05), and using the computer for *entertainment* (music and movies, *M* = 4.05, *SD* = 1.04).

2.3 Computer literacy measures

The computer literacy scales were taken from the revised version of the computer literacy inventory INCOBI (Richter et al., 2010). As outlined above, this is a theory-based instrument to measure computer literacy that was applied in a number of studies in recent years (e.g., Gauss & Urbas, 2003; Koch wt al., 2008; Wecker et al., 2007; Wittwer et al., 2008, see Appendix).

Theoretical Knowledge (TECOWI). The complete scale of 20 items was employed and showed a good reliability (Cronbach's α = .82). The sum of correct answers served as our indicator of theoretical computer knowledge.

Practical Knowledge (PRACOWI). All 20 items of this scale were employed. The reliability of the scale was good, as indicated by Cronbach's α = .84. The sum of correct answers served as our indicator of practical computer knowledge.

2.4 Computer Anxiety.

Computer anxiety was assessed with the help of the Computer Anxiety Scale (COMA, Richter et al., 2010). This scale consists of eight self-report items that address anxious feelings as well as worries regarding the respondents' own computer use (e.g., "Working with the computer makes me uneasy"). The items are rated on a 5- point scale ranging from -2 (*do not agree*) to 2 (*agree*). Cronbach's α of this scale was .82; the mean of items served as our indicator of computer anxiety.

2.5 Attitudes towards the computer

Positive and negative attitudes towards the computer were assessed with the help of two subscales of the *Questionnaire for the content-differentiated assessment of attitudes toward the computer* (QCAAC, Richter et al., 2000; 2010) which contains eight subscales in total. The dimensions we were particularly interested in referred to positive and negative personal experiences regarding the computer as an instrument for learning and working. Ten items addressed the attitude that the computer is a beneficial tool (e.g., "I find it useful to have a computer handy when I am working or studying", Cronbach's α = .78), and ten items addressed the attitude that the computer is an uncontrollable autonomous entity (e.g., "When I use the computer for work, I constantly worry that it might break down", Cronbach's α = .83). The items went with a 5-point scale ranging from -2 (*do not agree*) to 2 (*agree*). The means of each of the set of ten items were used for subsequent analyses.

3. Results

3.1 Preliminary analyses: Zero-order correlations, data distributions, and assumptions underlying the regression analyses

Table 2 presents the zero-order correlations of the variables involved in the present research, as well as these variables' skewness and kurtosis. The latter results indicate that the distributions of the literacy, anxiety, and attitude measures, as well as the distributions of most of the media use variables were within the range expected from a normal distribution. However, the statistics also indicate extreme scores (absolute values for skewness > 3 and for kurtosis > 10 according to Kline, 2005, who commented on structural equation modeling) for the time spent with computer games, particularly console gaming and handy gaming.[2] Normal distribution of all variables involved is desirable, but not a prerequisite of hierarchical regressions, our main method for data analysis. The assumptions underlying regression analyses do not include the normal distribution of the predictor or criterion variables. Rather, normal distribution is required for the residuals (e.g., Cohen, Cohen, Aiken, & West, 2003). The residuals of the equations reported below met this criterion. Moreover, graphical displays and/or quantitative coefficients indicated that the following assumptions underlying regressing analyses were met: linearity of the relationships between predictor and criterion, constant variance of the residuals (homoscedasticity), and no apparent residual auto-correlation (Durbin-Watson-coefficients ranged between 1.6 and 2.2 which is within the recommended range of 1.5 to 2.5; Hutcheson & Sofroniou, 1999). The analyses involved sufficient cases and sufficient cases per predictor variable. Moreover, the predictors are not very highly correlated, and all VIF coefficients range below 2.10, indicating that multicollinearity did not affect the regression results. In sum, there was no indication that the assumptions underlying regression analyses were violated. For all statistical procedures reported below, two-tailed tests were applied.

<Table 2>

3.2 Gender differences

The descriptive data for female and male participants point at substantial gender differences in many of the variables of the present study (Table 3). Particularly striking are the very large differences in favor of boys on the computer literacy scales. Cohen's *d* in theoretical knowledge amounts to $d = 1.43$ which is approximately the effect size found for gender differences in body height (Manning, 2002). Moreover, girls reported on more anxiety, perceived the computer more than boys as an uncontrollable entity, they spent less time with the computer overall, and used the computer less frequently for entertainment and programming. However, girls are more intensive users when it comes to homework and e-mailing. Girls spent less time playing computer games on either their PC system or on gaming consoles. Referring back to Table 1, both genders differed remarkably with regard to the particular games they prefer to play (see also Carr, 2005; Holtz & Appel, 2011). Girls enjoyed rather basic, easily accessible games, as well as simulations, including those provided by Facebook.com. Boys preferred games that involve shooting or some other form of aggression, racing games, and fantasy games. Although gender differences per se were not the main focus of the present research, these results are noteworthy as they point at distinct computer and internet activities, and – most importantly – they reveal a disconcerting disadvantage for girls with respect to computer literacy.

<Table 3>

3.3 Computer and Internet activities and computer literacy

We expected that the extent to which adolescents use their desktop computer for social media and gaming would be related to less computer anxiety, more favorable attitudes towards the computer, and more practical and theoretical knowledge, our main indicators of computer literacy. A hierarchical regression analysis was conducted to examine these predictions and to analyze the independent relationship of the computer and Internet activities with the literacy criteria (see Table 4, coefficients after final step are reported). Step 1 involved the adolescents' age and gender as control factors. In step 2 the computer and internet activities were entered, and the final step 3 included gaming on the PC/Mac, console gaming, and mobile phone gaming. Please note that the relationships were similar among male and female adolescents.[3]

<Table 4>

Social media. As expected, social media use was related to less anxiety and more practical knowledge; there was no relationship, however, with theoretical knowledge. Similarly, using social media predicted perceiving the computer as a beneficial tool rather than as an uncontrollable autonomous entity.

Time spent with video games. Whereas console gaming and mobile phone gaming were unrelated to the literacy and attitude measures, playing with one's PC/Mac predicted higher literacy, both, theoretical and practical. Moreover, avid computer game players were less likely to perceive the computer as an autonomous entity.

Other daily activities. To no surprise, programming was related to less computer anxiety (as was using the computer for school-related work at home) and more theoretical knowledge, albeit not to more practical knowledge. Using the computer for school-related work at home was also related to more positive and less negative attitudes towards the computer. Less foreseeable was the result that using the computer at school predicted more anxiety and that this activity was unrelated to all other literacy and attitude measures – a finding that may deserve more specific attention in future studies.

3.4 Computer game preferences and computer literacy

In addition to the mere time spent playing, we analyzed the contribution of preferences for particular genres. We conducted a series of regression analyses with the same predictors in the first and second step as before (Step 1 predictors: age and gender; Step 2 predictors: the computer and internet activities). Step 3 was changed and comprised eight variables for the eight most popular video game genres, first-person shooter, parlor games, arcade/jump'n'run, action/adventure, racing, Facebook-games, simulation, and fantasy/role playing. Each of these variables was dummy-coded (did at least one of the favorite games belong to this genre? 0 = no, 1 = yes). The criteria were the computer literacy and attitude variables. Practical computer knowledge was predicted by playing shooters (B = 2.24, SE_B = 0.67, β = 0.22, p = .001), by playing fantasy games (B = 1.70, SE_B = 0.77, β = 0.14, p = .03), and by playing Facebook-games (B = 2.24, SE_B = 0.67, β = 0.22, p = .001). Thus, even when controlling for gender, age, and the computer use variables, players of such games score higher on the test of practical computer literacy. Other significant relationships obtained were that playing fantasy games predicted more theoretical computer knowledge (B = 1.70, SE_B = 0.76, β = 0.14, p = .03), playing shooters predicted less computer anxiety (B = -0.26, SE_B = 0.13, β = -0.16, p = .04), and playing shooters predicted lower scores on the 'autonomous entity' attitude scale (B = -0.26, SE_B = 0.13, β = -0.16, p = .04).

3.5 Mediation analysis

In recent years, social scientists are increasingly interested in third variables that influence the strength and direction of the relationship between two variables of interest (the third variable functions as a moderator) and in third variables that transmit the relationship between two variables of interest (the third variable functions as a mediator; cf. MacKinnon, Fairchild, & Fritz, 2007). Based on previous research, we considered lower anxiety and more positive attitudes as mediators of the relationship between the engagement in social media and computer gaming on the one hand and practical computer knowledge on the other hand. As the time spent gaming was neither a significant predictor of anxiety nor of perceiving the computer as a beneficial tool, the mediation analysis was focused on the relationship between social media use and practical computer knowledge.

The statistical analysis of mediation is most often based on one out of two different approaches. In their seminal paper on mediation, Baron and Kenny (1986) recommended a step-by-step procedure based on a series of regression analyses. This approach has been employed in much of the empirical research on questions of indirect effects and mediation. In recent years, however, the shortcomings of this approach have been emphasized (e.g., its low power to detect mediation, MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). In the current literature on mediation, a bootstrapping analysis is recommended instead (e.g., Hayes, 2009; Preacher & Hayes, 2008). Bootstrapping is a method that is based on a resampling of data and has several advantages, including no distributional assumptions and the possibility to analyze multiple mediators at one and the same time. The SPSS macro created by Preacher and Hayes (2008) for bootstrap analyses with multiple mediators was employed. Practical computer literacy was entered as the criterion, social media use was entered as the predictor variable, and anxiety, and both attitude measures were entered as the proposed mediators. Gender, age, and all computer activities that served as predictors in the regression analysis (school, homework, programming, e-mail, entertainment, PC/Mac gaming, console gaming, handy gaming, see Table 4) served as covariates. The bootstrapping procedure points at the mediational role of computer anxiety, demonstrating that the 95% confidence interval for the indirect effect using 5,000 bootstrap samples did not include zero (lower limit = +0.056, upper limit = +0.557). Neither of the attitude measures was found to be a significant mediator (beneficial tool attitude: lower limit = -0.192, upper limit = +0.158; autonomous entity attitude: lower limit = -0.136, upper limit = +0.157). This finding indicates that part of the relationship between social media use and practical computer literacy can be attributed to a decrease in computer anxiety. More positive attitudes, however, failed to explain the relationship between social media use and practical computer literacy.[4]

To further illustrate the main mediation findings, results of a set of regression analyses are reported, following the well-known stepwise procedure to establish mediation (cf., Baron & Kenny, 1986, see Figure 1). As outlined earlier (Table 4), social media use was a significant predictor of both practical computer knowledge, B = 0.68, SE_B = 0.28, β = 0.16, p = .02 (path c in Figure 1), and anxiety B = -0.13, SE_B = 0.05, β = -0.18, p = .01 (path a in Figure 1). Second, an analysis was conducted that regressed practical computer knowledge on social media use and computer anxiety. Like in the regression analyses reported above, gender, age, and the computer activities served as controls. In this analysis computer anxiety predicted practical computer knowledge, B = -1.87, SE_B = 0.38, β = -0.31, p < .001 (path b in Figure 1), and the regression weight for social media use was no longer significant B = .44, SE_B = 0.27, β = 0.10, p > .10 (path c’ in Figure 1). According to the stepwise approach, this pattern of results indicates that computer anxiety serves as mediating variable of the relationship between social media use and practical computer literacy. In sum, both, bootstrapping and the series of regression analyses suggest that a reduction of computer anxiety could be a link between social media use and practical computer knowledge.

<Figure 1>

4. Discussion

4.1 Synopsis

Computer literacy is an important prerequisite to participate in modern societies. The present study was based on the idea that the amount of time adolescents spend with computer and Internet activities is positively associated with computer literacy. Much of adolescents’ computer and Internet activities take place in their leisure time and a potential acquisition of computer knowledge and skills is likely not a goal that drives adolescents' computer game play or use of social media such as Facebook. Nonetheless, computer literacy can be acquired en passant, without the intention to do so (incidental learning, cf. Marsick & Watkins, 2001) – and more computer literate adolescents likely find computer and Internet activities more appealing than less computer literate adolescents.

Based on a cross-sectional design, we examined the relationship between different forms of computer and Internet use with computer literacy measures of practical and theoretical computer knowledge, computer anxiety, and attitudes towards the computer. In line with our expectations, more frequent use of social media was associated with higher scores on a test of practical computer knowledge. Part of this relationship could be explained by a negative relationship between social media use and anxiety which was in turn associated with practical knowledge (mediation). The time spent with video games on the PC/home computer was associated with an increase in computer knowledge, both practical and theoretical. When the most popular genres were inspected, students who preferred first-person-shooters, fantasy games, and Facebook-games were those who exhibited stronger practical computer literacy than non-gamers of these genres. Moreover, playing fantasy games was related to more theoretical computer knowledge and playing shooters was related to less computer anxiety (these findings were observed when gender, age, and other daily computer activities were statistically controlled for). Regarding the further computer and Internet activities, programming was negatively correlated with computer anxiety and positively correlated with theoretical knowledge, and using the computer for school-related work at home was associated with less computer anxiety, more positive, and less negative attitudes towards the computer. One unanticipated finding was that using the computer at school was unrelated to the literacy and attitude measures, except for a positive relationship with computer anxiety: Those adolescents who worked a lot with the computer at school (at least perceived to do so) indicated more fear when using the computer. This finding is noteworthy, but it should be interpreted with caution. It needs to be replicated, including other regions and for other age samples. Longitudinal studies are of particular value to examine the direction of this relationship.

4.2 Causality and third variable influence

A main limitation of the present findings is that a correlational, cross-sectional design was employed. Thus, the data cannot shed light on the causal sequence underlying the relationships. The current study was motivated by the idea that informal media use may be beneficial for the development of computer literacy, particularly the development of practical computer literacy. However, adolescents may choose to use social media more or to play games because they are more computer literate and not afraid of new media in the first place. We believe that these two causal sequences do not contradict each other; rather, the relationship between computer use and computer literacy is conceived as a reciprocal interaction (cf. Bandura, 1999). Both directions of causal influence may be valid and they may be interdependent. To establish causality and to strengthen the role of anxiety as a mediating variable we expect the present study to be a starting point for longitudinal research, involving at least three times of measurement.

A second limitation of the correlational study design is the potential influence of extraneous variables (third variables). For example, adolescents' age, a likely influential third variable, may influence both, computer and Internet activities (e.g., frequency of e-mailing) and computer literacy (older adolescents outperform younger adolescents in cognitive abilities, including computer literacy). As a result, a potential correlation between the Internet activity and literacy could be inflated due to the influence of the third variable age. To reduce the potential influence of third variables, all results reported (except for the customary table of zero-order correlations) were based on statistical methods that controlled for the influence of age, gender, and all other computer and Internet activities. Thus, when practical computer knowledge was regressed on social media use, the relationship was controlled for – among other variables – adolescents' computer use at school, for their computer use for doing homework, and for their programming activities. Nonetheless, it needs to be noted that we cannot rule out the influence of extraneous variables we did not assess and therefore could not control statistically, given that the research design was non-experimental.

4.3 A cautionary note on 'heavy users'

Throughout the paper the computer and Internet use variables were treated as continuous variables. Moreover, we expected linear relationships between the frequency of computer and Internet activities and computer literacy. No non-linear relationships were discovered. The term 'heavy users' in this paper's title reflects one extreme of a continuum, it is not meant to describe a distinct group. 'Heavy users' in our sample (those with high scores on the continuous measures) are not equivalent to individuals with compulsive Internet use (e.g., van den Eijnden et al., 2008; Meerkerk, van den Eijnden, Vermulst, & Garretsen, 2009) or pathological video game use (e.g., Gentile, 2009). The latter concepts are defined by, among other things, a conflict with others or self-conflict due to computer or Internet use, and withdrawal symptoms (cf. Subramanyam & Smahel, 2011). Previous research showed that problematic Internet use and problematic gaming are positively related to the frequency of use (e.g. Meerkerk et al, 2009: $r = .33$; Gentile, 2009: Cohen's $d = .88$). It is an open question, however, whether individuals who suffer from compulsive Internet use and/or pathological gaming obtain higher scores on measures of practical and/or theoretical computer knowledge.

4.4 Gender Differences

In the current study, associations between computer use and computer literacy were similar for boys and girls, as demonstrated by a lack of interaction effects. However, substantial main effects were observed. Reflecting previous findings (e.g., Holtz & Appel, 2011), girls spent less time with computer games (except for mobile phone gaming), and their game preferences had little overlap with boys' preferences. Parlor games, simulations, and Facebook-games were much more popular among girls than among boys whereas the preferences were reversed for first-person-shooters, action, and fantasy games. Girls used the computer less for entertainment purposes and programming and more for emailing and schoolwork at home. They also reported on more computer anxiety and were more likely than boys to perceive the computer as an autonomous entity. Particularly noteworthy are the very large differences between boys and girls in the computer knowledge scores (*d*s > 1.15). As we have no indication that this result is due to sampling issues or any other third variable, the gender difference appears to be important as it points at a digital divide between both genders in actual ability (Cooper, 2006, but see also Bunz, Curry, & Voon, 2007). Most likely, several factors contribute to this finding. Possibly, one important factor is stereotype and social identity threat, an aversive psychological state that can arise when individuals face an evaluative situation which is associated with a negative stereotype for a group the individual belongs to (stereotype threat), or more generally, the individual feels disregarded due to his or her group status (social identity threat, cf. Aronson & McGlone, 2009; Steele, Spencer, & Aronson, 2002). Computer literacy is still considered to be a male-typed proficiency in many countries worldwide (cf., Volman, van Eck, Heemskerk, & Kuiper, 2005), including Austria where this study was conducted. Thus, stereotype threat might have impaired women during our knowledge test (Spencer, Steele, & Quinn, 1999; Koch et al., 2008) and in prior (informal) learning situations (Appel, under review; Appel, Kronberger, & Aronson, 2011). Future studies are encouraged to examine the antecedents of the substantial gender differences in detail. Moreover, more research on the pervasiveness of gender differences in computer knowledge and abilities is valuable (including its effect sizes), as gender differences in this field may vary with cohorts, age, as well as with the cultural background.

4.4 Conclusion

Computer and Internet use has become a dominant leisure time activity of adolescents in recent years. This study showed that computer gaming on a PC/MAC (but not on a console or a mobile phone) as well as using social media (such as Facebook) is associated with more practical and/or theoretical computer knowledge, whereas the amount of using the computer at school and the amount of using the computer for school-related work at home were unrelated to these computer literacy dimensions. Gaming and using social media extensively may pose adolescents at risk of developing externalizing and/or internalizing behavior problems – but these activities appear to be connected to beneficial attributes such as higher computer literacy as well, possibly because these activities reduce the fear to deal with practical challenges that daily computer use implicates.

References

Anderson, C. A., & Bushman, B. J. (2001). Effects of violent games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. *Psychological Science, 12*, 353-359.

Appel, M. (under review). Stereotypes and the achievement gap: Stereotype threat prior to test taking. *Educational Psychology Review*, accepted pending minor revisions.

Appel, M., Kronberger, N., & Aronson, J. (2011). Stereotype Threat impedes ability building: Effects on test preparation among women in science and technology. *European Journal of Social Psychology, 41*, 904-913.

Aronson, J., & McGlone, C. (2009). Stereotype and social identity threat. In T. D. Nelson (Ed.), *The handbook of prejudice, stereotyping, and discrimination* (pp. 153-178). New York: Guilford.

Bandura, A. (1999). A social cognitive theory of personality. In L. Pervin, & O. John (Eds.), *Handbook of personality* (pp. 154-196). New York: Guilford.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173-1182.

Bunz, U., Curry, C., & Voon, W. (2007). Perceived versus actual computer-email-web fluency. *Computers in Human Behavior, 23*, 2321-2344.

Carr, D. (2005). Contexts, gaming pleasures and gendered preferences. *Simulation and Gaming, 36*, 464-482.

Chua, S. L., Chen, D. T., & Wong, A. F. L. (1999). Computer anxiety and its correlates: A meta-analysis. *Computers in Human Behavior, 15,* 609-623.

Cooper, J. (2006). The digital divide: The special case of gender. *Journal of Computer Assisted Learning, 22*, 320-334.

Dominick G., Friedman, D., & Hoffman-Goetz, L. (2009). Do we need to understand the technology to get to the science? A systematic review of the concept of computer literacy in preventive health programs. *Health Education Journal, 68*, 296-310.

Dworak, M., Schierl, T., Bruns, T., & Strüder, H. K. (2007). Impact of singular excessive computer game and television exposure on sleep patterns and memory performance of school-aged children. *Pediatrics. 120,* 978-985.

Elkins, J. (Ed.) (2010). *Visual literacy*. New York: Routledge.

Gauss, B., & Urbas, L. (2003). Individual differences in navigation between sharable content objects: An evaluation study of a learning modules prototype. *British Journal of Educational Technology, 34*, 499-509.

Geissler, J. E., & Horridge, P. (1993). University students' computer knowledge and commitment to learning. *Journal of Research on Computing in Education*, *25*, 347–365.

Gentile, D. A. (2009) Pathological video game use among youth 8 to 18: A national study. *Psychological Science, 20, 594-602.*

Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature, 423*, 534–537.

Green, C. S., & Bavelier, D. (2006). Effect of action video games on the spatial distribution of visuospatial attention. *Journal of Experimental Psychology: Human Perception and Performance, 32*, 1465-1468.

Greenfield, P. M. (2009). Technology and informal education: What is taught, what is learned. *Science, 323,* 69-71.

Groeben, N. (2002) Dimensionen der Medienkompetenz: Deskriptive und normative Aspekte [Dimensions of media literacy: Descriptive and normative aspects]. In N. Groeben & B. Hurrelmann (Eds.), *Medienkompetenz. Voraussetzungen, Dimensionen, Funktionen* (pp. 160-197). Weinheim: Juventa.

Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs, 76*, 408-420.

Hayes, A. F., Preacher, K. J., & Myers, T. A. (2010). Mediation and the estimation of indirect effects in political communication research. In E. P. Bucy, & R. L. Holbert (Eds), *Sourcebook for political communication research: Methods, measures, and analytical techniques* (pp. 434-465). New York: Routledge.

Holtz, P., & Appel, M. (2011). Internet use and video gaming predict problem behavior in early adolescence. *Journal of Adolescence, 34*, 49-58.

Hull, G., & Schultz, K. (2001). Literacy and learning out of school: A review of theory and research. *Review of Educational Research, 71*, 575-611.

Hutcheson, G. D. & Sofroniou, N. (1999). *The multivariate social scientist: Introductory statistics using generalized linear models*. London: Sage.

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York: Guilford Press.

Koch, S. C., Müller, S. M., & Sieverding, M. (2008). Women and computers: Effects of stereotype threat on attributions of failure. *Computers & Education, 51*, 1795-1803.

Koroboli, S., Togia, A., & Malliari, A. (2010). Computer anxiety and attitudes among undergraduate students in Greece. *Computers in Human Behavior*, *26,* 399-405.

Levine, T., & Donitsa-Schmidt S. (1998). Computer use, confidence, attitudes and knowledge: A causal analysis. *Computers in Human Behavior*, *14*, 125-146.

Lucas, K., & Sherry, J. L. (2004). Sex differences in video game play: A communication-based explanation. *Communication Research, 31*, 499-523.

Maass, A., Klöpper, K. M., Michel, F., & Lohaus, A. (2011). Does media use have a short-term impact on cognitive performance? A study on television viewing and video gaming. *Journal of Media Psychology, 23,* 65-76.

MacKinnon, D. P., Fairchild, A. J., & Fritz, M. S. (2007). Mediation analysis. *Annual Review of Psychology, 58*, 593-614.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods, 7*, 83-104.

Mäkitalo-Siegl, K., Kohnle, C., & Fischer, F. (2011). Computer-supported collaborative inquiry learning and classroom scripts: Effects on help-seeking processes and learning outcomes. *Learning and Instruction, 21*, 257-266.

Manning, J. T. (2002). *Digit ratio: A pointer to fertility, behavior and health.* Piscataway, NJ: Rutgers University Press.

Mar, R. A., Djikic, M. & Oatley, K. (2008). Effects of reading on knowledge, social abilities, and selfhood. In S. Zyngier, M. Bortolussi, A. Chesnokova, & J. Auracher (Eds.). *Directions in empirical studies in literature: In honor of Willie van Peer.* (pp. 127-137). Amsterdam: Benjamins.

Marsick, V. J., & Watkins, K. E. (2001). Informal and incidental learning. *New Directions for Adult and Continuing Education, 89*, 25–34.

Marsick, V. J., Watkins, K. E., & Lovin, B. (2010). Revisiting informal and incidental learning as a vehicle for professional learning and development. In C. Kanes (Ed.), *Elaborating professionalism: Studies in practice and theory* (pp. 59-76). Dordrecht, NL: Springer.

Meerkerk, G. J., Van den Eijnden, R. J. J. M., Vermulst, A. A., & Garretsen, H. F. L. (2009). The Compulsive Internet Use Scale (CIUS): Some psychometric properties. *Cyberpsychology & Behavior, 12*, 1-6.

Naumann, J., Richter, T. & Groeben, N. (2001). Validierung des Inventars zur Computerbildung (INCOBI) anhand eines Vergleichs von Anwendungsexperten und Anwendungsnovizen. [Validation of the Computer Literacy Inventory INCOBI through a comparison of expert and novice computer users]. *Zeitschrift für Pädagogische Psychologie, 15*, 219-232.

Papacharissi, Z. (2002). The virtual sphere: The internet as a public sphere. *New Media and Society, 4,* 9-27.

Potter, W. J. (2005). *Media literacy*. Thousand Oaks, CA: Sage.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*, 879-891.

Poynton, T. A. (2005). Computer literacy across the lifespan: a review with implications for educators. *Computers in Human Behavior, 21*, 861-872.

Richter, T., Naumann, J. & Groeben, N. (2000). Attitudes toward the computer: Construct validation of an instrument with scales differentiated by content. *Computers in Human Behavior, 16*, 473-491.

Richter, T., Naumann, J. & Groeben, N. (2001). Das Inventar zur Computerbildung (INCOBI): Ein Instrument zur Erfassung von Computer Literacy und computerbezogenen Einstellungen bei Studierenden der Geistes- und Sozialwissenschaften [The computer literacy inventory (INCOBI): An instrument to assess computer literacy and computer attitudes]. *Psychologie in Erziehung und Unterricht, 48*, 1-13.

Richter, T., Naumann, J. & Horz, H. (2010). Eine revidierte Fassung des Inventars zur Computerbildung (INCOBI-R). [A Revised Version of the Computer Literacy Inventory]. *Zeitschrift für Pädagogische Psychologie, 24*, 23-37.

Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010). *Generation M². Media in the lives of 8- to 18-year-olds*. Kaiser Family Foundation. Accessed on May 25, 2012 at http://kff.org/entmedia/upload/8010.pdf

Ryan, J., & Capra, S. (2001). *Information literacy toolkit*. Chicago: American Library Association.

Simonson, M. R., Maurer, M., Montag-Torardi, M., & Whitaker, M. (1987). Development of a standardized test of computer literacy and a computer anxiety index. *Journal of Educational Computing Research, 3*, 231-247.

Spencer, S. J., Steele, C. M., & Quinn, D. M. (1999). Stereotype threat and women's math performance. *Journal of Experimental Social Psychology, 35*, 4-28.

Stanovich, K. (1993). Does reading make you smarter? Literacy and the development of verbal intelligence. In H. Reese (Ed.), *Advances in Child Development and Behavior* (pp. 133-180). New York: Academic Press.

Steele, C. M., Spencer, S. J., & Aronson, J. (2002). Contending with images of one's group: The psychology of stereotype and social identity threat. In M. Zanna (Ed.), *Advances in Experimental Social Psychology* (pp. 379-440). San Diego: Academic Press.

Subrahmanyam, K., & Smahel, D. (2011). *Adolescents' digital worlds.* New York, NY: Springer.

Taylor, E., Goede, R., & Steyn, T. (2011). Reshaping computer literacy teaching in higher education*:* Identification of critical success factors. *Interactive Technology and Smart Education, 8*, 28-38.

Tsai, M. J. (2002). Do male students often perform better than female students when learning computers? A study of Taiwanese eighth graders' computer education through strategic and cooperative learning. *Journal of Educational Computing Research, 26*, 67-85.

Tsai, M.-J., & Tsai, C.-C. (2010). Junior high school students' Internet usage and self-efficacy: A re-examination of the gender gap. *Computers & Education*, *54,* 1182-1192.

Ünlüsoy, A., de Haan, M. J., Leseman, P. P. M. & van Kruistum, C. J. (2010). Gender differences in adolescents' out-of-school literacy practices: A multifaceted approach. *Computers & Education, 55*, 742-751.

Valkenburg, P. M., & Peter, J. (2011). Adolescents' online communication: An integrated model of its attraction, opportunities, and risks. *Journal of Adolescent Health, 48,* 121-127.

van den Eijnden, R. J. J. M., Meerkerk, G.-J., Vermulst, A. A., Spijkerman, R., & Engels, R. C. M. E. (2010). Compulsive Internet use among adolescents: Bidirectional parent–child relationships. *Journal of Abnormal Child Psychology, 38*, 77-89.

Volman, M., van Eck, E., Heemskerk, I., & Kuiper, E. (2005). New technologies, new differences. Gender and ethic differences in pupils' use of ICT in primary and secondary education. *Computers & Education, 45*, 35-55.

Wecker, C., Kohnle, C. & Fischer, F. (2007). Computer literacy and inquiry learning: When geeks learn less. *Journal of Computer-Assisted Learning, 23*, 133-144.

Wittwer, J., Nückles, M. & Renkl, A. (2008). Is underestimation less detrimental than overestimation? The impact of experts' beliefs about a layperson's knowledge on learning and question asking. *Instructional Science, 36*, 27–52.

World Economic Forum (2011). *Global talent risk – seven responses*. Geneva: World Economic Forum.

Footnotes

[1] One participant with 960 minutes of daily computer use was identified as an outlier. Without this adolescent, the average daily time spent with the computer would amount to *M* = 227.62 minutes (*SD* = 168.94). Data of this participant were included in the following analyses, however, the results would not change substantially if this adolescent's data was excluded.

[2] Analysis which included a dummy-coding of both variables (0 = zero minutes spent; 1 = more than zero minutes spent playing) did not differ remarkably from the analyses with these variables as continuous measures which are reported in the results section. Transformations of the data (e.g., square-root, logarithm) were considered but discarded, in order to preserve clarity of the interpretation for a broad readership.

[3] To test for the influence of participants' gender, the product terms between the variables in the second and third step (z-standardized) and gender (dummy-coded) were entered as an additional step. No significant interaction effects emerged, except for the following: Computer anxiety was negatively related to doing homework for both genders, with a stronger relationship for girls, and gaming with the phone which was somewhat positively related to anxiety for boys and somewhat negatively for girls. Similarly, gaming with the phone was negatively related to both knowledge measures for boys and somewhat positively for girls.

[4] As an alternative model, we examined whether the relationship between social media use and practical knowledge might be due to both mediators being related in a row (X→M1→M2→Y, i.e., social media use negatively related to anxiety, anxiety negatively related to positive attitudes, which would be positively related practical literacy in turn). A bootstrapping analysis (based on the MED3C SPSS macro, cf. Hayes, Preacher, & Myers, 2010) indicated that this mediation model was not supported by the data, as the 95% confidence interval for the indirect

effect using 5,000 bootstrap samples included zero (second mediator M2 beneficial tool attitude: lower limit = -0.007, upper limit = +0.005; second mediator M2 autonomous entity attitude: lower limit = -0.08, upper limit = +0.10).

Table 1. *Video game genres and preferred games*

Genre	Description	Examples	Among Favorite Games			Gender Differences	
			Total (N=200)	Girls (n=116)	Boys (n=84)	p (exact test)	Effect Size: Cramer's V
First-Person Shooter	Games in which you shoot other characters (involving a first-person perspective)	*Call of Duty, Counterstrike, FarCry*	47	6	41	<.001	.51
Parlor Games	Video game versions of 'old-time favorites'	*Solitaire, Sudoku*	36	33	3	<.001	.32
Arcade/ Jump'n'Run	Rather simple games requiring dexterity and speed, browsergames	*Pinball, Tetris, Super Mario*	34	23	11	.25	.09
Action/ Adventure	Rather complex games involving 'action elements' like shooting and fighting in which you go on an adventure	*Resident Evil, Grand Theft Auto*	32	4	28	<.001	.40
Racing	Games that focus on driving fast in vehicles	*Trackmania, Need for Speed*	31	9	22	<.01	.25
Facebook-games	Rather simple games in which you take care for farming, fish, etc.	*Farmville, Happy Aquarium*	31	29	2	<.001	31
Simulation	Games involving a simulation of (close to) real-life activities	*SimCity, The Sims, Rollercoaster Tycoon*	30	24	6	<.01	.19

Fantasy/Role Playing	Games that let you assume a character role in a typical 'fantasy' environment	*World of Warcraft, Final Fantasy, Gothic*	28	5	23	<.001	.33
Sports	Games based on athletic teams and events	*FIFA Soccer, Ski Challenge*	23	1	22	<.001	.38
Strategy	Games that use strategic planning skills	*Age of Empires, Age of Mythology*	23	7	16	<.01	.20
Activity Games	Games involving a real-life activity or which are meant to improve real-life abilities	*Sing Star, Wii Sports*	8	7	1	.14	.12

Note. Seven expressions could not be identified as a computer game, and therefore could not be assigned to any of the categories.

Table 2. *Skewness, kurtosis, and zero-order correlations of the main study variables*

		Skewness	Kurtosis	1	2	3	4	5	6	7
1	Gender									
2	Age	0.22	-0.89	-.05						
3	Computer Anxiety	0.58	-0.45	-.33***	-.08					
4	Literacy: Theoretical Knowledge	0.33	-0.46	.55***	.18*	-.45***				
5	Literacy: Practical Knowledge	-0.15	-0.58	.51***	.17*	-.47***	.73***			
6	Attitude: Beneficial tool	-0.72	0.60	.14	.02	-.29***	.21**	.22**		
7	Attitude: Autonomous entity	0.59	-0.26	-.28***	.03	.76***	-.35***	-.39***	-.32***	
8	Total Computer Time	1.14	0.86	.35***	.19**	-.41***	.53***	.57***	.38***	-.41***
9	Gaming: PC/Mac	2.70	8.58	.30***	.05	-.19**	.35***	.37***	.15*	-.27***
10	Gaming: Console	3.01	9.67	.27***	.05	-.05	.12	.13	.11	-.04
11	Gaming: Phone	3.61	14.64	-.02	-.08	.03	-.05	.00	.01	-.08
12	Computer at School	-0.86	-0.20	-.04	.21**	.01	.10	.11	.22**	.00
13	Homework	-1.17	1.32	-.19**	.08	-.13	-.07	-.10	.18*	-.07
14	Programming	1.04	0.14	.36***	-.05	-.26***	.42***	.27***	.15*	-.14*
15	E-Mail	-0.54	-0.49	-.27***	.17*	.08	-.07	-.05	-.00	.07
16	Social Media	-1.63	2.51	-.04	-.09	-.14*	.01	.17*	.33***	-.18*
17	Entertainment	-0.99	0.37	.29***	.04	-.19**	.27***	.27***	.20**	-.21**

Note. *** p < .001; **p < .01; * p < .05

Table 2. *(continued)*

		8	9	10	11	12	13	14	15	16
1	Gender									
2	Age									
3	Computer Anxiety									
4	Literacy: Theoretical Knowledge									
5	Literacy: Practical Knowledge									
6	Attitude: Beneficial tool									
7	Attitude: Autonomous entity									
8	Total Computer Time									
9	Gaming: PC/Mac	.46***								
10	Gaming: Console	.04	.07							
11	Gaming: Phone	-.06	.02	-.04						
12	Computer at School	.29***	.10	.06	-.04					
13	Homework	-.23**	-.23**	.00	-.03	.36***				
14	Programming	.36***	.17*	-.01	.14*	.20**	.02			
15	E-Mail	-.08	-.14*	-.10	-.02	-.01	.21**	-.05		
16	Social Media	.26***	.09	-.01	.08	.13	.10	.01	.30***	
17	Entertainment	.28***	.08	.09	.09	.03	.04	.18*	-.06	.16*

Table 3. *Descriptives and gender differences*

	Total (N=200)		Female (n=116)		Male (n=84)		Gender Difference, Significance Level and (Cohen's ds)
	M	*SD*	*M*	*SD*	*M*	*SD*	
Knowledge Scores (number of correct answers)							
Literacy: Theoretical Knowledge	9.98	4.17	8.03	3.20	12.67	3.86	*** (1.43)
Literacy: Practical Knowledge	11.62	4.23	9.79	3.62	14.14	3.77	*** (1.17)
Anxiety and Attitudes (-2 = min, 2 = max)							
Computer Anxiety	-1.06	0.70	-0.86	0.69	-1.32	0.61	*** (0.70)
Attitudes: Beneficial Tool	1.20	0.46	1.15	0.46	1.28	0.56	(0.28)
Attitudes: Autonomous Entity	-0.82	0.69	-0.65	0.67	-1.05	0.64	*** (0.59)
Time spent on an average day (in minutes)							
Total Computer Time	80.07	104.39	50.41	74.39	121.03	124.63	*** (0.83)
Gaming: PC/Mac	63.56	98.20	38.88	66.08	97.64	122.65	*** (0.74)
Gaming: Console	9.60	23.28	4.24	14.75	17.00	30.03	*** (0.69)
Gaming: Phone	6.91	18.78	7.28	19.02	6.39	18.53	(0.05)
Further computer use (1=min, 5 = max)							
Computer at School	4.04	1.08	4.08	1.07	3.99	1.09	(0.08)
Schoolwork at Home	4.22	0.87	4.36	0.81	4.02	0.93	** (0.39)
Programming	2.03	1.20	1.66	0.91	2.54	1.37	*** (0.88)
E-Mail	3.62	1.05	3.86	0.93	3.29	1.13	*** (0.61)
Entertainment	4.05	1.04	3.79	1.14	4.40	0.76	*** (0.65)
Social Media	4.29	0.98	4.31	0.94	4.25	1.03	(0.07)

Note. *** $p < .001$; ** $p < .01$

Table 4. *Literacy and attitudes regressed on computer and Internet activities*

	Literacy Criteria								
	Anxiety			Literacy: Theoretical Knowledge			Literacy: Practical Knowledge		
	B	SE_B	β	B	SE_B	β	B	SE_B	β
Intercept (B_0)	1.97	0.88		-9.82	4.53		-9.86	4.83	
Step 1:									
Gender	-.35	.11	-.25**	3.53	.57	.42***	3.58	.61	.42***
Age	-.11	.05	-.15*	.79	.25	.18**	.81	.27	.18**
Step 2:									
Computer at School	.13	.05	.21**	.03	.25	.01	.17	.26	.04
Homework	-.22	.06	-.27***	.12	.30	.03	-.13	.32	-.03
Programming	-.10	.04	-.17*	.82	.22	.24***	.24	.23	.07
E-Mail	.09	.05	.13	.21	.25	.05	.11	.27	.03
Social Media	-.13	.05	-.18*	-.06	.26	-.01	.68	.28	.16*
Entertainment	-.02	.05	-.04	.34	.24	.08	.38	.25	.09
Step 3:									
Gaming: PC/Mac	-.06	.030	-.13	.46	.15	.18**	.52	.16	.20**
Gaming: Console	.06	.12	.03	-.15	.62	-.01	-.12	.66	-.01
Gaming: Phone	.03	.15	.01	.03	.75	.00	.13	.79	.01

Note. *** $p < .001$; **$p < .01$; **$p < .05$

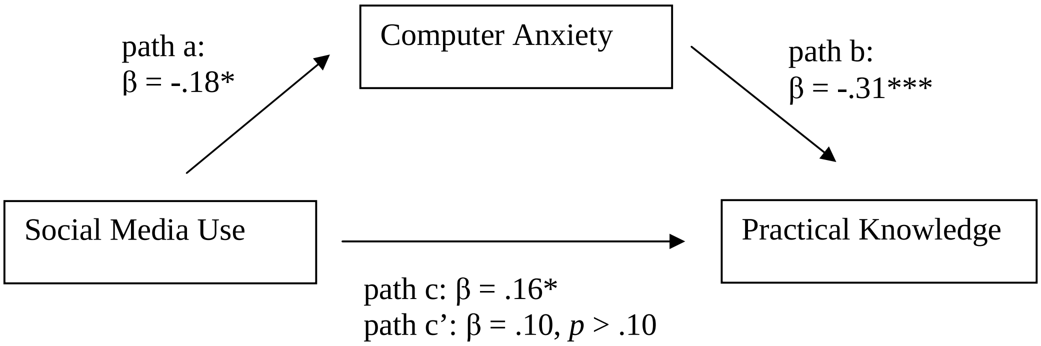
Table 4. (continued)

	Attitudes towards the computer					
	Beneficial tool			Autonomous entity		
	B	SE_B	β	B	SE_B	β
Intercept (B_0)	-.35	.60		.47	.90	
Step 1:						
Gender	.06	.08	.06	-.29	.11	-.21*
Age	.02	.03	.03	-.01	.05	-.01
Step 2:						
Computer at School	.04	.03	.08	.08	.05	.12
Homework	.09	.04	.17*	-.16	.06	-.21**
Programming	.03	.03	.06	-.02	.04	-.04
E-Mail	-.04	.03	-.09	.05	.05	.07
Social Media	.15	.03	.31***	-.12	.05	-.17*
Entertainment	.04	.03	.10	-.05	.05	-.08
Step 3:						
Gaming: PC/Mac	.03	.02	.10	-.09	.03	-.22**
Gaming: Console	.08	.08	.07	.07	.12	.04
Gaming: Phone	-.01	.10	-.01	-.14	.15	-.06

Figure Caption

Figure 1. The relationships between social media use, computer anxiety, and practical computer knowledge (standardized regression weights).

Figure 1.



Notes. * $p < .05$; *** $p < .001$

Appendix A

Sample items of the computer literacy inventory INCOBI-R (Richter et al., 2010) – Theoretical Computer Knowledge subscale (TECOWI)

Instruction (excerpt):
Your task for each of the problems is to choose the most likely alternative from the answers provided. If you do not know how to solve the described problem, do not guess the answer, but check ‘‘I don’t know”. Please read all alternatives closely and then choose your answer, you have enough time.

"IP Address"

(a) Code for distinct identification of a computer in a network
(b) Code for distinct identification of the memory device on the hard drive
(c) Code for the distinct identification of an information provider on the internet
(d) Code for distinct identification of an e-mail address on the mail server

I don't know

"SQL"

(a) Programming language for the presentation of animated graphics
(b) Database language for relational databases
(c) Structured programming environment for webpages
(d) Protocol for data transfer / transmission via the internet

I don't know

"Kernel"

(a) Alternative name for the operating system Linux
(b) Core element of the central processing unit (CPU)
(c) Central component of an operating system
(d) Elementary storage unit for windows files

I don't know

Appendix B

Sample items of the computer literacy inventory INCOBI-R (Richter et al., 2010) – Practical Computer Knowledge subscale (PRACOWI), see also Koch et al., 2008

Instruction (excerpt):
This is a questionnaire about practical computer knowledge (i.e., knowledge that is relevant when you use or work with a computer). Your task for each of the problems is to choose the most likely alternative from the answers provided. If you do not know how to solve the described problem, do not guess the answer, but check ‘‘I don’t know”. Please read all alternatives closely and then choose your answer, you have enough time.

"Your mouse does not work and you want to close the program that is open. What do you do?"

(a) I will close the program pressing the buttons ‘Ctrl’ + ‘End’. Alternatively the program can be closed pressing the buttons ‘Alt’ + ‘F 3’

(b) I will close the program pressing the button ‘Ctrl’ and in the meantime pressing the buttons ‘End’ + ‘Enter’. Alternatively the program can be closed pressing the buttons ‘Alt’ + ‘F 6’

(c) I will close the program pressing the buttons ‘Shift’ and ‘End’. Alternatively the program can be closed pressing the buttons ‘Alt’ + ‘F 5’

(d) I will close the program pressing the button ‘Alt’ and in the meantime pressing the buttons ‘F’ and ‘X’ after each other. Alternatively the program can be closed pressing the buttons ‘Alt’ + ‘F 4’

I don't know

"You receive a document as a zip-archive. What do you do?"

(a) I will open the document as usual using my word processing program

(b) I will unpack the program using Windows data explorer

(c) I will displace the file on my desktop using the mouse – in that way, the program is automatically unpacked

(d) I will change the extension of the file from *.zip to word extension *.doc. Then it becomes possible to open the file in word

I don't know

"You want to prevent that other people can track your internet behavior. Which action contributes to this goal?”

(a) I access the control panel and I delete the IP-address of my computer under the network connections menu

(b) I access the control panel and I modify the security adjustments that ny computer is invisible on the internet for other users

(c) I delete all cookies and I specify in the adjustments of my web-browser that no cookies must not be accepted

(d) I delete the MAC-address of my computer and I specify in the control panel that no new MAC-addresses must be obtained

I don't know