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Mamdouh Hassan

Vrije Universiteit Brussel

Benny Geys
BI Norwegian Business School

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Expectations, Realizations, and Approval of Tablet Computers in an Educational Setting[*]

Mamdouh Hassan [a] and Benny Geys [a, b]

[a] Vrije Universiteit Brussel, Department of Applied Economics, Pleinlaan 2, B-1050 Brussel, Belgium; email: mhassana@vub.ac.be

[b] Norwegian Business School BI, Department of Economics, Nydalsveien 37, N-0442 Oslo, Norway; email: Benny.Geys@bi.no

Abstract

The introduction of new technologies in classrooms is often thought to offer great potential for advancing learning. In this article, we investigate the relationship between such expectations and the post-implementation evaluation of a new technology in an educational setting. Building on psychological research, we argue that *i)* high expectations (*ex ante*) can undermine the approval ratings of new technologies (*ex post*); and *ii)* individuals' post-implementation evaluations are more likely to exceed their expectations when they can exert power over the introduction of a new technology. We test these predictions on a sample of 750 respondents from primary and secondary schools in Flanders with and without tablet computers. Our findings are supportive of both theoretical predictions.

Keywords: Tablets, Technology acceptance theory, Education, Survey, Belgium.

Word count: 8460 words

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1. Introduction

New technologies often create high expectations. In at least some cases, these high expectations also appear to be realized. A vast academic literature has indeed indicated that the introduction of new technologies in an educational environment – such as portable computers and, more recently, tablet computers (henceforth 'tablets') – can play a major role in the way students learn (Rossing *et al*., 2012; Falloon, 2013), as well as in the way instructors teach (Culp *et al.*, 2005; Pegrum *et al*., 2013). It has been associated with better test scores (e.g., Gulek and Demirtas, 2005; Ferrer *et al*., 2011; see, however, Sana *et al*., 2013, for a more critical view), higher student engagement and motivation (Martin and Ertzberger, 2013), and lower socio-economic inequality due to place of birth, gender and parental education (e.g., Ferrer *et al*., 2011).

In this study, we focus on tablets, which have recently received particularly widespread interest and implementation experiments in educational settings across Western countries. As such, it is particularly important to improve our understanding of what determines stakeholders' opinions towards these devices. From a technological perspective, tablets contain many features – including high mobility, connectivity, and integrated video- and sound options – that in principle can benefit learning in classroom settings (Lawless and Pellegrino, 2007; Couse *et al*., 2010). Especially the combination of its lightness, mobile connectivity and flexibility offers significant potential benefits over other technologies. Even so, given that technological innovations often fail due to a lack of approval by its target audience (Moran *et al.*, 2010; Ifenthaler and Schweinbenz, 2013), a successful adoption of tablets in schools depends on (potential) users' approval and endorsement. From this point of view, it is important to understand the drivers of such user approval.

In this article, we provide one step towards this aim, and particularly focus on whether (potential) users' opinions towards the introduction of new technologies in educational settings are affected by their *ex ante* expectations about the technology. Building on psychological research (Festinger, 1957; Caplin *et al.*, 2010; Rutledge *et al*., 2014), we argue that *i)* high expectations (*ex ante*) can generate a negative difference between expected and actual outcomes (referred to as 'reward prediction error'), which works to undermine the approval ratings of new technologies (*ex post*); and *ii)* individuals' post-implementation evaluations are more likely to exceed their *ex ante* expectations when they can exert power over the introduction of a new technology (deriving from a post-hoc rationalization of one's decision).

We test these predictions on a sample of 750 respondents obtained using an online survey distributed via email to almost 3,000 Flemish primary and secondary schools with and without tablet computers. The final respondent sample includes school principals, teachers, ICT-administrators and parents, which is important since these various user groups tend to have *both* varying *ex ante* expectations (important for our first research hypothesis) *and* different degrees of power over the introduction of tablet computers in schools (important for our second research hypothesis).[1] Our main results can be summarized as follows. First, we find that user groups with high *ex ante* expectations tend to have lower *ex post* approval ratings. This finding is in line with our first hypothesis, and conforms to a large psychological literature arguing that high expectations are more likely to induce disappointment *post hoc* (Kahneman and Tversky, 1979; Köszegi and Rabin, 2006; Caplin *et al.*, 2010; Rutledge *et al.*, 2014). Second, in line with our second hypothesis, we show that user groups exerting direct power over the introduction of

[1] We did not include students for two reasons. First, students have been the focus of the majority of existing research on ICTs in education (see also section 2.2 below). Second, focusing on stakeholders that have thus far received little attention (such as parents, principals and ICT-administrators) provides an important way to broaden the scope of the literature, and add to our *overall* understanding of the acceptance of ICTs in schools.

tablets (school principals and ICT-administrators) display a larger positive difference in tablet approval across schools with and without tablets, *ceteris paribus*.

2. Tablets in education: Costs, benefits and approval

2.1. Theoretical background

User approval of technological innovations can be studied at either the micro- or the macro-level using distinct theoretical frameworks. Diffusion theory offers a framework to understand the acceptance or rejection of technological innovations at the level of groups (Rogers and Shoemaker, 1971; Rogers, 1983). It studies "the process in which an innovation is communicated thorough certain channels over time among the members of a social system" (Rogers, 1983, p. 5), and elucidates the spread of adoptions from 'innovators' (or early adopters) to 'laggards' (or late adopters). At the individual level, the Concerns-Based Adoption Model (CBAM) analyses the needs of stakeholders involved in the implementation of an innovation (Van den Berg, 1993; and references therein), while the Technology Acceptance Model deals with the elements affecting the acceptance or rejection of a technological innovation (Davis, 1989; Davis *et al.*, 1989). Given our empirical focus, our theoretical argumentation builds on – and extends – the Technology Acceptance Model.

The Technology Acceptance Model was originally developed to predict the usage of technological innovations, and is therefore mainly concerned with (the drivers of) individuals' behavioral intention to use a new technology (Legris *et al.,* 2003). The theory maintains that users' behavioral intention to accept or reject an information technology – and subsequent actual system usage – is determined by the perceived ease of use and the perceived usefulness of the technology (Davis, 1989; Davis *et al.*, 1989). Perceived usefulness is the extent to which a person

thinks that using a given technology will benefit his/her job performance[2], whereas perceived ease of use is an individual's expectation regarding the convenience of using a new technology (Venkatesh and Davis, 2000). External variables (such as system characteristics, task-technology fit, or support and training) can influence both perceived ease of use and perceived usefulness, but are not modeled explicitly in the original version of the Technology Acceptance Model.[3] Moreover, perceived usefulness increases with the perceived ease of use, since technologies perceived as overly complicated will tend to be viewed as less advantageous and valuable to users (Davis, 1989; Davis *et al.*, 1989).

Although the Technology Acceptance Model has proven a useful model for explaining the success or failure of new technology systems (for reviews, see Venkatesh and Davis, 2000; Legris *et al.*, 2003), it predominantly concerns the behavioral intention to accept or reject a new technology. As such, a key variable of interest is (potential) users' attitudes towards the technology in the phase *before* they use the technology. More recent extensions and applications of the model have, however, also taken into account users' attitudes in the phase *after* the technology has been introduced (e.g., Pikkarainen *et al*., 2004; Hernandez and Mazzon, 2007; Hernandez *et al.*, 2009; Hanafizadeh *et al*., 2014). This is a critical extension since user opinions not only affect the probability of technology introduction (i.e. *ex ante*), but are also affected by one's experience with the technology (i.e. *ex post*) (see also Bonds-Raacke and Raacke, 2008). This implies that using a technology may well feed back into users' perceptions of the usefulness

[2] 'Job performance' refers to the effectiveness and efficiency with which people perform specific tasks – i.e. whether or not (s)he performs a job accurately, appropriately and effectively. This can be applied to teachers, students, or any other relevant stakeholders. For instance, if tablets help teachers to prepare and run their classes in a more professional and effective way, then it improves their 'job performance'. Likewise, if students' educational achievement improves by using tablet in classrooms, it helps their 'job performance', and so on.

[3] For a more explicit modelling of such factors, see, for instance, Agarwal and Prasad (1997), Igbaria et al. (1997), Dishaw and Strong (1999), Karahanna et al. (1999), Lucas and Spitler (1999), Venkatesh and Davis (2000), Venkatesh and Morris (2000). Note also that the effectiveness of any change practice is likely to depend on the interdependence among the technology and organizational and social factors (Orlikowski and Hofman, 1997), leading to the extension of the Technology Acceptance Model via so-called social influence effects (i.e. subjective norms, image, and voluntariness) as well as cognitive effects (i.e. job relevance, output quality, etc.).

and ease of use of new technologies (indicated by the bold arrows in figure 1), and thereby their attitude towards the technology. One reason for such a 'feedback loop' is that usage can induce a validation or rejection of what Ifenthaler and Schweinbenz (2013) refer to as potential users' 'performance anticipation'. Most basically, the costs and benefits of a new technology are difficult to anticipate without actually experiencing it. Consequently, using a new technology can result in a reappraisal of its (lack of) usefulness and ease of use. This, in turn, will affect user attitudes towards the new system.[4]

Figure 1 about here

Taking this feedback loop into account puts user attitudes towards new technologies at the heart of the model (highlighted by the bold-face typescript in figure 1), and generates testable hypotheses regarding *ex ante* and *ex post* user attitudes towards new technologies.

First, as mentioned, the technology acceptance literature maintains that potential users may hesitate to use new devices when they do not recognize any advantages for their (job) performance (Venkatesh and Davis, 2000; Venkatesh *et al.*, 2003). The feedback loop induced by actual technology usage highlights that higher levels of performance anticipation may also have important additional effects. Indeed, high expectations regarding the perceived usefulness of a technology – which benefit the actual acceptance or introduction of a new technology (see above) – have in the psychological literature been argued to induce disappointment after the fact. Rutledge *et al.* (2014: 12255), for instance, define momentary happiness as "the state that reflects

[4] Our argument here is conceptually closely related to the idea that painful medical procedures are remembered as less unpleasant when they have led to a less painful period (see Kahneman et al., 1993; Redelmeier and Kahneman, 2003). The reason is that individuals' attitudes towards a given experience (in our case, usage of a new technology) mostly depend on how experiences were at the peak and end phases (known as the peak-end rule; Kahneman, 2000).

not how well things are going, but instead whether things are going better than expected". They argue – and empirically validate using brain-scanning technologies – that expectations and beliefs not only "play a central role in theories of decision-making and learning" (Caplin *et al.*, 2010, 923), but also affect individuals' happiness in the sense that low expectations increase the probability of positive emotions later on (and vice versa) (Rutledge *et al.*, 2014).[5] The idea is that high expectations are more likely to generate a (negative) difference between one's expected and actual outcome (referred to as the 'reward prediction error'). This, in turn, will generate a (negative) utility shock, and thereby engender feelings of disappointment. In our setting, this line of argument would imply that high levels of performance *anticipation* may lower the approval ratings when the technology is actually employed. This is reflected in our first testable hypothesis:

H1: *High performance anticipation (ex ante) lowers the approval ratings of new technologies (ex post).*

Second, Venkatesh and Davis (2000: 188) argue that voluntariness – defined as "the extent to which potential adopters perceive the adoption decision to be non-mandatory" – plays an important role as one of the external variables moderating the behavioral intention to accept or reject a new technology. In our extended version of the Technology Acceptance Model, voluntariness can play an important additional role. Specifically, bearing in mind the core tenet of cognitive dissonance theory – i.e. that people experience mental stress or discomfort from cognitions that are inconsistent with one another, and thus strive to reduce or avoid dissonant views (Festinger, 1957) – voluntariness may affect how users evaluate a technology *after* it was

[5] Decision-makers' reference points – in part determined by their expectations and beliefs – are also central to "theories of reference-dependent choice, such as loss aversion" (Caplin et al., 2010, 924; see also Kahneman and Tversky, 1979; Köszegi and Rabin, 2006).

introduced. Choosing to adopt a technology – rather than having it forced upon them – may indeed bias individuals to focus on the positive aspects of the technology and downplay any negative effects that materialize. Clearly, such selective judgment of the subsequent evidence amounts to a form of *post-hoc* rationalization of one's choice, and is a rational response to the investment of a significant amount of time, effort and money in the new technology. This implies, however, that individuals most directly involved in the choice to introduce a new technology (in our setting, this concerns school principals and ICT-administrators) are most likely to adjust their attitudes towards a new technology upwardly *after* its introduction. This is reflected in our second testable hypothesis:

H2: User power over technology introduction bolsters approval ratings following its introduction.

2.2. Existing empirical evidence

Previous empirical work on user approval of tablets (in particular) and new technological innovations (in general) in education has mostly been conducted in the United States (e.g., Davis *et al.*, 1989; Venkatesh and Davis, 2000; Finn and Inman, 2004; Bonds-Raacke and Raacke, 2008; Sommerich *et al.*, 2007; Moran *et al.*, 2010; Weisberg, 2011); with some recent studies done in Germany (Ifenthaler and Schweinbenz, 2013) and Singapore (Teo *et al.*, 2008). Moreover, the majority of studies have concentrated on higher education (for a recent exception, see Ifenthaler and Schweinbenz, 2013), and the opinions of students (Finn and Inman, 2004; Bonds-Raacke and Raacke, 2008; Sommerich *et al*., 2007; Moran *et al*., 2010) and teachers (Teo *et al*., 2008; Ifenthaler and Schweinbenz, 2013; Vanderlinde *et al.*, 2014). We briefly review this literature – which will also serve to highlight the empirical contributions of our own analysis in section 3.

Previous work finds that students usually approve technological innovations in education (Bonds-Raacke and Raacke, 2008). The reasin is that students feel more integrated in the learning process thanks to the introduction of technological educational tools. A German study conducted by Schaumburg (2001), for instance, discovered that students who received portable computers were more likely to express positive feelings about their role in learning, as well as about the communication between students and tutors or principals. This result was confirmed in a study of educational tablet usage by Sommerich *et al.* (2007). They report that 67% of the students with access to tablets agreed that such devices helped them to communicate better with other students, while 42% reported that tablets helped them to interact more closely with their teachers. Similarly, Bonds-Raacke and Raacke (2008) find that tablets made students feel more integrated in schools by making classrooms more active and communicative. Closely related, Alvarez *et al.* (2011) found that students with tablets were more self-confident to express their own ideas. These findings are consistent with the idea that tablets in classrooms reinforce collective communications (Alvarez *et al.*, 2011), and are likely to have a positive effect on social development among students (Straker and Pollock, 2005).

In the literature on *teachers'* opinions regarding technological advancements in educational settings, tablets tend to trigger a more mixed response. Although some teachers successfully integrate tablet into classes, others consider them as a source of distraction or express doubts about the technology's (general) applicability (Ifenthaler and Schweinbenz, 2013; Kim *et al.*, 2013; Vanderlinde *et al.*, 2014). More generally, scholars have argued that "the strongest barriers preventing other teachers from using technology were their existing attitudes and beliefs toward technology, as well as their current levels of knowledge and skills" (Ertmer *et al*., 2012, p. 423). This includes both their pedagogical beliefs (Liu, 2011; Ertmer *et al*., 2012), their beliefs in terms

of “epistemology and conceptions of teaching” (Kim *et al*. 2013, p. 76), and their self-efficacy beliefs (defined as their self-perceived “abilities within a given domain”; Abbitt, 2011, p. 136). As such, teacher beliefs are held to constitute a second-order barrier to technology integration, which is independent of the first-order barriers external to the teacher (such as hardware and software resources, training, and support) (Ertmer, 1999, 2005).

Overall, while previous work has extended our understanding of technology acceptance among students and teachers, there is very little literature about how technology affects other stakeholders – such as school principals, ICT-administrators or parents. Since school principals and ICT-administrators have a larger say in the decision to introduce new technologies than parents and teachers, and generally also differ in terms of *ex ante* expectations regarding the potential for advancing learning offered by new technologies, we aim to cast a wider net in order to address our key propositions. In the next section, we thus move beyond the opinions of students and teachers.

3. Empirical analysis

3.1. Survey design and data

Our empirical approach consists of a four-by-two research design where we compare four groups of users (school principals, teachers, ICT-administrators and parents) under two conditions (presence or absence of tablet computers in the school). Our data collection relied on an online closed-form survey administered between May and July 2014. We distributed a link to this survey among 679 Flemish secondary schools and 2293 Flemish primary schools, and asked them to circulate it among their staff. Although we did not know in advance which schools had tablets in their ICT infrastructure, one third of all responses in our sample was from schools making use of tablet computers. To reach parents, we collaborated with a magazine called *Klasse*

voor ouders (“Education for parents”) – a monthly magazine in the Flemish region providing parents with information about schools, teaching, and broader educational tips – that uploaded a link to our survey on its website and mentioned it in its newsletter.

The survey collected information about a number of characteristics of the respondent (including sex, age, education level, marital status, and interest in ICT). Two key questions enquire into respondents’ assessment of tablet computers in schools. The first question asks: “*What is your assessment of the use of tablet computers in an educational environment?*”. Responses are collected on a five-point scale from 1 (‘very negative’) to 5 (‘very positive’), and are referred to below as the variable *General Evaluation*. The second question includes a more explicit reference to the potential costs of tablet computers in schools: “*How do you judge the costs and benefits of using tablet computers in an educational environment? The costs exceed the benefits*”. Answers are again collected on a five-point scale ranging from 1 (‘fully disagree’) to 5 (‘fully agree’), and constitute the variable *Cost-Benefit*. To minimize contamination of answers on the second question by answers on the first question, both questions were separated from each other in the survey by a series of questions regarding the actual use of media and ICT in the school.

It is important to observe that, ideally, we would have liked to present our central survey questions to the same respondents *before* and *after* a school introduces tablets in its ICT infrastructure. Although this would allow to evaluate any individual respondent’s ante expectations and ex post evaluation most directly, this was practically unfeasible. Alternatively, we could have explicitly asked respondents from schools with tablets to make two evaluations of tablets: i.e. one retrospective evaluation of the situation before tablets and one present evaluation after the situation after tablets. This approach, however, is likely to induce a correlation between people’s answers on the ‘ex ante’ and ‘ex post’ questions in the same survey

– which would lead to biased inferences in the subsequent empirical analysis. Given these difficulties, we opted for an alternative approach where we asked our central survey questions once to all respondents. Responses in the set of schools *without tablets* provide our approximation for individuals' ex ante expectations, while responses in the set of schools *with tablets* provide our approximation for ex post evaluation of technologies. We will return to the possible implications of this approach for our inferences in more detail below.

We received 877 valid responses to our survey: 283 from parents, 355 from teachers, 126 from school principals, and 113 from ICT-administrators. Since each school has one unique principal and ICT-administrator (given the relatively small size of most schools in Flanders), the response rate for principals and ICT-administrators is about 4%. This is admittedly low, and in part derives from our inability to remind people of our survey. Note also that we have no way of estimating how many parents followed the link that was uploaded by Klasse (see above), or how many schools forwarded our survey to their teachers. As such, we unfortunately cannot calculate the overall, nor the group-specific, response rates of our survey. This has important implications for the external validity of our empirical results. Still, this is less problematic given that we are predominantly interested in generalizing towards the theory (i.e. theory development) rather than the population (i.e. policy implications). After removal of respondents lacking all information necessary for the analysis below, the final sample contains just over 750 respondents.

Figure 2 – which represents the distribution of responses to our two key survey questions (*General Evaluation* and *Cost-Benefit*) – indicates at best a lukewarm attitude towards tablets. The median of the distribution in both cases lies at the midpoint of our five-point Likert scale, even though the distribution itself tends to be skewed slightly towards positive attitudes. The latter observation is more pronounced for the question enquiring about respondents' *General*

Evaluation of tablets, which suggests that merely mentioning the costs involved in introducing tablets already reduces respondents' approval rating.

The summary statistics detailing the characteristics of the respondents are provided in table 1. The average age of our respondents is 42 years (standard deviation = 9.75 years), whereas 66% are female, 78% are married, 32% have a college or university degree, 69% own a tablet computer, and 75% are registered on at least one social media website (most often Facebook). The sample is likewise evenly spread across primary and secondary schools, as 47% of respondents work, or have children in, a secondary school. Finally, the bottom three rows of table 1 (variables TabletOwner, SocialMedia and GadgetBuyer) show that our respondents are individuals with a strong interest in ICT. Self-selection of ICT-oriented individuals into the sample is likely to increase the approval ratings for tablets in education, and thus lead to an over-optimistic appraisal of the societal acceptance of tablets in schools. Nonetheless, this positive bias is less problematic for the central part of our analysis, since we predominantly study the *relative* acceptance of tablets across school principals, teachers, ICT-administrators and parents. Unless self-selection of ICT-oriented individuals varies systematically across these different groups of respondents or ICT-orientation variously affects the opinions of individuals depending on their role in the school – which appears intuitively unlikely – it should not affect the *relative* assessments made below.

Table 1 and Figure 2 about here

Before turning to the analysis, it should be noted that parents and school respondents were recruited via different avenues (see above). This directly implies that contextual characteristics

such as the use of technologies in formal setting (school) and informal setting (home) are delinked. Unfortunately, however, it was impossible for us to recruit parents and school respondents in a way that allowed linking their contextual characteristics. Any such linkage was complicated further by the strict anonymity requirements imposed on our survey, which prevented us from including questions that allowed identification of specific schools and link the data from the survey to external data sources about the schools. To nonetheless account for potential effects deriving from the use of tablets in respondents' non-school settings (i.e. at home), we included questions on respondents' private ownership of tablet computers and their overall interest in ICT – and control for this in the analysis below.

3.2. Empirical approach

In this section, we turn to hypotheses H1 and H2, and set out the methodological approach followed to compare (the drivers of) approval of tablet computers across school principals, teachers, ICT-administrators and parents in schools with and without tablet computers. We rely on two complementary empirical methods. The first empirical approach employs non-parametric tests assessing the equality of medians across groups, and Mann-Whitney U tests evaluating whether two samples share their distributional characteristics (Wilcoxon 1945; Mann and Whitney 1947).[6] The second empirical approach builds on ordered logistic regression models.

Mann-Whitney U tests evaluate the null hypothesis that two samples are likely to have come from the same population (in terms of its distributional characteristics). The alternative hypothesis is that the two samples derive from populations with a different distribution (Wilcoxon 1945; Mann and Whitney 1947), which would imply that respondents express

[6] We rely on comparison of the median rather the mean because our central dependent variables are ordinal scales, such that the mean of the responses arguably has very limited meaning (unlike the median).

different attitudes towards tablets for educational purposes. Intuitively, a validation of the null hypothesis thus implies that both groups exhibit the same probability of having low or high ranks. This test procedure does not require any assumptions regarding the characteristics of the distribution from which the preference order samples are drawn. This is important because the distribution is *a priori* unknown, which requires a sufficiently general test procedure. Also, since the test procedure compares two samples, this stage of the analysis will engage in pair-wise assessments of approval rates. As such, we compare respondents from schools with tablets to respondents from schools without tablets, parents to teachers, parents to principals, and so on. Nonetheless, to accommodate the fact that we generally compare more than two groups, we also run non-parametric K-sample tests on the equality of medians across all groups (i.e. parents, teachers, principals and ICT-administrators, or tablet and non-tablet schools).

Depending on the direction of any observed shift in the distribution, we can employ the Mann-Whitney U tests also to evaluate whether certain groups of respondents are more or less sympathetic towards tablets in schools. To obtain an easily interpretable estimate for such effect sizes, we report the immediate Mann-Whitney statistic. It is calculated as the "proportion of pairs in which cases of one type (…) have a higher value for the dependent variable than do cases of the other type" (Goldstein, 1997, 29). The result can be interpreted as representing the "probability that a randomly selected member of one group will have a better result than a randomly selected member of the other group" (Goldstein, 1997, 29).

Our second set of tests employs a parametric methodology based on an ordered logistic regression model (which accommodates the ordinal ordered nature of our dependent variables). While necessitating the specification of a particular functional form, this approach provides the opportunity to control for respondents' background characteristics (which may affect their

approval of tablets), and thus learn more about the *drivers* of expressed approval levels. The estimation model takes the following basic form (with subscript *i* for respondent *i = 1,…,N*).

$$Approval_i = \alpha + \beta_1 Parent_i + \beta_2 Teacher_i + \beta_3 Principal_i + \beta_4 Tabletschool_i + Controls_i + \varepsilon_i \quad (1)$$

Where *Approval* either reflects respondents' answers to the general tablet evaluation question (*General Evaluation*), or to the cost-benefit question (*Cost-Benefit*). The regression model is estimated separately for the two dependent variables. The central independent variables are three indicator variables reflecting respondents' role in the school (i.e. parent, teacher or principal; ICT-administrators are the excluded reference category) and an indicator variable for the presence of tablets in the school (*TabletSchool*). These two sets of variables jointly allow us to evaluate the empirical validity of hypotheses H1 and H2. The set of control variables ($Controls_i$) includes respondents' sex, age (in years), marital status (1 if married, 0 otherwise), education level (i.e. medium or high; low is the excluded reference category), and interest in ICT (dummies for owning a tablet, being on social media, and being first to buy new electronic gadgets). Finally, as the survey was distributed among primary and secondary schools, we also include an indicator variable for respondents linked to secondary schools.[7]

3.3. Main findings

Non-parametric comparisons

We start our discussion with the results from the group-wise comparisons. Figure 3 documents the distribution of approval ratings across the four user groups. As can be seen, the ratings vary only marginally when taking together tablet and non-tablet schools. In fact, using non-parametric

[7] The financing scheme of tablets in schools in Flanders varies substantially among schools. Some finance the adoption of tablets from their own budget (generally at the expense of other issues), while others add the cost to parents' school bills or require children to bring their own tablet. Although this financial approach may affect expressed approval ratings, we unfortunately lack the necessary information to assess this in our empirical model. We return to this in our concluding discussion.

K-sample tests on the equality of medians across all groups, we cannot reject that the medians are the same when using *General Evaluation* as our approval measure (Pearson $chi^2(3) = 2.1261$, $p = 0.547$). When using *Cost-Benefit*, we can reject equality of the medians with 90% confidence (Pearson $chi^2(3) = 6.2875$, $p = 0.098$). Still, the latter result should be interpreted very cautiously, since Mann-Whitney U tests on paired groups never reach statistical significance at conventional levels and the immediate Mann-Whitney statistic never deviates far from 50% (details upon request). The latter indicates that the probability that a randomly selected member of one group will show higher tablet approval than a randomly selected member of the other group is never much better than that predicted by a coin toss.

Figure 3 about here

When respondents are separated by schools' tablet usage, however, we observe that the median of the approval ratings is different between tablet and non-tablet schools (not depicted). This conclusion holds both when using *General Evaluation* as our approval measure (Pearson $chi^2(1) = 22.4820$, $p = 0.000$), as when analyzing *Cost-Benefit* (Pearson $chi^2(1) = 12.9322$, $p = 0.000$). Moreover, the immediate Mann-Whitney statistic suggests that the probability that a randomly selected respondent from a tablet school will have a higher approval rating than a randomly selected member of a non-tablet school is more than 60% ($p<0.01$ for both *General Evaluation* and *Cost-Benefit*). This suggests that there is an important difference in the approval ratings between respondents from schools that employ tablets in their ICT infrastructure, and those from schools that do not. Figure 4 looks at this observation in more detail by displaying the distribution of approval ratings of a given group of users (i.e. parents, teachers, principals, and ICT-

administrators) depending on the presence of tablets in the school (using *General Evaluation* as the approval variable).

Figure 4 about here

Figure 4 highlights that the higher approval of tablets in tablet- versus non-tablet schools is driven by the substantially higher approval among teachers, ICT-administrators and, particularly, school principals. There is indeed a significant shift in the median of the distribution for these three groups when looking at *General Evaluation* ($p<0.01$ for all three groups), which is confirmed for principals when looking at *Cost-Benefit* ($p<0.01$). No similar observation, however, holds for parents. They do *not* appear to have a different evaluation of tablets depending on whether such devices have been adopted in the school. This pattern strongly suggests that *either* tablets are predominantly introduced in schools where principals are strong proponents of this technological tool (which would constitute a form of self-selection), *or* that this user group is particularly prone to post-hoc rationalization of the choice to introduce tablet computers (see hypothesis H2).[8] Our data allow only partial separation of both arguments. The data in figure 4, for instance, suggest *both* more critical principals in non-tablet schools *and* more approving principals in tablet schools, which is consistent with a self-selection scenario. However, the fact that we observe no statistically significant increase in approval among parents in tablet versus non-tablet schools (i.e. p-values above 0.20 for both approval measures) suggests

[8] Intuitively, a third possible explanation might be self-selection among parents in our sample. Imagine, for instance, that parents with children in tablet schools are equally likely to respond to our survey when they approve or disapprove of tablets, but parents with children in non-tablet schools are more likely to respond when they disapprove of tablets. This would induce a pattern in approval ratings as discussed in the main text. While we cannot conclusively reject this possibility, our data suggest that such self-selection among parents appears to have been very limited. Indeed, looking at respondents' ICT preferences, we find that parents in both types of schools are *not* significantly different in terms of tablet ownership ($p = 0.617$) and desire for electronic gadgets ($p = 0.449$).

substantial over-estimation among school principals of the benefits brought about by the *de facto* introduction of tablets. The latter is consistent with a line of argument based on post-hoc rationalization (see hypothesis H2): Having invested a significant amount of time, effort and money in the introduction of tablets, principals might be prone to 'rationalise' this choice by viewing this technology as very successful and beneficial.

Ordinal regression analysis

The results presented thus far do not control for individual-level background characteristics, which may induce biased inferences due to missing variable bias (especially where it concerns respondents' inherent ICT-orientation). In table 2, we therefore report the results of a series of ordered logit regressions that control for potential confounding factors (see equation (1)). These results not only provide an opportunity to assess the robustness of the findings presented above, but can also take us one step further by providing a more complete picture of the drivers of tablet approval. Columns (1) and (2) report results using the full sample of respondents, whereas the remaining four columns report results when splitting the sample between respondents from schools with and without tablets. Odd-numbered columns employ *General Evaluation* as the dependent variable, while even-numbered columns have *Cost-Benefit* as the dependent variable.

Table 2 about here

The results in table 2 first of all illustrate that respondents owning a tablet computer and being early buyers of electronic gadgets are more likely to strongly approve of using tablets in schools – as might be expected. Respondents working in, or having children in, secondary schools consistently are found to be *less* supportive of tablets than respondents linked to primary schools.

One potential explanation is that older children may be more experienced with, or know how to make use of, the non-educational possibilities offered by tablets. As such, tablets can become a source of distraction in class among such older age cohorts, which undermines the educational benefits of tablets. While this tentative explanation requires further substantiation in future research, it lends some support to the view that ICT can easily turn into a double-edged sword in classrooms (Vanderlinde *et al.*, 2014).

Turning to our central explanatory variables, we find that our addition of control variables tends to refine the results from the pairwise comparisons discussed above. That is, we still observe that approval ratings are significantly higher in schools that have tablets in their ICT infrastructure (see columns (1) and (2)). Yet, we now also find that parents are *most* positive about tablets in the sample drawn from schools that make no use of tablets (relative to ICT-administrators; see columns (5) and (6)) and *least* positive in the tablet-school sample (relative to all other user groups; see columns (3) and (4)). This interesting divergence provides some substantiation of the idea that high 'performance anticipation' often comes with some degree of disappointment of these high expectations (hypothesis H1). Parents are inclined to have high hopes for the potential benefits brought by tablets, but do not see them realized when tablets are actually available in their children's schools (at least not to the same extent that teachers, and especially school principals, perceive the realization of such benefits). As such, in terms of the 'feedback loop' presented in figure 1, they appear to experience the largest discrepancy between their ex ante expectations regarding the perceived usefulness of tablets in educational settings, and their ex post evaluations of their introduction.

Finally, controlling for individuals' background characteristics (and, particularly, their ICT-orientation), we find that ICT-administrators are, other things equal, *least* positive about tablets

in schools. Indeed, the point estimates of the dummies for parents, teachers and principals are statistically significantly positive in column (1) and statistically significantly negative in column (2) – both of which indicate that approval of tablets is *lowest* among ICT-administrators.[9] The effect is strongest in non-tablet schools, but likewise materializes in tablet schools (though it generally falls short of statistical significance at conventional levels in tablet schools). Controlling for ICT-administrators' higher interest in, and inherent positive inclination towards, electronic devices, this suggests that ICT-administrators might be most critical towards introducing new mobile electronic technology into classrooms. Hence, in terms of figure 1, this implies that their ex ante reservations regarding the perceived usefulness of tablets tend to be born out, inducing a relatively small feedback effect when it concerns their ex post evaluations of tablets' introduction.

One likely explanation for the latter result might be that ICT-administrators have the most realistic assessment of the substantial investment – not only financially, but also in terms of maintenance and training (as well as adding extra workload for ICT-administrators) – that is required to introduce tablets in schools. Partial confirmation of this idea is provided by the comments left by several respondents at the end of our survey (where we provided a possibility to leave feedback on the survey or its topic). ICT-administrators frequently highlighted the limited budgets, lack of educational apps, bottlenecks in the efficient use of tablets and teacher training, and the high demands placed on the development of a wireless network within the school. These constraints were much less obvious in the comments of the other user groups. For instance, parents most often left comments about the potential effects of tablets on health and

[9] This initially appears at odds with our earlier findings showing that ICT-administrators have high tablet approval ratings. Remember, however, that our earlier results did not control for respondents' background characteristics, and particularly ICT-administrators' very strong interest in ICT. This ICT interest is clearly what drives ICT-administrators' high tablet approval.

learning, or about the financial costs for households – while school principals most often highlighted the lack of government subsidies for ICT infrastructure.

4. Concluding discussion

In this article, we argued that user opinions towards the usefulness and ease of use of new technologies not only drive actual introduction decisions, but are themselves affected by actual experience with the technology (see also Bonds-Raacke and Raacke, 2008). Introduction of this 'feedback loop' into the Technology Acceptance Model leads to a number of novel predictions regarding user attitudes towards new technologies. These predictions are confirmed in our comparative analysis of the attitudes of school principals, teachers, ICT-administrators and parents towards tablet computers in primary and secondary schools in Flanders. First, we find that groups with high performance anticipation (*ex ante*) are also the groups with lower *ex post* approval ratings. This is consistent with a large psychological literature arguing that high expectations are more likely to induce disappointment *post hoc* (Kahneman and Tversky, 1979; Köszegi and Rabin, 2006; Caplin *et al.*, 2010; Rutledge *et al.*, 2014). Second, we show that the groups who are most directly involved in the introduction of new technologies (school principals) document the largest difference in approval across schools with and without tablets, *ceteris paribus*. This is in line with the idea that user power over technology introduction bolsters approval rating increases following its actual introduction. Both findings extend the existing literature and generate a more complete view on user endorsement of new technologies in an educational setting.

Based on our study, we believe that one of the central reasons fuelling high expectations about tablets concerns the predominant focus in available information on the potential benefits that new technologies – and tablets specifically – can offer in the educational context (such as

improving academic achievement or increasing students' participation). This leads to arguably unrealistic expectations among many stakeholders, which is also what is likely to cause the subsequent reward prediction error. In our survey, this channel is evident, for instance, in the fact that only ICT-administrators make reference to possible downsides of tablets such as lack of educational apps, bottlenecks in teacher training, and the cost of a wireless network within the school. Awareness of these issues among our other respondent groups appears much more limited. Consequently, one important policy recommendation from our analysis is that detailed and accurate information should be available about both benefits and difficulties related to introducing tablets in schools. This is likely to dampen unrealistically high expectations, and mitigate subsequent reward prediction error.

While we only test the predictions of our extended Technology Acceptance Model to tablet computers in Flemish schools, it is worth highlighting that the model is likely to have broader applicability across different types of educational technologies (e.g., whiteboards, school websites, and so on) as well as beyond the educational environment studied here. Future research should thus assess to what extent the patterns observed in our Flemish school setting are replicated elsewhere. Furthermore, our findings raise a number of additional questions. First of all, the actual process of integration of tablets in schools – i.e. whether they are effectively integrated into the teaching environment, added to the curriculum, or simply employed for relaxation purposes between teaching moments – was not included in our analysis. We also lack detailed information about how these devices were used in the classroom (i.e. based on a constructivist inquiry approach, or more didactically), and how frequently they were used. Yet, it is conceivable that the exact process of integration and the specific nature of their day-to-day usage affects the *ex post* assessment of such technologies. Similarly, we were unable to take into account the ownership model behind the introduction of tablets: i.e. whether the government,

school or parents (or some mixture thereof) is expected to provide the financing of the technological innovation. However, this ownership model could affect individuals' (*ex post*) evaluation of the technology. Finally, it is important to realize that expectation levels can differ within as well as across tablet schools. Our analysis currently looks at tablet and non-tablet schools as homogenous groups, but this is likely to deserve further attention. These issues therefore remain important avenues for future research.

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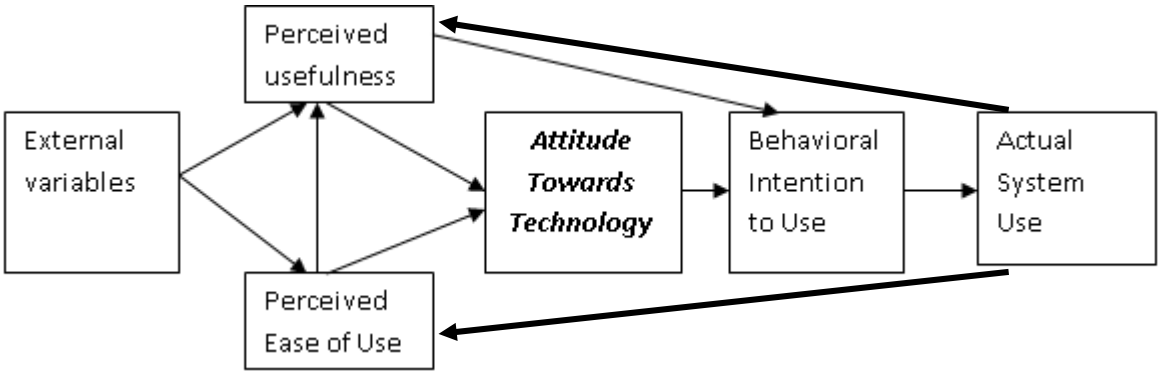
Figure 1: Feedback Effects in the Technology Acceptance Model



Note: Figure extended from Davis (1989).

Figure 2: Evaluation of tablet computers among all respondents

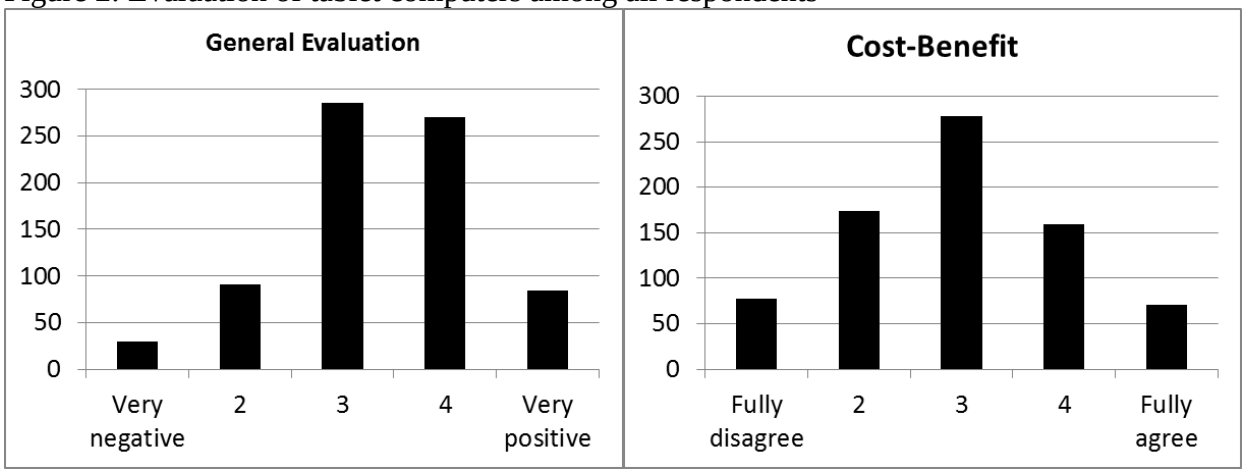
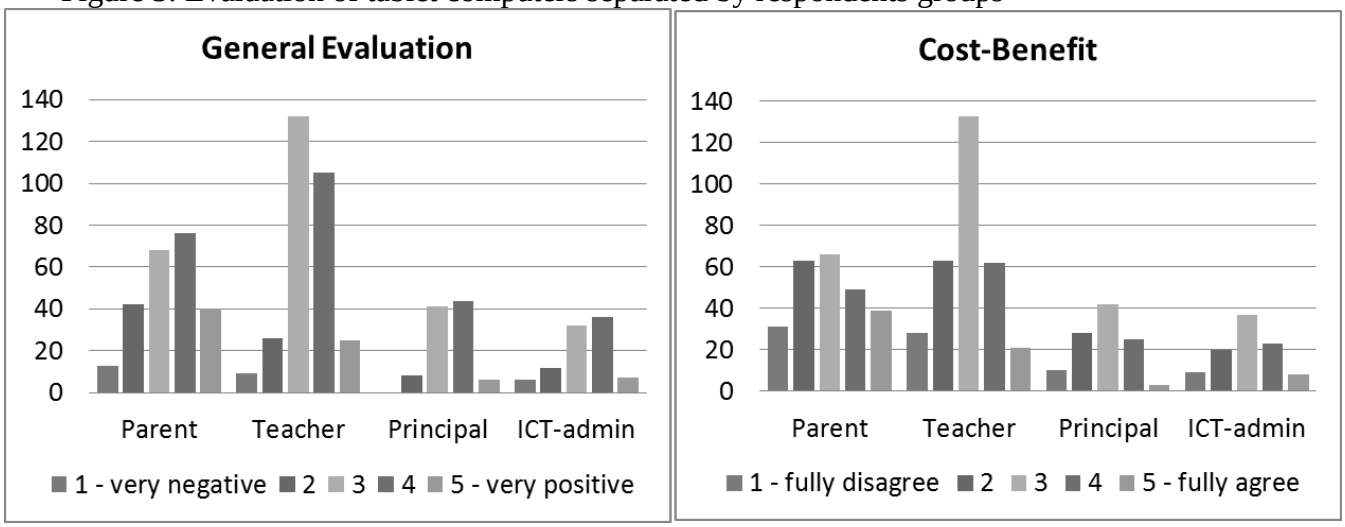
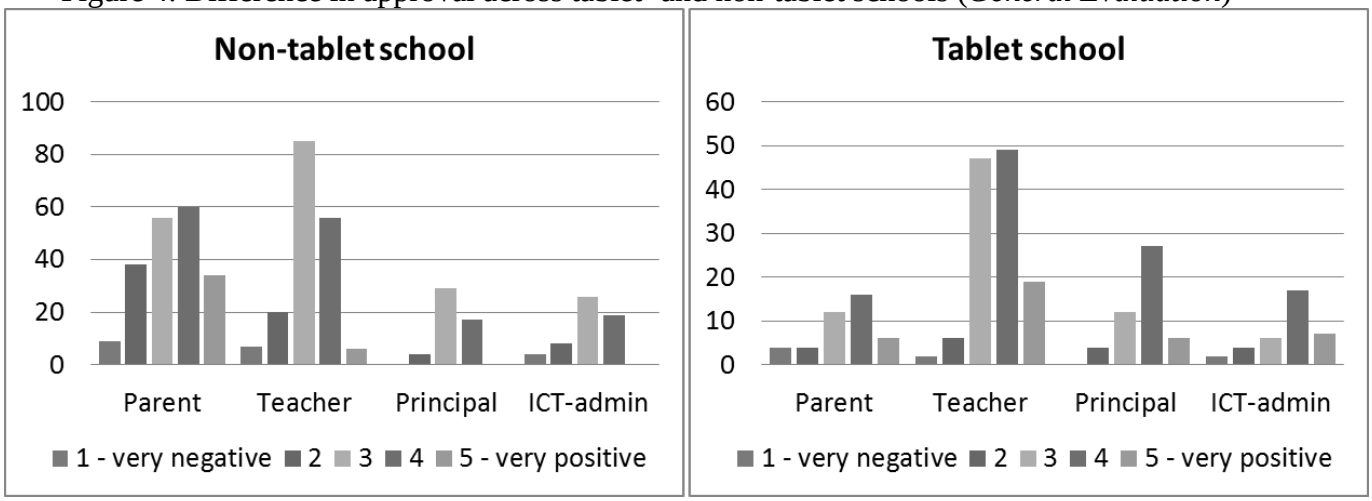


Figure 3: Evaluation of tablet computers separated by respondents groups



Note: The left-hand figure represents the results for *General Evaluation*, while the right-hand figure represents the results for *Cost-Benefit*. Responses are collected on a five-point scale from 1 ('very negative') to 5 ('very positive') for *General Evaluation*, and on a five-point scale ranging from 1 ('fully disagree') to 5 ('fully agree') for *Cost-Benefit*.

Figure 4: Difference in approval across tablet- and non-tablet schools (*General Evaluation*)



Note: The left-hand figure represents the results for respondents from schools which do not make use of tablets, while the right-hand figure represents the results for respondents from schools which do make use of tablets. In both cases, we depict results for *General Evaluation*. Responses are depicted on a five-point scale from 1 ('very negative') to 5 ('very positive').

Table 1: Summary Statistics

Variable	Mean	St. Dev.	Min - M ax
TabletSchool (dummy)	0.342	0.474	0 – 1
Parent (dummy)	0.326	0.469	0 – 1
Teacher (dummy)	0.405	0.491	0 – 1
Principal (dummy)	0.142	0.340	0 – 1
Woman (dummy)	0.656	0.476	0 – 1
Age (years)	42.378	9.752	16 – 70
Married (dummy)	0.783	0.413	0 – 1
Education (4-pt scale)	3.152	0.573	2 – 4
SecondarySchool (dummy)	0.472	0.500	0 – 1
TabletOwner (dummy)	0.691	0.462	0 – 1
SocialMedia (dummy)	0.746	0.436	0 – 1
GadgetBuyer (dummy)	0.279	0.449	0 – 1

Table 2: Regression results

	Full sample		*Tablet school*		*Non-Tablet school*	
	(1) General Evaluation	(2) Cost-Benefit	(3) General Evaluation	(4) Cost-Benefit	(5) General Evaluation	(6) Cost-Benefit
TabletSchool (dummy)	0.607*** (3.91)	-0.690*** (-4.40)	-	-	-	-
Parent (dummy)	0.431* (1.70)	-0.442* (-1.83)	-0.143 (-0.27)	-0.144 (-0.34)	0.609** (2.02)	-0.533* (-1.69)
Teacher (dummy)	0.504** (2.16)	-0.586*** (-2.63)	0.509 (1.07)	-0.419 (-1.07)	0.539* (1.92)	-0.703** (-2.39)
Principal (dummy)	0.533** (2.09)	-0.509** (-2.06)	0.707 (1.43)	-0.805* (-1.95)	0.474 (1.59)	-0.178 (-0.57)
Woman (dummy)	0.282* (1.75)	-0.158 (-1.04)	0.276 (1.05)	-0.100 (-0.42)	0.304 (1.42)	-0.126 (-0.60)
Age (years)	-0.003 (-0.50)	0.011 (1.49)	-0.008 (-0.59)	0.020 (1.50)	0.0002 (0.03)	0.004 (0.44)
Married (dummy)	0.113 (0.64)	-0.095 (-0.60)	-0.267 (-0.98)	0.197 (0.73)	0.293 (1.23)	-0.195 (-0.96)
Education (dummy level 3)	-0.358 (-1.26)	-0.185 (-0.79)	-0.515 (-0.98)	-0.724 (-1.63)	-0.210 (-0.59)	0.027 (0.10)
Education (dummy level 4)	-0.339 (-1.10)	-0.252 (-0.91)	-0.668 (-1.21)	-0.674 (-1.23)	-0.187 (-0.48)	-0.048 (-0.14)
SecondarySchool (dummy)	-0.581*** (-3.65)	0.518*** (3.42)	-0.751** (-2.51)	0.784** (2.50)	-0.461** (-2.36)	0.414** (2.33)
TabletOwner (dummy)	0.905*** (5.29)	-0.868*** (-5.27)	1.152*** (3.64)	-1.429*** (-4.42)	0.824*** (3.90)	-0.647*** (-3.37)
SocialMedia (dummy)	0.102 (0.60)	0.042 (0.25)	0.480 (1.63)	-0.058 (-0.17)	0.002 (0.01)	0.061 (0.30)
GadgetBuyer (dummy)	0.909*** (4.88)	-0.641*** (-3.56)	0.813*** (2.77)	-0.418*** (-1.43)	0.962*** (3.91)	-0.745*** (-3.26)
Observations	716	724	245	246	471	478
Wald Chi^2	130.99***	104.92***	50.19***	46.68***	70.84***	45.21***

Note: Dependent variable is the level of approval for tablets in schools measured on a 5-point scale via either *General Evaluation* or *Cost-Benefit*. In columns (1) and (2), we include the entire sample, whereas columns (3) and (6) split the sample by the presence (columns (3) and (4)) or absence (columns (5) and (6)) of tablets in the school. *t* statistics in parentheses; * p<0.10, ** p<0.05, *** p<0.01.

Appendix: Survey questionnaire

Separate though partly overlapping surveys were designed to address parents and teachers/principals. While the complete survey questionnaires (in Dutch) are available upon request from the authors, the questions of key relevance to the present study are summarized in table A.1 in their order of appearance in the original surveys.

Table A.1. Summary of survey questionnaires

Parents	**Teachers / school principals**
Part I: Demographic characteristics 1. What is your gender? 2. What is your age? 3. What is your marital status? 4. What is your highest degree? 5. What is your professional status? 6. What is the monthly net income of your family? 7. How many children do you have? 8. What is the age of your children? 9. What types of education do your children currently follow? (pre-school, primary, secondary)	*Part I: Demographic characteristics* 1. What is your gender? 2. What is your age? 3. What is your marital status? 4. What is your highest degree? 5. What is your function in your school? (teacher, principal, ICT-administrator) 6. How long have your worked in the school? 7. What levels of education are offered in your school? (pre-school, primary, secondary) 8. What level of education reflects the majority of your teaching load? (pre-school, primary, secondary)
Part II: Attitudes towards ICT & social media 1. I am usually quick to test/buy new electronic gadgets. (agree – disagree) 2. Which types of electronic equipment do you currently possess (portable computer, tablet computer, smartphone, netbook, e-book reader)? 3. Do you have a profile of a social network site? 4. How often do on average you use social media for private purposes? (in hours per week) 5. How often do on average you use social media for professional purposes? (in hours per week)	*Part II: Attitudes towards ICT & social media* 1. I am usually quick to test/buy new electronic gadgets. (agree – disagree) 2. Which types of electronic equipment do you currently possess (portable computer, tablet computer, smartphone, netbook, e-book reader)? 3. Do you have a profile of a social network site? 4. How often do on average you use social media for private purposes? (in hours per week) 5. How often do on average you use social media for professional purposes? (in hours per week)
Part III: Tablets in education 1. Does the school of your child possess tablets as part of its ICT infrastructure? 2. How do you judge the costs and benefits of using tablet computers in an educational environment? The costs exceed the benefits. 3. In your opinion, what types of tasks in an educational environment would benefit most from the use of tablet computers? 4. What is your assessment of the use of tablet computers in an educational environment? 5. Do you observe a change in your child's test scores since the school started using tablet computers?	*Part III: Tablets in education* 1. Does your school possess tablets as part of its ICT infrastructure? 2. How do you judge the costs and benefits of using tablet computers in an educational environment? The costs exceed the benefits. 3. In your opinion, what types of tasks in an educational environment would benefit most from the use of tablet computers? 4. What is your assessment of the use of tablet computers in an educational environment? 5. Do you observe a change in your pupils' test scores since you started using tablet computers?