Educational Master Plan

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Comparative study of netbooks and tablet PCs for fostering face-to-face collaborative learning

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A B S T R A C T

With the recent appearance of netbooks and low-cost tablet PCs, a study was undertaken to explore their potential in the classroom and determine which of the two device types is more suitable in this setting. A collaborative learning activity based on these devices was implemented in 5 sessions of a graduate engineering course of 20 students, most of whom were aged 22–25 and enrolled in undergraduate computer science and information technology engineering programs. Student behavior attributes indicating oral and gesture-based communication were observed and evaluated. Our findings indicate that in the context in which this study was undertaken, tablet PCs strengthen collective discourse capabilities and facilitate a richer and more natural body language. The students preferred tablet PCs to netbooks and also indicated greater self-confidence in expressing their ideas with the tablet's digital ink and paper technology than with the netbooks' traditional vertical screen and keyboard arrangement.

1. Introduction

Mobile technologies such as laptops and mobile phones are becoming one of the most commonly used tools in our everyday lives and have overtaken traditional desktop PCs (Lundin, Lymer, Holmquist, Brown, & Rost, 2010; Reuters, 2008), spurring the emergence of widespread access to wireless connectivity. This reality has prompted considerable interest in finding fruitful ways of integrating mobile technologies, such as wireless laptops and tablet computers, into educational settings. Recent studies reveal that participatory learning environments supported by one-to-one mobile computing can foster a richer social interaction context among the students, contrasting sharply with the passive lecture-based methods present in educational institutions everywhere (Baloian & Zurita, 2009; Barak, Lipson, & Lerman, 2006; Koile & Singer, 2006). In the light of these trends, education researchers and practitioners are driven to investigate whether pedagogies supported by mobile technologies can succeed in eliciting better teaching and learning outcomes (Barak et al., 2006; Looi, Chen, & Ng, 2010; Säljö, 2010). Complementarily, human–computer interaction research is concerned with establishing design criteria for technology-supported learning environments, as well as evaluating the usability of mobile technologies in the educational contexts under study (Sharples, 2009; Vatrapu, Suthers, & Medina, 2008). In this regard, the variety of mobile devices available nowadays, presenting different characteristics, such as input possibilities and form factors (Guerrero, Ochoa, Pino, & Collazos, 2006), calls for investigating whether device-specific affordances may positively (or negatively) influence teaching and learning processes in the classroom.

According to Fried (2008), clearly defined factions have taken sides both for and against the incorporation of wireless laptops into the learning process. A number of researchers examining classroom laptop use have discovered benefits for students such as greater motivation and willingness to collaborate, better connections between different subject fields, a narrowing of the digital divide, improvements in problem-solving skills and the promotion of academic achievement (Finn & Inman, 2004; Lowther, Ross, & Morrison, 2003; Mitra & Steffensmeier, 2000). Other studies, however, have found evidence that laptops in the classroom can create adverse conditions for learning, limiting or even reducing academic performance (Fried, 2008; Gay, Stefanone, Grace-Martin, & Hembrooke, 2001). Research on this issue is still clearly in its infancy, and as long as the findings remain inconclusive, further investigation of the use of these devices in education is essential (Barak et al., 2006; Warschauer, 2008; Zucker & Light, 2009).

Although laptops and now netbooks (Goth, 2008; Holcomb, 2009) have become very popular and enjoy definite advantages over desktop computers, especially as regards portability, they continue to fall short in applications that demand high mobility or employ drawing and handwriting user interfaces (Guerrero et al., 2006). An ideal alternative that addresses the requirement of mobility and ink-based input capability is the tablet PC, a device that is easy to carry thanks to its slate shape and supports direct

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interaction with the screen using a stylus, similar to the traditional interaction between paper and pencil.

Ozok, Benson, Chakraborty, and Norcio (2008) note that although a fairly substantial body of research has grown up in the last few years on desktop and laptop usability, very few studies have reported on experiments with tablet PCs. Recent studies focusing on educational applications have reported on the use of tablet PCs for enriching the lecture presentation, i.e., as a digital replacement for the white (or black) board Anderson et al., 2004, and providing the students digital means for note taking (Casas, Ochoa, & Puente J., 2009; Kam et al., 2005). More recent initiatives have explored supporting collaborative note taking in the classroom and collaborative learning activities (Looi & Chen, 2010; Steimle, Brdiczka, & Mühlhäuser, 2008). Approaches leveraging tablet PCs in collaborative learning settings have targeted taking advantage of the digital ink affordances provided by the tablet PC as a means to support collaborative resolution of open-ended tasks (Baloian & Zurita, 2009; Looi et al., 2010; Nussbaum et al., 2009). Despite the increasing number of experiences involving tablet PCs in the classroom, more research is required in order to establish significant advantages (or disadvantages) of tablet PCs in comparison to laptops in these educational settings.

While laptops and tablet PCs have been widely available in the market for many years, low cost models specifically targeted at education have emerged only recently (Cramer, Beauregard, & Sharma, 2009; Zucker & Light, 2009); therefore, less research has been done on these newer technologies. This situation motivates exploring the potential of education-aimed netbooks and tablet PCs with a view to determining which of these devices would be the most appropriate for the classroom.

In this article we offer a comparative analysis of two netbook-type computers designed for educational applications, one presenting a more traditional format (i.e., small size laptop) and the other containing tablet PC features (i.e., slate shape and stylus-based input). They were utilized in this study during lectures for a graduate-level engineering course as a supporting technology for a face-to-face small group collaborative learning activity aimed at solving open-ended questions (Alvarez, Nussbaum, Recabarren, Gomez, & Radovic, 2009; Nussbaum et al., 2009). Each student in the study was equipped with either a netbook or a tablet and the behavior of the groups was observed and compared. Given the particular context in which our study was conducted, the conclusions we obtained cannot be generalized to scenarios involving different demographics or tasks, however, our findings yield evidence supporting specific device features as being more appropriate for supporting collaborative work in the classroom. In what follows we present a description of the collaborative activity (Section 2), the experimental design that was implemented (Section 3), the results obtained (Section 4) and our conclusions.

2. Wireless netbooks geared towards a participative classroom

In the traditional lecture-driven classroom, students must pay careful attention to the instructor and concentrate on carrying out assigned tasks without interrupting others. These strictures discourage rich interaction between the students (Galton, Hargreaves, Comber, Wall, & Pell, 1999; Gillies, 2006), leaving them little opportunity to develop skills in teamwork, language and interpersonal relations. Wireless netbook technology can help overcome this situation by creating a workspace that fosters participation through collaboration and rich face-to-face interaction.

To examine how wireless netbook devices can be used to promote interaction between students and classroom participation, they must be introduced into the classroom within the framework of a clearly defined pedagogical purpose. In this study, we used a collaborative learning activity known as CollPad (Nussbaum et al., 2009), which relies on 1:1 mobile computing (e.g. PDAs, netbooks and tablet PCs) to support students in solving open-ended questions assigned by the instructor, related to the material covered in class.

The educational value of CollPad has been assessed and reported by previous studies conducted in engineering courses at the Pontificia Universidad Catolica de Chile (Alvarez et al., 2009) and in K-12 classrooms in Chile and the UK (Nussbaum et al., 2009). The studies assert that CollPad offers a constructivist model of knowledge building, which fosters an environment favorable for the development of communication, interpersonal and decision-making skills, and ensures interaction between class members who do not normally work together, by means of composing the work groups randomly.

In the initial Individual Response phase of CollPad (see Fig. 1), the students all receive the assigned question from the instructor on their devices, and each of them writes his/her individual answer without interacting with their group mates. The software installed on the devices supports editing on virtual paper by means of a text tool, which writes text with user-configurable font attributes (size, color, etc.) and a pen tool that draws using a pointing device (touchpad, stylus or mouse) in a range of line weights and colors. Handwriting created with the pen tool is preserved as such, with no automatic recognition or conversion into text.

In the second CollPad phase, denoted Collective Decision, students see their group mates' answers on their device screens, and must then discuss which one of them to send to the instructor. Alternatively they may decide on a new response (the New Proposal phase), in which case one group member is elected to the role of the *scribe* while the other members, acting as *reviewers*, agree on the response text before the scribe writes and submits it.

As the students generate and send in their group answers, the instructor reviews them on his/her device and selects those he/she considers most suitable for initiating a discussion involving the whole class. Members of the groups whose responses were chosen may be called before the class to argue for and justify them.

3. Classroom experiment

This study sought to determine how netbooks and tablet PCs impact technology-supported collaborative work activities in the classroom. In a previous study (Alvarez et al., 2009), we observed the use of the CollPad method in a classroom using handheld devices (PDAs) to validate the ability of this technology tool to stimulate the development of students' language, interpersonal and decision-making skills. Given the rising popularity of netbooks, we believe they can be a practical alternative for conducting collaborative classroom activities. Thus, in the experiment reported here we again observed a CollPad activity, but this time to compare conventional and tablet-style netbooks in order to establish which device type better empowers classroom communication and interaction.

3.1. Context of observed activity

The context for the activity experiment was the Knowledge Management course taught in the first semester of 2009 at the School of Engineering of the Pontificia Universidad Catolica de Chile. The course consists of weekly lectures and its objective is to increase students' awareness of the significance of human beings amid the dizzying pace of current technological development in order to better comprehend their role in this process and how to take part in it.

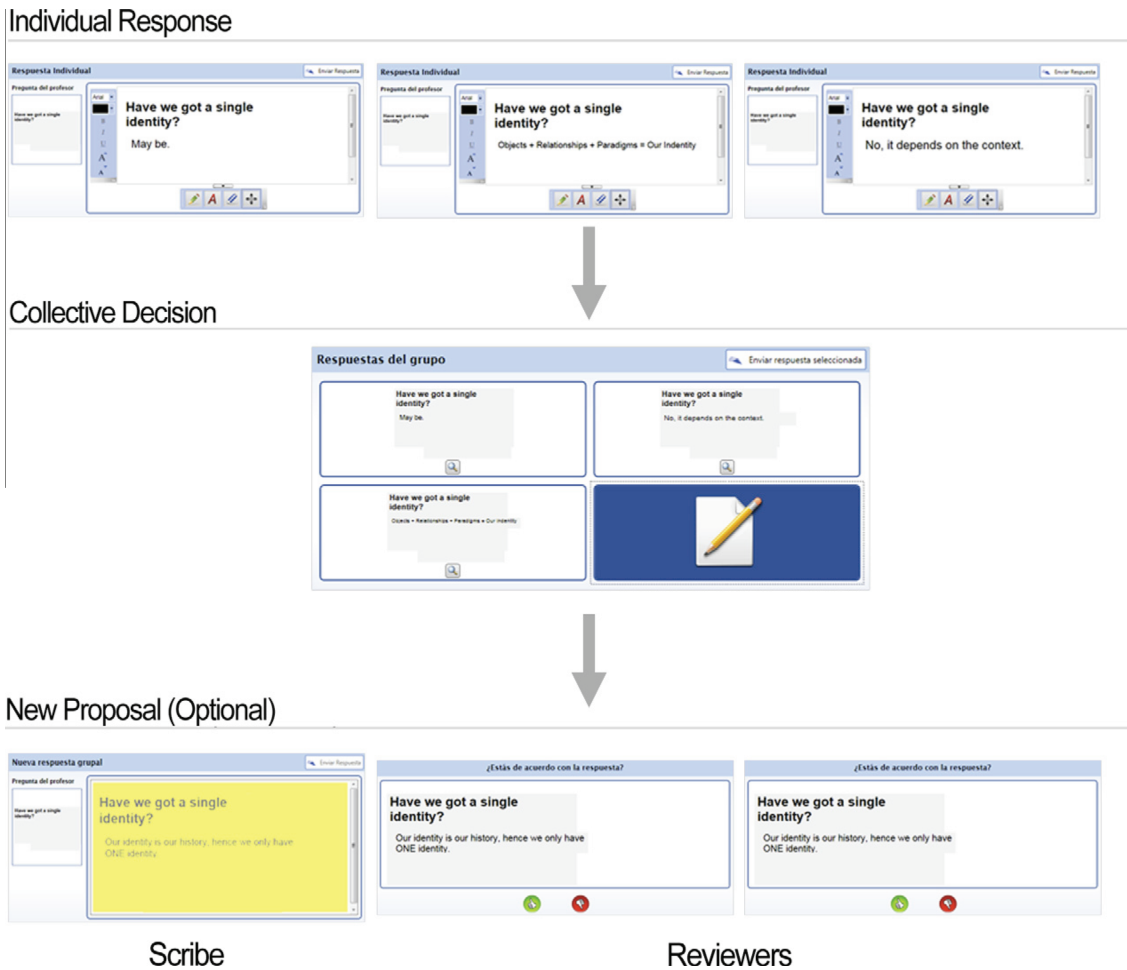

Fig. 1. Phases of the CollPad method implemented in the present study. In the Individual Response phase, each student creates his/her own answer to the instructor's question. In the Collective Discussion phase that follows, the students must either agree to submit to the instructor one of the individually created answers or create and submit a new one.

Before the observations pertaining the present study were undertaken in the Knowledge Management course, the students were briefed about the nature of the study and introduced to the two kinds of devices involved. All the students in the course accepted being involved in the experience. Activity sessions were carried out in 12 classes during the semester, always following the same dynamic. The activity itself was held in the last 30 min of the class period. Mobile devices were handed out randomly to the students, CollPad was launched and the group (randomly formed) each was assigned to was indicated on his/her device screen. Once they were all sitting face to face in their respective groups, the instructor sent an open-ended question related to the material covered in the first part of the class and the activity proceeded as described in Section 2.

3.2. Tasks in the observed activity

The tasks the students solved using CollPad in the Knowledge Management course consisted solely of open-ended questions. These were designed by the instructor to strengthen the students' abilities in understanding and critically analyzing the ways in which people's day-to-day lives are built, modeled and influenced by cultural contexts. In most cases, more than one answer to the question was acceptable; the instructor was in control of steering the discussion towards the answers he considered was the best one. None of the questions demanded that the students elaborated their answers in a schematic or pictorial way, but rather, all of the questions could be responded with concise explanations in sentences.

Each CollPad task was related with the subject matter being taught in the lectures, and required that students choose and apply suitable concepts in their answers with proper justification. For example, the course had a unit dedicated to a general model about people's understanding of the world. The CollPad task for that specific unit consisted in first having the students watch a video of an orchestra interpreting John Cage's 4′33″ composition. 4′33″ is a special composition because the score instructs the whole orchestra not to play the instruments during the entire duration of the piece. Consequently, the resulting interpretation of the piece consists of the sounds of the environment that the listeners hear while it is performed. At the end of the interpretation shown to the students on video, the audience applauds vigorously. The task for the students in CollPad was to explain why the audience applauded after 4′33″ of silence, according to the model seen on class.

The format of the other CollPad tasks in the experience was similar in the sense that the students had to elaborate how a real-life issue could be understood with the models taught in class. The students could elaborate valid answers using any type of input on their devices, such as keyboard or digital ink (i.e., stylus input). Drawings, schemas or special symbols were not required, thus the tasks were not biased towards benefiting students with devices supporting digital ink capability (i.e., tablet PCs or PDAs).

3.3. Hardware used during the study

For the first 7 of the 12 sessions, the activity was performed using a version of CollPad on HP iPAQ rx1950 Pocket PC (PDA) devices (Fig. 2a), as described in Alvarez et al. (2009). In the last 5 CollPad sessions, the students worked with two types of Intel Classmate netbook devices designed for the classroom: the first generation Classmate PC (Cramer et al., 2009) (hereafter CMPC) and the Convertible Classmate PC (hereafter C-CMPC), both shown in Fig. 2b–d. In order that the two technologies could be compared, CollPad ensured that all students assigned to a given group had the same device type, whether CMPC or C-CMPC.

The CMPC we used was a 7-inch screen netbook powered by a 900 MHz Celeron processor, with 2 gigabytes of flash memory, 512 megabytes of RAM and WiFi capability. The C-CMPC, on the other hand, had an 8.9-inch touchscreen that supports user interaction through a stylus and can be rotated and folded down over the keyboard (Fig. 2c and d). It featured a 1.4 Ghz Intel Atom processor, 1 gigabyte of RAM, a 40 gigabyte hard disk drive and WiFi capability. Both devices ran the Microsoft Windows XP operating system.

3.4. Observation procedure

To observe and analyze the work performed by the students during the activity sessions, data were collected from three different sources. First, four groups of students were filmed, two of which were working on CMPC devices and the other two with the C-CMPCs. Individual cameras were employed for each group. To obtain a more accurate recording of the group conversations, the sound was also captured separately using MP3 digital audio players. The instructor-mediated discussion in the final phase of the activity was always filmed with a single camera.

The second data source was a survey of the students conducted at the end of the semester to gather information on their experiences, criticisms and views of each of the technology types. Finally, the third source was the data stored in the instructor's device on the groups who were chosen by the instructor for the final (whole-class) discussions to determine the relationship between the frequency with which groups were so chosen and the device they used.

3.5. Description of the samples

The experimental observations for the comparative analysis between CMPC and C-CMPC devices were conducted on the last 5 sessions of the Knowledge Management course, involving 20 students, most of whom were aged 22–25 and enrolled in undergraduate computer science and information technology engineering programs. All of the students were already familiar with the PDA version of CollPad, and all of them were skilled at operating Windows based laptops. However, few students did not have prior experience operating tablet PCs, therefore, basic instructions on how to use the stylus of the C-CMPC and how to convert the device to slate format were given to them before starting the experimental observations. The version of CollPad for CMPCs and C-CMPCs has a similar user interface to the PDA version the students had used previously, thus no additional training was required for the students to become familiar with the new CollPad software.

3.6. Device and group assignment

In each of the 5 CollPad sessions observed, the group composition policy was random student-to-group assignment; hence the group composition was different and unpredictable in each session (Zurita, Nussbaum, & Salinas, 2005). For the comparative analysis, in each of the 5 sessions 4 groups were observed (i.e., filmed): two of them using C-CMPCs and the other two CMPCs. Therefore, throughout the 5 sessions 20 groups were observed in total (10 equipped with CMPCs and 10 with C-CMPCs). Noticeably, each individual student was observed a random number of times throughout the sessions due to the random group composition criteria used (see Fig. 3).

At the beginning of each CollPad session, a CMPC or C-CMPC device was assigned to each student fortuitously. When the CollPad software was initialized on the devices, each student was randomly assigned to a group of three students. There were always two groups (and therefore six students) in the activity that used C-CMPCs, while all the other groups used CMPCs. This was so because only six C-CMPCs were available for student use, with one additional unit reserved for the instructor. The groups using C-CMPCs were always observed during the CollPad sessions, while other two groups using CMPCs were randomly chosen for

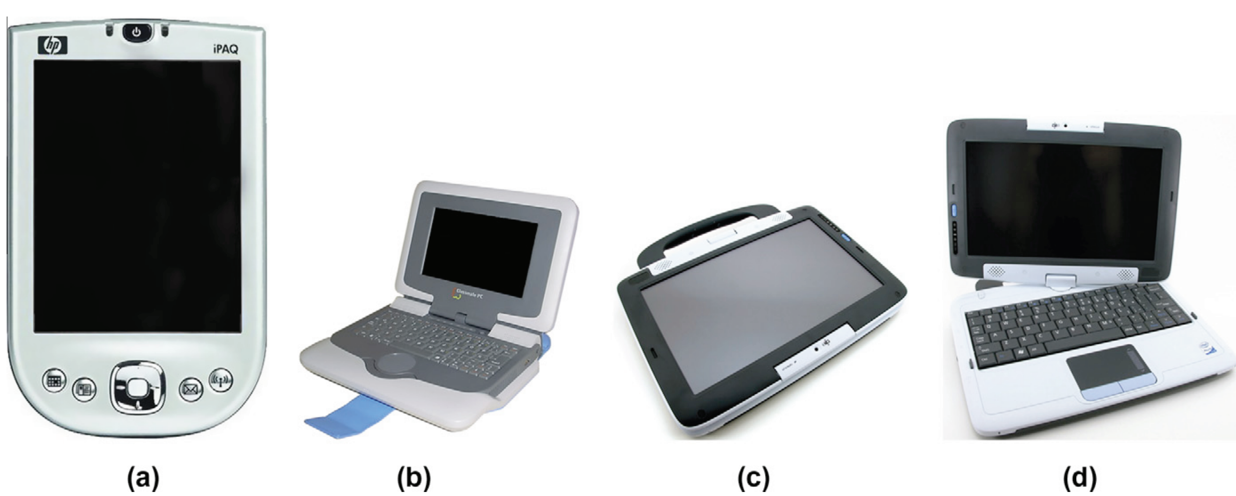

Fig. 2. The devices used in the study were (a) HP iPaq rx1950, (b) Classmate PC (CMPC), and (c and d) Intel Convertible Classmate PC (C-CMPC).

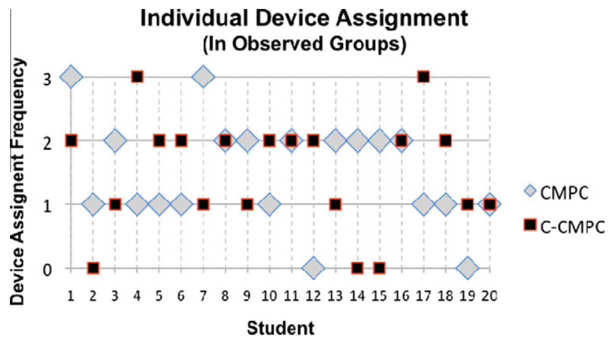

Fig. 3. Devices assigned to each student while being under observation throughout the sessions.

Table 1
Distribution of devices used by number of groups and by session.

Session	C-CMPC	CMPC	Total
1	2	4	6
2	2	5	7
3	2	4	6
4	2	3	5
5	2	3	5

observation. Considering that the student attendance varied in each session, the total number of groups differed among sessions as shown in Table 1. Given that only four groups were observed in each session, there were groups using CMPC devices that were not sampled for empirical data.

Fig. 3 shows the devices that were assigned to each student while being under observation throughout the 5 sessions. With the resulting random assignment of devices and groups on each session, it can be seen that while most students used a C-CMPC at least twice, only three students (2, 14 and 15) did not have a chance to use a C-CMPC at all. On the other hand, two students were not observed using a CMPC (12 and 19). However, by inspection of the video footage recorded, the latter students could be found using CMPC in groups that were not observed, thus it is possible to affirm that all the students in the cohort had the chance to work with a CMPC.

4. Results

The students' work as captured on the audiovisual recordings was reviewed and evaluated on an observation form based on Infante et al.'s (Infante, Hidalgo, Nussbaum, Alarcón, & Gottlieb, 2009), adapted to the aims of our study. The review and evaluation process sought to ascertain whether groups using CMPC and C-CMPC devices presented any significant differences in the quality of their communications depending on the devices used. The evaluation was based on oral and gesture-based communication categories. The oral communications category was concerned with the observation of bidirectional and multidirectional dialogues within a group, and the gesture-based communication category covered characteristics of gestures accompanying oral expression. Gesture-based communications were included in our observation criteria given that they are indicative of a more expressive and natural face-to-face communication between persons (Bernardis & Gentilucci, 2006; Goldin-Meadow, 1999). We were therefore interested in determining whether there are differences in this aspect between CMPC and C-CMPC.

The observation process focusing on communications was motivated by previous evidence of CollPad's potential of generating a rich interaction environment in the classroom (Alvarez et al., 2009). This benefit of CollPad has been found possible thanks to the portability and mobility of the handheld devices used (i.e., PDAs), which facilitate effective face-to-face communications in collaborative work. By contrast, standard desktop PCs and larger laptops can hinder the quality of face-to-face communications in collaborative work (Guerrero et al., 2006). Since both CMPC and C-CMPC devices are larger than PDAs we paid special attention to the way they affected communications and how they differed in this aspect.

4.1. Observation form

The observation form used in the audiovisual evaluations for assessing the group collaborative work was based on the above-mentioned communication categories, each of which was defined by a series of attributes whose corresponding measure is quantitative, reporting the total number of occurrences observed. The attributes of the oral communication category (see Table 2) included person-to-person dialogues, observed when a person talked to one of his/her companions, and person-to-group dialogues, taken into account when a person talked to his/her group mates. The attributes of the gesture-based communication category included hand gesticulation in person-to-person and person-to-group dialogues, in events in which a group member talked to one of his/her companions pointing to his/her device's screen with hands/fingers, a person held the device with his/her hands or moved it (e.g. rotated) it to communicate, and where a person moved his/her device aside on the desk due to discomfort when communicating.

In the observation process for the attributes in the observation form, the observers watched the video material simultaneously and recorded the number of events (i.e., occurrences) identified for each attribute in separate logs. The logs had a two-column layout: a column for the timing of the events, and a column for their classification, indicating category and attribute. Whenever an event was encountered, one of the two observers paused the video playback (being the playback controls available to both of them) and both of them registered the timing of the event in their respective logs. The identification of the attribute to which each event corresponded was often a matter of discussion between the observers. For instance, in particular scenarios for the observers it was not easily recognizable whether an event of verbal communication was in person-to-person or person-to-group modalities. In such cases, the observers had to analyze the respective conversation repeatedly until they could make a consensual decision on the attribute to which the event corresponded. When the observers finished analyzing a group, they checked their event logs forms for consistency. If discrepancies were still found, they analyzed the conflicting events and discussed them until they reached a consensus.

The results of the evaluation are summarized in Table 2. The first column shows the observation category, the second its observed attribute, and the third the attribute's description. The next two columns, labeled 'Freq. C-CMPC' and 'Freq. CMPC', contain the total number of observed occurrences for each attribute and device type. The following five columns in the observation form present the differences between the totals or scores obtained by the different devices and the corresponding mean and standard deviation.

To make an objective comparison between CMPC and C-CMPC devices, we conducted mean-comparison t tests on the previous data, for the two independent samples assuming different variances in them, using STATA 10 software. The tests were based on a null hypothesis H_0: mean$(\mu_{\text{C-CMPC}} - \mu_{\text{CMPC}}) = 0$ (i.e., the difference between the mean frequencies observed for C-CMPC and CMPC is zero), and alternative hypotheses H_a^1: mean$(\mu_{\text{C-CMPC}} - \mu_{\text{CMPC}}) < 0$

Table 2
Observation results. The first column gives the observation categories, the second column contains the attributes being measured, the third column provides a brief description of the attribute. The fourth and fifth columns show the number of occurrences in which the attribute was observed with C-CMPC or CMPC. The sixth column displays the difference between the number of occurrences. The seventh and eighth columns display the average number of occurrences in which the attribute was observed per session. The ninth and tenth columns present the standard deviation of the observed frequencies. The eleventh column presents the *t*-value for the independent-samples *t* tests conducted, and the twelfth column the degree of freedom of the tests. The last three columns indicate the *p*-values obtained on the left-tailed, right-tailed and two-tailed *t* tests, respectively.

Category	Attribute	Description	Freq.C-CMPC	Freq. CMPC	$\|D\|$	$\mu_{C\text{-}CMPC}$	μ_{CMPC}	$\sigma_{C\text{-}CMPC}$	σ_{CMPC}	T	df*	p_l	p_r	p
Oral communication	Person to person	Number of occurrences in which a person talks to one of his/her companions	133	146	13	13.3	14.6	7.53	7.14	−0.396	17.9	0.348	0.652	0.697
	Person to group	Number of occurrences in which a person talks to his/her group mates	234	150	84	23.4	15	9.32	7.64	2.20	17.3	0.979	**0.0207**	**0.0414**
Gesture-based Communication	Person to person	Number of occurrences in which a person talks to one of his/her companions gesticulating with his/her hands	23	18	5	2.3	1.8	3.23	0.92	0.470	10.4	0.676	0.324	0.648
	Person to group	Number of occurrences in which a person talks to his group mates gesticulating with his/her hands	110	64	46	11	6.4	5.62	5.04	2.14	17.8	0.977	**0.0468**	**0.0234**
	Person to group mate's device	Number of occurrences in which a group member talks to one of his/her companions pointing to his/her device's screen with hands/fingers	24	10	14	2.4	1	2.37	1.05	1.71	12.4	0.944	0.0561	0.112
	Hold/move the device to communicate	Number of occurrences in which a person holds the device with his/her hands or moves it (e.g. rotates) it to communicate	15	5	10	1.5	0.5	2.22	0.53	1.38	10.4	0.902	0.0983	0.1965
	Move the device aside	Number of occurrences in which a person moves his/her device aside on the desk due to discomfort when communicating	5	9	4	0.5	0.9	0.71	1.20	−0.910	15.2	0.189	0.811	0.378

* Computed with Satterthwaite's approximation.

(henceforth left-tailed test), H_a^2: mean($\mu_{C\text{-CMPC}} - \mu_{CMPC}$) not equal to 0 (henceforth two-tailed test), and H_a^3: mean($\mu_{C\text{-CMPC}} - \mu_{CMPC}$) > 0 (henceforth right-tailed test). Significance was based on a 95% confidence level ($p = 0.05$). The last three columns of Table 2 show the *p*-values obtained on the left-tailed, right-tailed and two-tailed *t* tests, respectively.

The results show that the differences in mean frequencies are significant in favor of the C-CMPC on the person-to-group attribute both in oral and gesture-based communication. The observers' qualitative appreciation of these differences is that C-CMPCs used in slate format may promote dialogues in the groups with notoriously increased body language (i.e., hand gestures), compared to CMPCs with traditional vertical screen and keyboard arrangement. When using CMPC devices, the students tended to keep their eyes constantly on the vertical screen, which at the same time acted as a barrier to attaining the more fluid face-to-face communication that was perceived in groups using C-CMPCs. With both CMPC and C-CMPC devices, there is a positive correlation between oral and gesture-based communication in person-to-group utterances. The Pearson's correlation coefficients obtained for these variables were 0.85 in the case of C-CMPC, and 0.66 for CMPC. The correlation between oral and gesture-based communications in person-to-group utterances is stronger with the C-CMPC devices, which is consistent with the group behavior that was perceived by the observers (i.e., group members had a propensity to gesticulate more when speaking). This behavior is consistent with previous research from Zurita and Nussbaum (2004), which argues that devices with vertical screen arrangement (e.g. desktop PCs or laptops) are prone to hinder proper communication and coordination in face-to-face collaborative activities. C-CMPC devices in slate shape format may therefore facilitate a more fluid and natural face-to-face communication (Bernardis & Gentilucci, 2006; Goldin-Meadow, 1999) in the context defined by this study.

4.2. Survey

At the end of the semester, the students who participated in the experiment were surveyed to obtain their views of CollPad and their feelings and opinions regarding the devices they worked with. In the following sections we report on the method for the survey and give a detailed account on the results.

4.2.1. Method

The survey was delivered to the students as a paper-based questionnaire and conducted with all the students in the cohort present. It contained 27 questions that were asked as Likert items on a five-level scale (i.e., level 1 associated with "strongly disagree" and level 5 associated with "strongly agree"), 6 open-ended questions on the best and worst aspects of using the CollPad software on C-CMPC, CMPC and PDA devices, plus one final question asking which device they preferred. The Likert-item questions were divided into two groups according to their aims: (1) questions for comparing and contrasting students' opinions about specific CMPC and C-CMPC features and affordances, and (2) questions for querying students' opinion about specific device features when used in the CollPad activity. To make an objective quantitative data analysis we performed *t* tests on the sample data, computed using STATA 10 software. For the first group of Likert-item questions, paired-samples *t* tests were conducted, with null hypothesis stating equal means in answers to questions comparing C-CMPC and CMPC features (i.e.,

H_0: mean($\mu_{C\text{-}CMPC} - \mu_{CMPC}$) = 0, rejected with p-value < 0.05), and alternative hypotheses H_a^1: mean($\mu_{C\text{-}CMPC} - \mu_{CMPC}$) < 0, H_a^2: mean ($\mu_{C\text{-}CMPC} - \mu_{CMPC}$) not equal to 0, and H_a^3: mean($\mu_{C\text{-}CMPC} - \mu_{CMPC}$) > 0. For the second group of Likert-item questions, univariate-sample t tests were conducted with null hypotheses stating a sample mean equal to the neutral value of the Likert scale (i.e., H_0: $\mu = 3$, with 3 being the neutral value in the scale from 1 to 5), and alternative hypothesis analogous to the ones listed above. These tests sought to determine whether the sample mean differed positively or negatively from the neutral value of the Likert scale at the 95% confidence level.

4.2.2. Results

The students could generate answers for the tasks in CollPad by using any of the available inputs in the devices, i.e., keyboard, touchpad or stylus. Given that both CMPC and C-CMPC devices present reduced size keyboards due to the devices' constrained dimensions, the students were queried about their acceptance of the keyboards in both devices as an input method for generating answers in CollPad. The results shown in Fig. 4a favor the C-CMPC over the CMPC, however, these results are not statistically significant ($t(19) = 1.75$, $p > 0.05$). Notably, the t test with the alternative hypothesis H_a^3: mean($\mu_{C\text{-}CMPC} - \mu_{CMPC}$) > 0 reported a significant p-value = 0.0481, which can be interpreted as the keyboard of the C-CMPC not being less comfortable than the keyboard of the CMPC. This is consistent with the fact that the students preferred the C-CMPC's keyboard to the CMPC's with predominately neutral or less unfavorable opinions. In this regard, the observers of the audiovisual material reported that those who used C-CMPCs rarely entered text on the keyboard, preferring to write by hand on the screen with the device's stylus.

Regarding screen size, no statistically significant difference was found in the students' preference for screens on CMPC or C-CMPC devices ($t(19) = 0.698$, $p > 0.05$). However, most of the students in the cohort found that both devices' screens were adequately sized for the use of CollPad (Fig. 4b). The fact that the diagonal measurement of the C-CMPC screen is 2 inches larger than that of the CMPC was not considered relevant by the cohort.

In regard to the students' perception of the added value of using a stylus in CollPad, as indicated in Fig. 5a, the majority of respondents considered that the C-CMPC stylus was a good complement to the keyboard for writing answers in the activity ($t(19) = 5.51$, $p < 0.05$). Furthermore, this view was naturally related to the general opinion that it was both desirable and useful to be able to include drawings with answers ($t(19) = 6.33$, $p < 0.05$) (Fig. 5b), which cannot be done efficiently with the CMPC touchpad due to its awkwardness and lack of precision for drawing tasks (Fig. 5c). In this regard, the students showed no significant difference in their preferences for touchpad input on CMPC and C-CMPC devices ($t(19) = 0.568$, $p > 0.05$). Concerning handwriting using the stylus (Fig. 5d), the majority of students had an either positive or neutral opinion about the readability of the handwritten text. The corresponding test, $t(19) = 1.37$, $p > 0.05$, indicates that the students may be indifferent to the readability of the handwritten text, as the null hypothesis is not rejected and the hypothesized neutral value of the Likert scale, i.e., 3, falls into the respective 95% confidence interval (2.84, 3.75).

The number of students supporting that the C-CMPC allows expressing ideas better than the CMPC (Fig. 6) was as much as four times the number of students that disagreed with this view, and this result was found to be statistically significant ($t(19) = 2.85$, $p < 0.05$). Arguably, the fact that the C-CMPC allows handwriting and drawing meant that students could express their ideas better using the C-CMPC. As explained in Section 3.2, none of the tasks observed compelled the students to make drawings, hence, a significant number of students intuitively preferred using the stylus to express their ideas through combining handwriting and drawings.

Twelve students stated that the C-CMPC facilitated communication with their group mates (Fig. 7a), compared to only one student that agreed so about the CMPC. Notably, the difference in the students' opinions, favoring the C-CMPC, is statistically significant ($t(19) = 2.34$, $p < 0.05$) and consistent with the results of the observations conducted on the audiovisual material presented in Table 2. With regard to motivation using the devices, the number of students that reported greater motivation to work in CollPad by using a C-CMPC almost doubled the number of students that felt motivated by using a CMPC (Fig. 7b). However, this difference was not found to be statistically significant by a very narrow margin ($t(19) = 2.07$, $p = 0.0528 > 0.05$).

Regarding the question for device preference, 11 students favored the C-CMPC, 7 the PDA and only 1 the CMPC, with two not responding. They also showed a clear inclination towards devices with touchscreens and stylus input. Preference for PDAs over CMPCs together with the evidence in Fig. 4b commented earlier, support the fact that students do not necessarily value a larger screen size for writing open answers in CollPad. According to group conversations found in the recorded video material, few students declared feeling forced to write more concise answers when constrained to a smaller screen size, and had a positive appreciation of this limitation. The course instructor shares this view, however, further empirical data is required to support this fact.

In response to a question about CollPad, the students indicated that they considered it a valuable contribution to the Knowledge Management course (Fig. 8). This result suggests that the CollPad

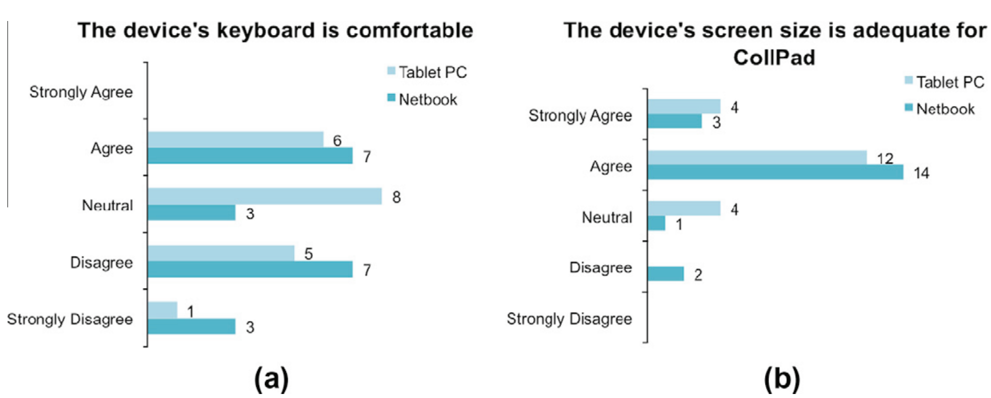

Fig. 4. Students' opinions on keyboard comfort were divided while the majority agreed that the screen was adequately sized for using CollPad.

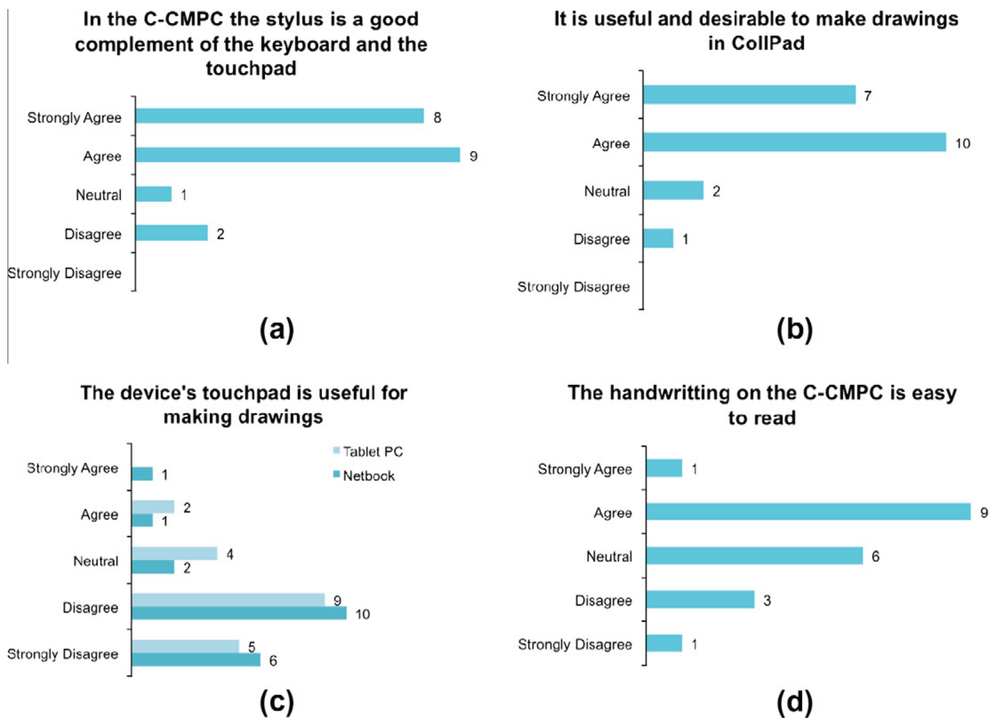

Fig. 5. In CollPad, answering questions often involved making drawings, which was facilitated by C-CMPC due to its stylus handwriting input which is relatively easy to read.

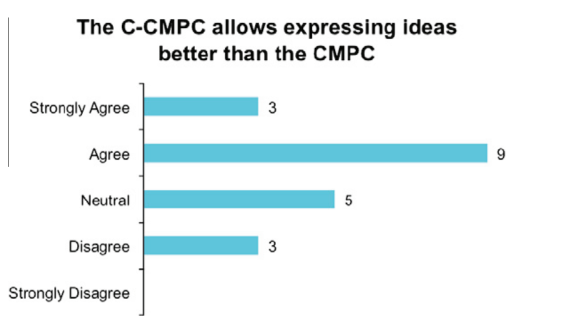

Fig. 6. The majority of students agreed that with the C-CMPC, ideas could be expressed better than with the CMPC.

activity was a success, and it is consistent with results obtained from experiences in the same course in the previous year (Alvarez et al., 2009). CollPad fulfilled its aim of generating discussion of course material covered in class and fostering the active participation of students through collaborative work.

4.3. Time elapsed in CollPad phases

The elapsed times in the Individual Response and Collective Decision phases of CollPad were recorded for each group in the video analysis conducted by the observers. Comparative statistics for the elapsed times in the Individual Response and Collective Decision phases of CollPad are reported in Table 3. Independent sample t tests were conducted on the means of the recorded times of groups working with each kind of device, in an analogous manner to the t tests conducted on the observation form data (Table 2).

The results show that groups using C-CMPC devices took in average 25% less time in completing the Individual Response phase of CollPad than students using CMPCs. This result is statistically significant ($t(16) = -2.54$, $p < 0.05$), and consistent with the students' perception of the CMPC's input devices reported on the

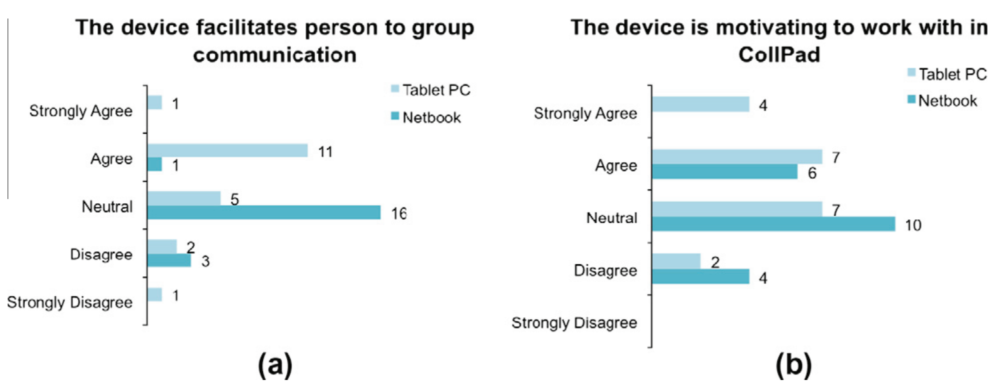

Fig. 7. The C-CMPC facilitated person–group communication and most students felt more motivated working with this device.

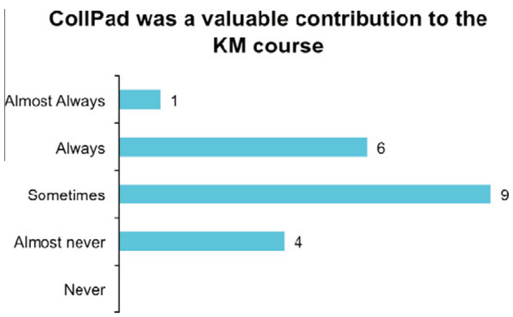

Fig. 8. Students agreed that CollPad made a valuable contribution to the process of understanding and learning the course material.

survey, which regarded the input devices as uncomfortable for typing (keyboard) and inadequate for making drawings (touchpad). Contrastingly, the students reported on the survey that the C-CMPC's stylus is a good complement of the keyboard and the touchpad. Hence, the students' positive perception of the stylus may be also related to the fact that they can write their answers more efficiently and more comfortably using this input device.

The results obtained for the elapsed times in the Collective Decision phase of CollPad are opposite to the results of the Individual Response phase, as groups using C-CMPC devices took in average 47% more time in the Collective Decision phase than groups using CMPC devices. This result was also found to be statistically significant ($t(17) = 2.46$, $p < 0.05$). Arguably, this result can be related to the fact that groups using C-CMPC devices presented significantly more dialogues (i.e., person-to-group utterances) than groups using CMPC devices (see Table 2), thus it is probable that the C-CMPC devices influenced the students' attitude towards being more open to thoroughly discuss their views and negotiate consensus before submitting the final answer to the instructor, however, an extensive analysis of the dialogues would be necessary to support this finding.

4.4. Answers selected for CollPad discussions

As explained previously, in each CollPad session the instructor assigned the students an open-ended question on the material covered earlier in the class. The instructor evaluated the different group answers received to determine which had the most potential for stimulating a lively debate as part of a whole-class collaborative task in which a range of complementary, opposing and conflicting visions would be expressed. The CollPad system allowed for a maximum of 4 such group responses to be chosen. These may or may not have included responses from the 4 groups in the sample, as the total number of groups in the CollPad sessions was always at least 5 (see Table 1).

Table 4 indicates the number of groups selected by the instructor for the discussion with each kind of device. Notably, in almost all the discussions, except for session 2, the answers generated by the two groups using C-CMPCs were selected for the discussions. However, there is no evidence supporting that answers generated using C-CMPCs were consistently better in relation to the pedagogical objectives than answers generated using CMPCs. As a matter of fact, not all the answers selected by the instructor for the discussion were necessarily correct. In most sessions, this was done intentionally by the instructor for fostering discussions with opposing and/or conflicting views. Moreover, it is possible that the instructor may have been subjectively biased towards privileging selection of answers generated by C-CMPCs. Given that the instructor was not tested for such a bias, by means of the results obtained it is not possible to establish an objective relationship between the instructor's selection of answers for the discussion and the quality (i.e., correctness) of the answers. In total, the instructor selected nine answers from each kind of device for the CollPad discussions, and there were always more groups using CMPC than C-CMPC devices, thus there was an evident tendency of the instructor to select answers generated by groups using C-CMPC devices.

Table 4
Number of groups selected for the CollPad discussions with each kind of device.

Session	C-CMPC	CMPC
1	2	2
2	1	3
3	2	1
4	2	2
5	2	1

5. Discussion

The observations conducted on the audiovisual material together with the results of the survey lead us to conclude that the tablet type of netbook used in the slate format (Fig. 9a and b) promotes fluid physical and verbal interaction between students, stimulating person-to-group dialogue and integrating all group members in group discussions. Using these devices the students were less inhibited about expressing their points of view and in complementary fashion were more willing to listen to others. On the other hand, it was recurrently observed in the audiovisual material that when the students used netbooks with traditional vertical screen and keyboard arrangement they tended to be immobilized by the need to keep their eyes constantly on the screen (Fig. 9c and d). This resulted in the group members limiting their body language when expressing themselves, and confining their conversation to the group mate sitting next to them, rather than communicating with the group as a whole. The experiment was thus conclusive in measuring a statistically significant quantitative difference both in oral and gesture-based communication, therefore indicating that tablet-style devices can facilitate a richer face-to-face communication in small group collaboration scenarios.

The results also show that in the context of a technology-supported small group collaborative learning activity such as CollPad, in which open-ended questions may be answered using both text and drawings, the students expressed a clear preference for tablet

Table 3
Comparative statistics for elapsed times in the individual answer and Collective Decision phases of CollPad. The first column gives the name of the CollPad's phase for which time statistics are reported, the second and third columns specify the average elapsed times (in seconds) recorded for groups using C-CMPC and CMPC devices, the fourth column reports the absolute difference between the average values, and the fifth and sixth columns report the standard deviation of the times recorded for groups using C-CMPC and CMPC devices. The seventh column presents the *t*-value for the independent-samples *t* tests conducted, and the eighth column the degree of freedom of the tests. The last three columns indicate the *p*-values obtained on the left-tailed, right-tailed and two-tailed *t* tests, respectively.

Phase	$\mu_{C\text{-}CMPC}$ [S]	μ_{CMPC} [S]	$\lvert D\rvert$ [S]	$\sigma_{C\text{-}CMPC}$ [S]	σ_{CMPC} [S]	T	df^{*}	p_l	p_r	p
Individual answer	337	448	111	77.9	113	−2.54	16	**0.0107**	**0.0214**	0.989
Collective Decision	623	424	199	160	198	2.46	17.3	0.9877	**0.0245**	**0.0123**

* Computed with Satterthwaite's approximation.

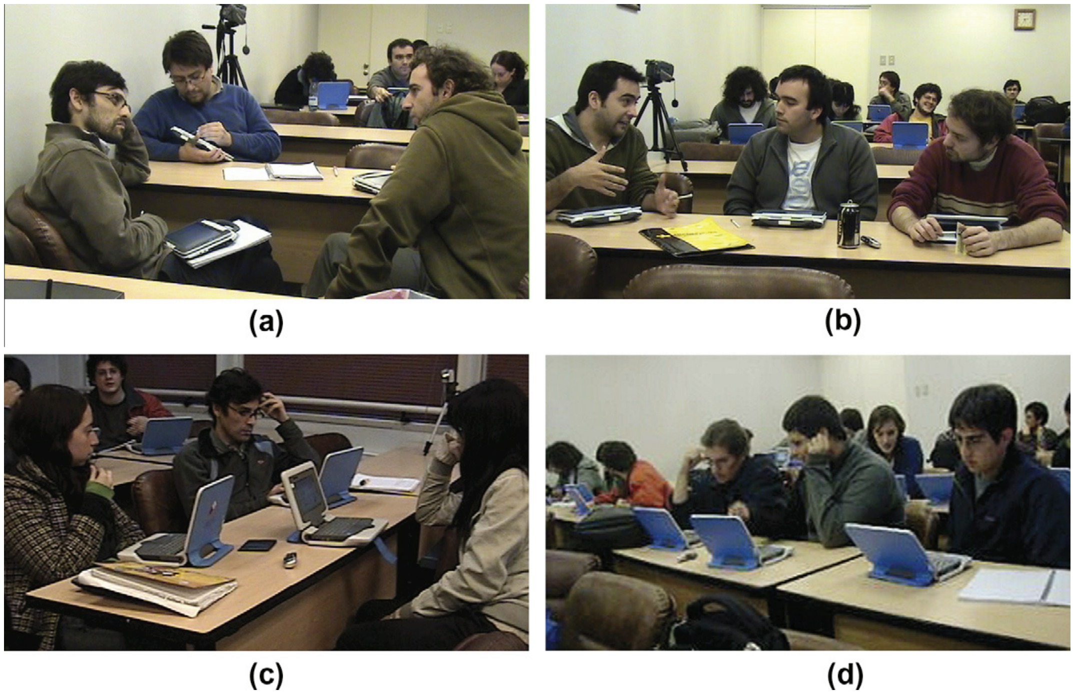

Fig. 9. Groups using C-CMPCs (a and b) and CMPC (c and d).

PC and PDA devices with their stylus-based input that facilitates drawing and handwriting, even though none of the tasks assigned to the students required them to make drawings. Although netbooks with touchpads also support drawing, the students' experience revealed that for the purposes of answering the questions put to them this capability was dysfunctional. In this regard, according to the instructor's own testimony, he preferred the responses generated by the students working on the C-CMPCs due to their greater expressive capacity.

6. Conclusions and future work

Our findings indicate that in the context in which this study was conducted, students prefer tablet PCs to netbooks. Tablet PCs strengthen collective discourse capabilities and facilitate a richer and more natural body language. The students also indicated greater self-confidence in expressing their ideas with the tablet's digital ink and paper technology than with the netbooks' traditional vertical screen and keyboard arrangement. Thus, at the same time as the CollPad pedagogical model used in this study facilitates face-to-face collaborative work (Alvarez et al., 2009), the use of tablet PCs improve the communication of ideas within the work groups.

Given the specific context in which the present study was conducted, involving a cohort of limited size comprising students in technology-related fields with high skills in operating both the hardware and software involved, our future efforts will aim at pursuing the generalization of the current findings, based on further experimentation with larger cohorts and different courses, not necessarily restricted to the engineering curricula. We also embrace the possibility of conducting more thorough studies for establishing relationships between the devices used to support collaboration and academic achievement.

Acknowledgements

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Appendix : Survey

1. The CollPad software is confusing.
   ○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
2. I like using the CollPad software.
   ○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
3. The CollPad software is frustrating.
   ○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
4. I would like to participate in CollPad activities in another course.
   ○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
5. CollPad was a valuable tool in the course.
   ○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
6. The tablet PC keyboard is comfortable.
   ○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
7. The netbook keyboard is comfortable.
   ○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
8. The netbook's screen size is adequate for CollPad.
   ○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
9. The tablet PC's screen size is adequate for CollPad.
   ○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
10. When working with CollPad, my handwritten annotations on the tablet PCs are easy to read for my classmates.
    ○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
11. It is desirable and useful to make drawings in CollPad answers.
    ○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○

(*continued on next page*)

Strongly Agree
12. The netbook's trackpad is useful for making drawings in CollPad answers.
○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
13. The tablet PC's trackpad is useful for making drawings in CollPad answers.
○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
14. For writing answers in CollPad, the tablet PC's stylus is a good complement for the keyboard and the trackpad.
○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
15. In CollPad I express my ideas better when working with a tablet PC than a netbook.
○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
16. In CollPad activities the tablet PC facilitates my conversations with my group mates.
○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
17. In CollPad activities the netbook facilitates my conversations with my group mates.
○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
18. I feel motivated working with a tablet PC in CollPad.
○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
19. I feel motivated working with a netbook in CollPad.
○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
20. I like netbooks better than tablet PCs.
○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree
21. Which kind of device is better for working with CollPad, PDA, tablet PC or netbook?
22. Describe the best of the tablet PC in one line.
23. Describe the worst of the tablet PC in one line.
24. Describe the best of the netbook in one line.
25. Describe the worst of the netbook in one line.
26. Describe the best of the pocket PC in one line.
27. Describe the worst of the pocket PC in one line.

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The GCCCD is starting a year-long process to develop an Educational Master Plan that will serve as the blueprint for our future. The Educational Master Plan is a long-range, comprehensive document intended to guide institutional and program development at both the college and district levels. The priorities established in the Educational Master Plan will serve to guide College and District decisions about growth, development and resource allocation.

As the first step in this planning process, everyone in the GCCCD community (faculty, staff, students and community members) are invited to identify and submit information sources to be reviewed for the trend analysis in one of six taxonomy areas - society, technology, economy, environment, politics, and education. We are not asking you to do new research - only to identify information you already have or that you encounter during the search period (March 21 - April 25) and bring it to the attention of the Scan Teams for review.

Please feel free to submit as many of these forms as you would like. Please answer the following questions for each submission:

1) What is the document we should review? : Steady employment growth and generates billions of dollars a year. There are

2) Author: Entertainment Software Association

3) Source: ESA Webpage

4) Which of the following taxonomy areas does it fit into? (Please select only one):

- ☐ Society
- ☒ Technology
- ☐ Economy
- ☐ Environment
- ☐ Politics and Legal Issues
- ☐ Education
- ☒ Other: Video Gaming

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Education Master Plan
Information Submission Form

The GCCCD is starting a year-long process to develop an Educational Master Plan that will serve as the blueprint for our future. The Educational Master Plan is a long-range, comprehensive document intended to guide institutional and program development at both the college and district levels. The priorities established in the Educational Master Plan will serve to guide College and District decisions about growth, development and resource allocation.

As the first step in this planning process, everyone in the GCCCD community (faculty, staff, students and community members) are invited to identify and submit information sources to be reviewed for the trend analysis in one of six areas - society, technology, economy, environment, politics, and education. We are not asking you to do research, only to identify information you already have or that you encounter during the search period (March 21 - April 25) and bring it to our attention for review.

Please answer the following questions for each document you submit:
(Feel free to submit as many of these forms as you would like)

1) What is the name of the document? Lerning Technololgy Market Trends Meet Cutomer Demand

2) Author: Anne Pace

3) Source: T + D. Alexandria: Mar 2011. Vol. 65, Iss. 3

4) Which of the following areas does this document best address? (Please select only one)

- ☐ Society
- ☒ Technology
- ☐ Economy
- ☐ Environment
- ☐ Politics and Legal Issues
- ☐ Education
- ☐ Other:

5) Relevance: online/Distance Education, Tech. in the classroom

6) Page / Section: 62-65

7) **Attach Document / Place URL Here**:

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For questions email: lynne.davidson@gcccd.edu *Research, Planning and Institutional Effectiveness*

STRIKING THE BALANCE: Learning Technology Market Trends Meet Customer Demands
Ann Pace
T + D; Mar 2011; 65, 3; ABI/INFORM Global
pg. 62

STRIKING THE BALANCE:

Learning Technology Market Trends Meet Customer Demands

By Ann Pace

Photo by Getty Images

The future is bright for the learning technologies marketplace, and technology suppliers are poised to make the most of the gradually recovering economy in 2011. Encouraged by growth in the training and development industry, the following companies anticipate greater product and service customization, enhanced salesforce and leadership training, and increased mobile learning demand within the coming months.

Blackboard

Working with its clients to build a better education experience, Blackboard's longstanding brand reputation speaks for itself. Blackboard first arrived on the learning technologies scene more than 10 years ago with popular resources for students, but its corporate education products and services have since made a name for the company within the workplace learning marketplace.

Blackboard Learn for corporations is an online learning platform that provides onboarding, sales training, leadership coaching, and partner training capabilities. Additionally, Blackboard claims its specialization is different, but complimentary, to a traditional learning management system. "Most LMSs identify with the 'M'—management—while we're the 'L,' the learning and delivery side," says Kevin Alansky, senior director of marketing for Blackboard. "Our focus is on teaching and learning, which has tremendous corporate value. We deliver a continuous learning environment that benefits our customers' businesses and delivers learning results rapidly.

"I think our tools are well positioned for the future," Alansky adds. "We've focused a lot on asynchronous learning in the past, and we're now rounding out our offerings with more synchronous tools." Furthermore, Blackboard recently launched its mobile learning platform, Blackboard Mobile, which enables learners to access learning content on-demand.

In December Blackboard announced its plans to partner with Salesforce.com to invest in an improved corporate LMS. The application will be co-developed on Salesforce.com's cloud computing platform and will add capabilities to Blackboard Learn, including certification, registration, reporting, and tracking. The integrated platform will give sales managers the ability to identify skills gaps in their employees' development, select and assign the training needed to develop those skills, and track employee performance.

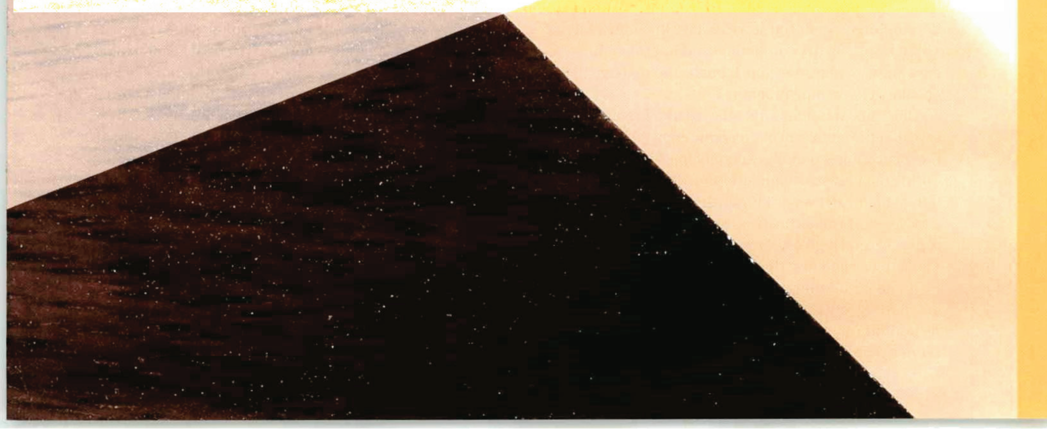
This application, which is poised to generate a greater demand for Blackboard's sales training, onboarding, and professional development offerings and expand its audience to the population served by Salesforce.com, is expected to be launched in the summer of 2011. While the platform will initially focus on sales training, Blackboard has plans to integrate customer service and leadership development content in the future.

Development Dimensions International

Development Dimensions International (DDI), "the talent management expert," offers a comprehensive approach to talent management, including employee interviewing and behavioral assessments, leadership development training, and succession and performance management tools and expertise. DDI's array of products and services includes web-based training and virtual classroom options, which the company is expanding this year as a result of a growing customer demand.

"With severe cutbacks, a lot of new technology decisions were put on hold by organizations [during the recession]," says Jim Concelman, vice president of leadership development for DDI. "Most organizations didn't have the funding to go through with major technology-related changes. We are seeing 2011 as a transition year—companies are moving from dreaming about expanding their learning and development technology offerings to actually going through with it."

During the past few years, many organizations have also undergone major business strategy changes and reformed internal operating structures and functions to respond to customer demands and marketplace shifts. Talent strategies must adapt to these changes as well. Organizations are now asking whether or not they have the talent in place to execute these new goals, Concelman notes. For the learning and



development industry, there is a renewed focus on leadership development as companies are searching for talent to execute their new strategies and fill their leadership pipelines.

One new learning technology tool DDI is rolling out this year is Manager Ready, a frontline leadership online behavior assessment center. Manager Ready is different from a 360-degree assessment because it is objective and based on the leader's actual performance. Leaders complete their assessments online, are scored by DDI assessors, and sent a report of their results. "You can lower the cost and increase the value of development by developing people in what they really need to be trained in," notes Concelman. "Manager Ready helps focus training on leader needs, and because it's objective, it's motivating and actionable. As organizations are looking for ways to best use their business dollars and pull frontline leaders into their business strategies, this tool will help."

While DDI has not been immune to the social learning craze, it is taking a new approach to informal learning by focusing on building content that can be used by social media, rather than making social media technologies fit training. "Social media is a 'how,' not a 'what,'" Concelman says. "We are focusing more on the 'what'—the training content—because every organization is at a different place in its social media adoption."

DDI continues to focus on blended learning as well, purporting that "the magic is in the mix." "We will continue to develop ways of enhancing the mix so organizations can build training in a way that will help them get results," Concelman adds.

■ Element K

Learning solution provider Element K offers a variety of capabilities that span the entirety of a learning program. These include more than 6,000 e-learning courses, more than 1,300 print courseware titles, a learning platform, hands-on labs, professional certifications, custom content development, managed services, and integration services. These resources are compatible and interoperable, allowing customers to plan, develop, launch, and manage their own customized learning programs.

Dave Snider, senior director of marketing at Element K, says that the company has recently enjoyed the fruits of the recovering economy, experiencing double-digit growth during the past year, with its online offerings—a combination of online delivery, content, and custom products and services—especially thriving. Furthermore, Snider has observed several high-level trends in the learning technologies marketplace and describes Element K's responses to each.

It's no secret that mobile learning is the new actor on learning and development's stage, and Element K is responding accordingly by launching a mobile learning service that delivers high-end audio and video downloads designed specifically for leadership development and sales training audiences. "When you buy Element K's content libraries, you can also purchase this service, so the content is automatically enabled on your mobile device," Snider explains.

Mobile learning must make some room, however, because the training profession's obsession with blended learning continues to gain momentum in 2011, Snider notes. For those companies interested in a mix of e-learning and live classroom training, Element K is launching an upgrade of its blended learning solution this year—a combination of online and classroom-based content for a variety of training programs, as well as facilitator guides and resources.

An emphasis on leadership development continues this year as well, and Element K offers training programs to meet this demand, including Feedback that Works and Managers in Transition. "We continue to have some of best partnerships in the world," Snider says. "For example, this year we partnered with the Center for Creative Leadership to help them deliver their exceptional programs online."

Just-in-time training is another hot topic, as companies want to get employees to the content that they need quickly and without hassle. "Element K developed a series of portals in our LMS that are job-specific, and information is brought to people when they log in," Snider says. Content can be integrated with a client's LMS and accessed via single sign-on capabilities.

Finally, Snider sees a trend toward technology-enabled talent management with the linking of learning programs with more formal talent management programs. Element K's products and services are compatible with a variety of learning management systems and talent management systems. "This makes it very easy for organizations that have these systems in place to flawlessly access our content within their environments."

▲ Great Circle Learning

Training provider Great Circle Learning is the creator of the learning technology software package LeaderGuide Pro Plus, which leverages Microsoft Office programs to build consistent, reusable, and professional training materials in the form of leader guides and participant guides.

Originally called LeaderGuide Pro, the newly coined LeaderGuide Pro Plus package symbolizes a recent shift in Great Circle Learning's focus on product customization in an effort to better serve its customers. "We're broadening our base of options to allow for the fact that there is increasingly more specialization," says Nancy Michaels, executive vice president for Great Circle Learning. "LeaderGuide Pro has always performed a number of functions; it's an integrated set of sub-tools that work together. Now we're continuing to offer the full packages as a suite of products, called the Plus product, but we also provide solo products,

Photo by Getty Images

so people can purchase a particular function of the suite that is more focused on their needs or budget."

The solo products include E-LeaderGuide Pro Solo for facilitators delivering virtual instructor-led trainings; LeaderGuide Pro Solo to create leader guides for live training sessions; ParticipantGuide Pro Solo for easy-to-use participant guides; Librarian Solo, a cataloging tool for managing training program content that allows for easy transfer to an LMS; and george! Solo to design professional speaker notes and session materials.

Great Circle Learning is taking its commitment to customization a step further by beginning to layer integrated functionality between the solo products so that they can operate together, Michaels adds. The company is also working on a new MAC-compatible version of its products to reach a broader audience in 2011.

NexLearn

Staying on the cusp of emerging learning technologies is nothing new for NexLearn, the custom education software developer that specializes in creating immersive learning situations through the use of innovative simulation training. During the past decade, NexLearn has combined cutting-edge technology with the social aspect of human interaction to design more than 1200 engaging social simulations for learning.

"In 10 years, we expect experience design to be the norm in trainings as it's proven to be an effective way to teach and train staff," says Curt Renard, executive director of sales at NexLearn. "Experience design teaches the 'why' and 'when' of the job—critical factors when training employees."

With businesses under greater budget pressure and staff constraints as a result of the recession, leaders are counting on a significant return for every training and development investment. Learning professionals have an opportunity to demonstrate how training is essential to driving business strategy and improving the bottom line, Renard notes. "One way they can show value is by integrating experience design and highly immersive learning technologies to supplement the traditional instructional design methods."

NexLearn's flagship product, SimWriter Professional, is a comprehensive, customizable social simulation authoring tool that facilitates every step of the development process from storyboarding to writing, designing, building, and testing, therefore placing the capabilities of an instructional designer, graphic designer, and engineer in the hands of the learning department. Furthermore, SimWriter Professional allows users to update and maintain their content after development.

The reduction in training and development staff and resources, especially in small- and mid-sized companies, was one unfortunate repercussion of the economic downturn. In February, NexLearn launched its newest product, SimWriter Simplicity, to respond to the growing need for learning professionals within these smaller organizations to effectively train their staff.

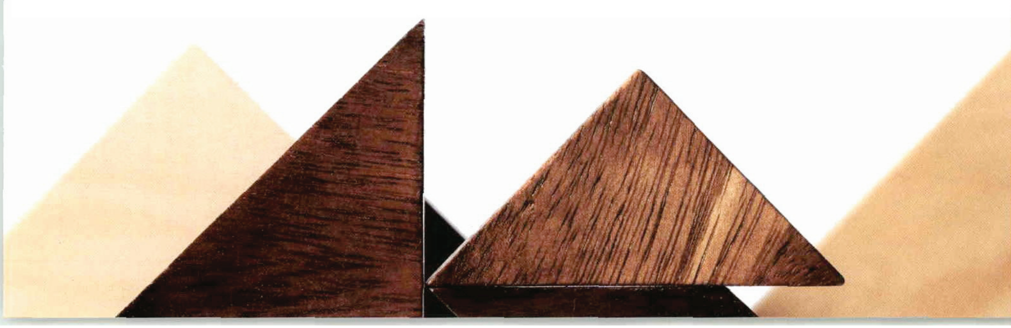
"SimWriter Simplicity has many of the same features of our SimWriter Professional product, but Simplicity is a scaled-back version, which makes it affordable for small and medium businesses," Renard explains. "Additionally, it provides a similar interface for developing customized in-house simulations, which has earned NexLearn its reputation.

"The authoring software is specifically designed to help training and development managers shorten the learning curve for employees. Knowledge that would typically take years of experience to achieve can now be taught, explained, and experienced by employees in multiple locations in a matter of minutes. Through the use of the highly interactive simulation modules, trainees can get real-time feedback and results of selected actions played out in real-world problem solving. We believe Simplicity fills a major gap in the market and provides huge opportunities for these businesses that otherwise would not be able to use these types of interactive training simulations."

Innovation and opportunity in 2011

Technology suppliers have a difficult line to juggle: They must cater to customers' current interests while simultaneously anticipating future market trends. Those companies that strike the appropriate balance will find themselves on top, leading the learning and development profession toward greater technology innovation and opportunity.

Ann Pace *is writer/editor for ASTD; apace@astd.org.*



Educational Master Plan

Information Submission Form

1) Title: Teachers make the move to the virtual classroom

2) Author: Ash, Katie

3) Source: Education Week (Jan. 2011)

4) Taxonomy Area:

- [ ] Society
- [x] Technology
- [ ] Economy
- [ ] Environment
- [ ] Politics and Legal Issues
- [ ] Education
- [ ] Other: ____________________

5) Relevance: Tech in classroom

6) Page / Section: 32-34

7) Link to document: ____________________

or

8) Attach Document Here: [ ]

Teachers Make the Move to the Virtual World

Teaching in an online-only environment takes more than just expertise with technology.

BY KATIE ASH
From *Education Week*

When Jim Kinsella began teaching online, little was known about the best way to support students, train teachers, or build an online classroom. It was 2001, and he was asked to teach at the Illinois Virtual High School, now known as the Illinois Virtual School.

The social studies and government teacher had long incorporated digital elements into his classes at University High School, and he was curious about teaching online.

"I wanted to see what the new technology would do, and how much you could bring to the students, and how well they would do with it," Kinsella said.

But making the move from a regular classroom to a virtual setting is about more than the technology, he and other experts on e-learning say. Individualizing instruction, creating an engaging and supportive online classroom, and learning how to communicate with students who aren't physically present are among the challenges.

Today, Kinsella teaches online courses for the Illinois Virtual School, Northwestern University, and Sevenstar Academy, a private Christian school in Cincinnati.

Curiosity initially attracted Kinsella to online learning, but the relationships he found he could build with online students hooked him. "Online teaching is much more hands-on than face-to-face teaching," he said. "The interactions that I have are one-on-one, so I get to know my students much better and in a much different way."

Communicating with students and building relationships with them are among the hardest, and most important, parts of online teaching.

"One of the big pitfalls of online learning is that high school kids have a tendency to disappear,"

Katie Ash is a writer for Education Week. *Condensed, with permission, from* Education Week, *30 (September 22, 2010), S6,7.* *For more information, visit www.edweek.org.*

Kinsella said, especially right before tests or term papers are due.

To help combat that inclination, Kinsella requires students to initiate contact with him by phone or through Skype at least once a week.

Solving Technological Problems

Kinsella was successful transitioning to the online classroom, but it might not be the right move for every teacher, said Evan Abbey, project manager for online learning for the Iowa Area Education Agency. "Just because you can effectively integrate technology in a face-to-face classroom doesn't mean you're ready to teach online," he said.

Of course, some comfort with technology is essential for online teachers, said Barbara Treacy, director of EdTech Leaders Online at Education Development Center.

"An online facilitator or teacher needs to be prepared for technological problems," she said. "They must be willing to be a calming front line of defense with technical issues."

Becoming more comfortable with technology and learning-management systems, such as Blackboard and Moodle, was one reason Matt Lozano began teaching online. After 10 years of face-to-face teaching, Lozano taught his first online course through the Maynard, MA-based Virtual High School Global Consortium (VHS) last year.

"I really wanted to learn how to use [Blackboard] because in the future, my face-to-face courses will be using something like Blackboard," he said.

Guiding the Students

What Lozano didn't expect was how well he would get to know his students. "At first, my perception was that it was going to be awkward and difficult to get to know them, but the way the course is structured, they're being required to express themselves more than a lot of my kids in the face-to-face classroom would," he explained.

The hardest part about the transition to an online classroom was getting used to allowing students to direct their own learning. "In my face-to-face classroom, I am used to being the star, presenting the material, and in an online environment you can't do that," Lorenzo said. "I wanted to jump into a discussion and take it over, but that's not necessarily helpful for those kids."

Allowing conversations to go off on a tangent and land on topics that the students themselves found interesting was both challenging and rewarding.

"It took some maturity on my part," Lozano said, "to be able to trust them and give them little guiding remarks rather than jumping in with the answer."

Liz Pape, president of VHS, a network of over 660 member districts, said many new online teachers reported a greater emphasis on higher-order thinking skills in online discussions. The teacher is helping and fostering community, communication, and collaboration," she said. "Problem-solving skills, creativity, innovation, and real-world applications of content knowledge—those are all skills that you want to foster."

Asking open-ended questions that can't be answered by just one student is especially important, said Pape, since the teacher is not there to facilitate the discussion in real time. And teachers who train to teach online often note that those skills helped improve their teaching in a face-to-face classroom as well.

In her first year, Kim Solomon, a 2nd grade teacher at the Chicago Virtual Charter School, a blended-learning environment in which students learn mostly online but have some in-person lessons, noticed that the online classroom required teachers to develop a tailored set of time-management skills, such as setting a daily schedule and sticking to it, keeping track of emails and phone calls, and planning lessons well in advance.

Learning how to evaluate students who are not physically present can be challenging, said Steven Guttentag, executive vice president and chief education officer of Connections Academy, which operates online schools in 21 states.

"[Teachers] in a brick-and-mortar school are used to talking to kids and watching them to see if they're OK," said Guttentag. Online, teachers have to depend on data and online feedback to evaluate whether their students comprehend the curriculum.

Working With Parents

Online teachers also need to work more closely with parents. In many online-learning programs, parents become learning coaches, and therefore frequent, open communication between teachers and parents is essential. The teacher must establish "good customer relations" to foster productive discussions about student progress without allowing parents to overstep their boundaries, Guttentag said.

Online teaching is not for those looking for an easier alternative to a regular classroom, said Jeff Murphy, the director of instructional support for the Florida Virtual School.

"You have to really care about students and want to go out of your way to help them be successful. That means working long hours and staying on the phone for an hour to get a student to understand an important concept," he said.

And just as in a face-to-face classroom, it takes time for online teachers to feel at ease in their environment. "It takes most teachers at least a year to a year and a half to get comfortable in an online classroom," said Murphy. ■

Educational Master Plan

Information Submission Form

1) Title: A New Era for Internet Domains: Why .XXX Is Just the Beginning

2) Author: Ben Crawford

3) Source: yahoo News

4) Taxonomy Area:

- [ ] Society
- [x] Technology
- [ ] Economy
- [ ] Environment
- [ ] Politics and Legal Issues
- [ ] Education
- [ ] Other: ____________________

5) Relevance: emerging internet trends

6) Page / Section: Tech

7) Link to document: ____________________

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Ben Crawford – Mon Mar 28, 9:40 am ET

Ben Crawford is the CEO of domain industry firm CentralNic. Prior to joining that firm in 2009, Crawford worked at various jobs which combined his love of sports with Internet technology, including serving as executive producer for IBM's official Sydney Olympic Games website.

A new era of Internet use is about to begin, marked by the recent decision by the Internet Corporation for Assigned Names and Numbers (ICANN) to approve the long-debated .xxx top-level domain (TLD).

ICANN will shortly be announcing the final rules and roll-out schedule for hundreds of other new TLDs. The program will let brands, trademark holders, industry associations and entrepreneurs bypass traditional extensions and become “masters of their own domains” by acquiring and controlling their own domain suffixes such as .canon, .nyc or even .mashable.

The Benefits of New Top-Level Domains

Where domains like .com and .net have little informational value in-and-of-themselves, most of the upcoming extensions contain information about the content of the websites they support. The domain .xxx will mark sites that contain adult content, and ICANN’s recently approved domain extensions in Cyrillic, Arabic and Chinese characters indicate that the content of websites using these domains is written in those scripts. In the future, locally focused websites will use their city TLD, websites on specific cultures will use their community TLD, and businesses will use their industry TLD or their own .brands.

New and more secure distribution methods will emerge with these more informative TLDs. The current model for distributing domain names using generic extensions (.com, .net, .org, etc.) has huge consumer benefits, in that anyone can get a domain name online quickly and affordably from more than 100,000 registrar and reseller websites.

However, the system also contains serious flaws. Because these domains are sold as an unrestricted commodity, anyone can obtain domain names that include trademarks — legitimate trademark owners and “brand pirates” alike. The result is that the current domain name system is rife with speculators, squatters, phishing sites and so on, with an entire industry built around processing complaints, legal actions and the arbitration of domain name disputes.

The .brand TLDs will remedy many of these issues by creating a regulated online space that can be tightly controlled by the principal that sets its policies. As a result, consumers will benefit from the assurance that all domain names with a given ending are authentic and trustworthy. Banks, charities, online merchants, industry associations and other entities that rely on online transactions will particularly benefit from this controlled online presence.

The Red Cross offers a good example. In the midst of recent tragedies in Japan, it has had to deal with domains registered by third parties containing the words "Red Cross" and "Japan." Taking action against these registrants to curtail possible misdirected donations can cost hundreds if not thousands of dollars (even under ICANN's Uniform Dispute-Resolution Policy) that could otherwise be used to aid the victims of this horrible disaster. A .redcross TLD could help to avoid this scenario entirely. The Red Cross would have control over who could obtain one of its domains, and therefore bring unprecedented clarity and security to consumers with the simple message, "If the web address doesn't end with .redcross, it's not authentic."

With the controversial .xxx debate out of the way, ICANN will shortly be announcing the final rules and rollout schedule for other new TLDs. While there has been much resistance to the introduction of these new TLDs, largely from representatives of trademark owners concerned about compounding the problems of the current system, ICANN has been through years of laborious policy consultation, publishing a half-dozen drafts of the applicant guidebook, which now includes many new protections like rapid take-down provisions for knockoff sites. Although many observers feel that ICANN's bottom-up policy-making methodology has led to paralysis, the .xxx decision is a sign that new TLDs are sure to come soon. After all, the ICANN Board does not wish to be remembered for approving .xxx but declining more worthy domains, like .unicef.

Transitioning Away From a .com World

Some marketers are throwing their arms up in despair as 15 years of guiding consumers to their brand's .com destinations must soon be "unlearned." But in fact, the introduction of new TLDs will be quite seamless, and consumers' experience of the Internet will be drastically improved.

First, despite all the regulation, technology and expense that is implemented behind the scenes, the customer message from any major brand or global website with its own TLD will be as simple as: "You no longer have to type '.com' at the end of our web address."

Second, search results will be populated with web addresses with much more variety, as smaller companies take advantage of new domain extensions that are more informative and intuitive or more creative than the options they currently enjoy. New TLDs will improve the user experience by making it even easier to distinguish between the websites of Mary Smith the lawyer (marysmith.law), Mary Smith the children's entertainer (marysmith.kids) and Mary Smith the porn star (marysmith.xxx).

And for consumers wishing to start their own websites, they may be able to get their domain names for free from their telecom provider, or even from a sponsor.

Regardless of its impact on accessing or suppressing adult content online, .xxx is poised to be the extension that incites 1,000 new top-level domains, and now is the time to prepare for the impending Internet revolution.

Interested in more Tech resources? Check out **Mashable Explore**, a new way to discover information on your favorite Mashable topics.

Image courtesy of Ryan Christopher VanWilliams.

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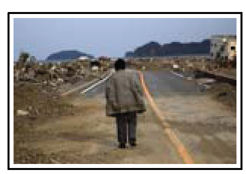

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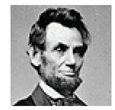

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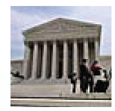

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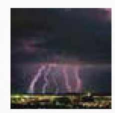

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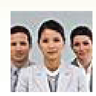

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Education Master Plan
Information Submission Form

The GCCCD is starting a year-long process to develop an Educational Master Plan that will serve as the blueprint for our future. The Educational Master Plan is a long-range, comprehensive document intended to guide institutional and program development at both the college and district levels. The priorities established in the Educational Master Plan will serve to guide College and District decisions about growth, development and resource allocation.

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Please feel free to submit as many of these forms as you would like. Please answer the following questions for each submission:

1) What is the document we should review? : Video Gaming Web Site

2) Author: None

3) Source: Internet

4) Which of the following taxonomy areas does it fit into? (Please select only one):

- ☐ Society
- ☒ Technology
- ☐ Economy
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- ☐ Politics and Legal Issues
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5) Relevance: Steady employment growth and generates billions of dollars a year. There are no 2 yr. colleges that offer gaming edu

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Questions: lynne.davidson@gcccd.edu *Research, Planning and Institutional Effectiveness*

Educational Master Plan

Information Submission Form

1) Title: How Technology Is Changing School

2) Author: Curtis J. Bonk

3) Source: EDUCATIONAL L E A D E R S H I P / A P R I L 2010

4) Taxonomy Area:

- [ ] Society
- [x] Technology
- [ ] Economy
- [ ] Environment
- [ ] Politics and Legal Issues
- [ ] Education
- [ ] Other: ______

5) Relevance: Tech & education/ distance ed.

6) Page / Section: ______

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For Openers How Technology Is Changing School

Whether you're sailing around the world, homebound with the flu, or just in the market for more flexible learning, thanks to the Internet, schooling never stops.

Curtis J. Bonk

Sometimes it takes a major catastrophe to transform how we deliver schooling. In 2005, in the aftermath of Hurricanes Katrina and Rita, Web sites went up in Louisiana, Texas, and Mississippi to help educators, students, families, and school districts deal with the crisis. The Mississippi Department of Education (2005) announced free online courses at the high school level, and institutions from 38 states provided more than 1,300 free online courses to college students whose campuses had been affected by the hurricanes (Sloan-C, 2006).

Health emergencies in recent years have also caused educators to ponder the benefits of the Web. In 2003, during the SARS epidemic in China, government officials decided to loosen restrictions on online and blended learning (Huang & Zhou, 2006). More recently, as concerns about the H1N1 virus mounted, many U.S. schools piloted new educational delivery options, such as free online lessons from Curriki (www.curriki.org) and Smithsonian Education (www.smithsonianeducation.org). Microsoft has even offered its Microsoft Office Live free of charge to educators dealing with H1N1. The software enables teachers to share content, lesson plans, and other curriculum components, while students access the virtual classroom workspace, chat with one another on discussion topics, and attend virtual presentations.

Blended Learning Is Here

The focus today is on continuity of learning, whether learning is disrupted because of a hurricane or the flu—or because of other factors entirely. Schools may have difficulty serving students who live in rural areas; reduced budgets may limit the range of learning that a school can offer; people young and old involved in serious scholarly, artistic, or athletic pursuits may find it difficult to adhere to the traditional school structure.

In light of these developments, some school districts are resorting to blended learning options. They are using tools like Tegrity (www.tegrity.com); Elluminate (www.elluminate.com); and Adobe Connect Pro (www.Adobe.com/products/acrobatconnectpro) to provide online lectures. Many are developing procedures for posting course content and homework online. Some are trying phone conferencing with Skype (www.skype.com) or Google Talk (www.google.com/talk). Others are evaluating digital textbooks and study guides. Still others are sharing online videos from places like Link TV (www.linktv.org); FORA.tv (http://fora.tv); or TeacherTube (www.teachertube.com), with teachers often asking students to post their reflections in blogs or online discussion forums. Many schools have begun to foster teamwork by using Google Docs (http://docs.google.com) and wikis. Although some schools use e-mail to communicate messages districtwide, others are experimenting with text messaging or Twitter (http://twitter.com).

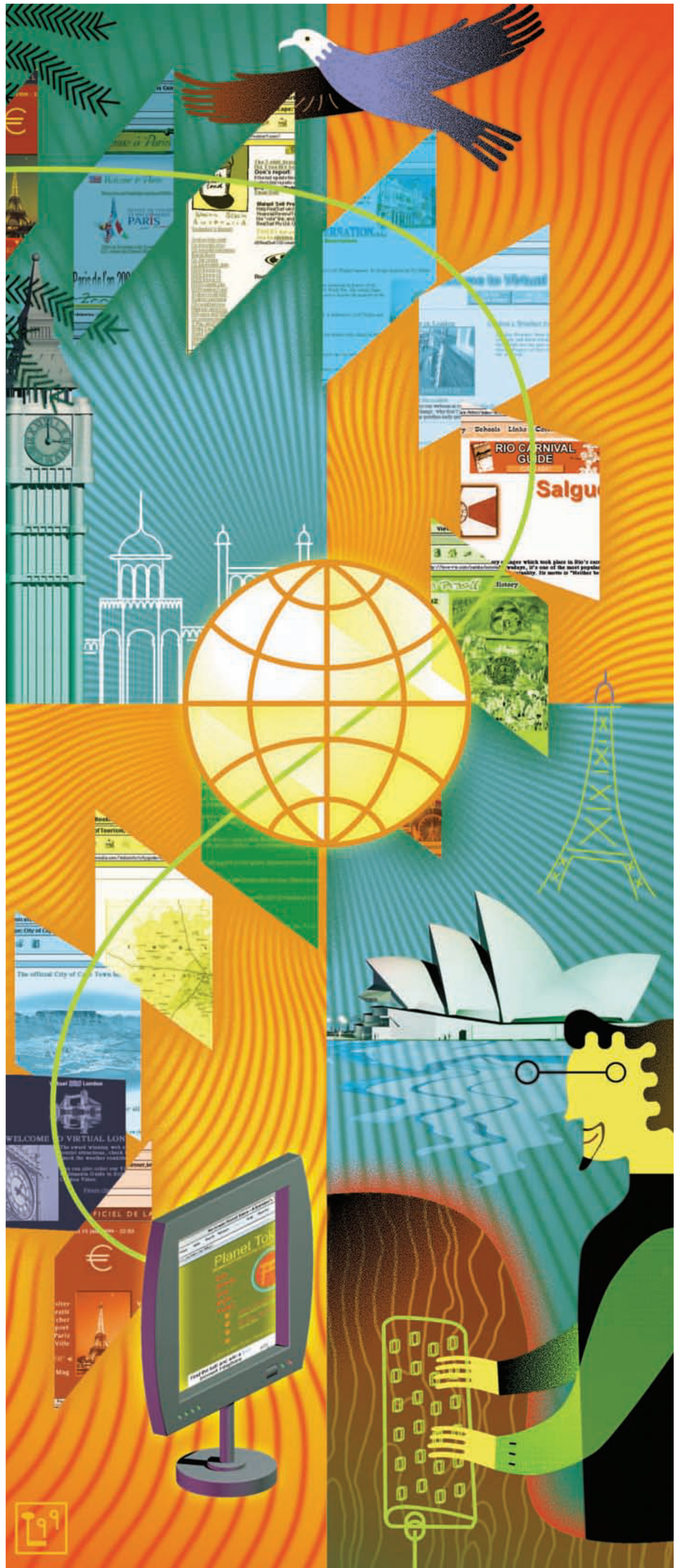
The wealth of information available online is also changing teaching practices. Teachers can access free online reference material, podcasts, wikis, and blogs, as well as thousands of free learning portals, such as the Periodic Table of Videos (www.periodicvideos.com) for chemistry courses and the Encyclopedia of Life (www.eol.org) for biology.

Science teachers can use portals devoted to Einstein (www.alberteinstein.info); Darwin (www.darwin-online.org.uk); or Goodall (www.janegoodall.org). English teachers can find similar content repositories on Poe (www.eapoe.org); Shakespeare (http://shakespeare.mit.edu); and Austen (www.janeausten.org), to name just a few.

High School—Online

Tools like these enable great flexibility in learning. When I take a break from work and jog across my campus, smack in the middle of it I come to Owen Hall, home of the Indiana University High School (http://iuhighschool.iu.edu). Indiana University High School (IUHS) students can take their courses online or through correspondence or some combination of the two. Students range from those who live in rural settings to those who are homebound, homeschooled, pregnant, or gifted. Some are Americans living in other countries; some are natives of other countries whose parents want them to have a U.S. education. Some are dropouts or students academically at risk. Still others are teenagers about to enter college who need advanced placement courses or adults who want to finish their high school degrees (Robbins, 2009). Across the board, many of the 4,000 students enrolled in IUHS simply did not fit in the traditional U.S. high school setting.

Take 16-year-old Evren Ozan (www.ozanmusic.com), the Native American flute prodigy whose music I've enjoyed for several years. I'm listening to him as I write this sentence. Many of Evren's vast accomplishments—he's been recording music since he was 7 years old—would not have been possible without the online and distance education experiences he benefited from during his teen years when most of his peers were attending tradi-



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tional high schools. Also attending IUHS is 15-year-old Ania Filochowska, a Polish-born violinist who has studied with several great masters of the violin in New York City since 2005. Similarly, Kathryn Morgan enrolled in IUHS so she could continue her quest to become a professional ballerina. With the flexibility of online courses and degrees, Kathryn danced full-time and pursued an apprenticeship with the New York City Ballet.

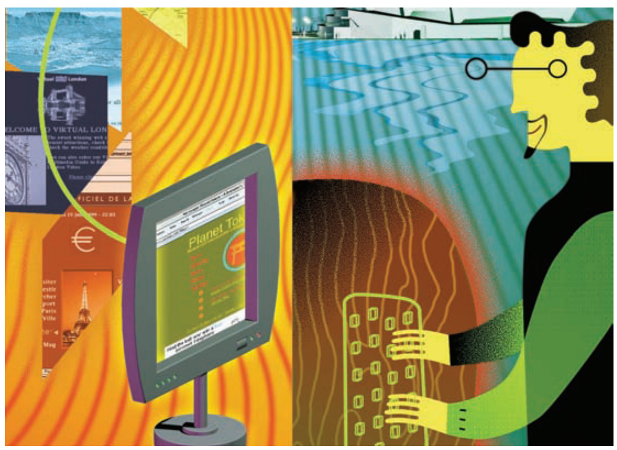
Then there is the amazing story of Bridey Fennell. Bridey completed four IUHS courses while enjoying a five-month sailboat journey with her parents and two sisters from Arcaju, Brazil, to Charleston, South Carolina. Ship dock captains and retired teachers proctored her exams in port, and she practiced her French lessons on different islands of the Caribbean. Her sister Caitlin posted updates about their daily activities to her blog, and elementary students in the Chicago area monitored the family's journey and corresponded with Caitlin.

We All Learn

All this raises the question of why so many people only see the benefits of online learning for musicians, dancers, athletes, and other performers or for those affected by some calamity. I personally benefited from nontraditional education a quarter of a century ago when I was taking correspondence and televised courses from the University of Wisconsin. Back then, I was a bored accountant, and distance learning was my only way out. It got me into graduate school and changed my life. I now speak, write books, and teach about the benefits of distance learning.

The 21st century offers us far more options to learn and grow intellectually. Today, more than a million people in the United States alone are learning online.

To make sense of the vast array of Web-based learning opportunities possible today, I have developed a framework based on 10 *openers*—10 technological opportunities that have the potential to transform education by altering where, when, and how learning takes place. The openers form the acronym WE-ALL-LEARN.[1] They include



- **W**eb searching in the world of e-books.
- **E**-learning and blended learning.
- **A**vailability of open-source and free software.
- **L**everaged resources and open courseware.
- **L**earning object repositories and portals.
- **L**earner participation in open information communities.
- **E**lectronic collaboration.
- **A**lternate reality learning.
- **R**eal-time mobility and portability.
- **N**etworks of personalized learning.

Online and blended learning opportunities are just one opener (opener #2). Let's look at two more.

Web Searching in the World of e-Books

A decade ago, books were limited to being physical objects. Today, all that has changed. Government, nonprofit, and corporate initiatives are placing greater emphasis on digital book content.

The digital textbook project in Korea (www.dtbook.kr/eng), for instance, is being piloted in 112 schools with hopes of making textbooks free for all Korean schools by 2013. Digital textbooks include such features as dictionaries, e-mail applications, forum discussions, simulations, hyperlinks, multimedia, data searching, study aids, and learning evaluation tools.

Right behind Korea is California, which is steeped in a huge deficit. Governor Arnold Schwarzenegger is seeking ways out. One direction is a greater emphasis on digital education (Office of the Governor, 2009). By using digital books, California not only addresses its budgetary problems, but also assumes a leadership role in online learning. Officials in the state plan to download digital textbooks and other educational content into mobile devices that they will place in the hands of all students.

Some digital book initiatives are taking place at the district level. Vail School District in Arizona has adopted an approach called Beyond Textbooks (http://beyondtextbooks.org), which encourages the use of Web resources and shared teacher lesson plans geared to meet state standards (Lewin, 2009). Rich online videos, games, and portals of Web materials as well as podcasts of teacher lectures extend learning at Vail in directions not previously possible.

Innovative companies and foundations are also finding ways to offer free textbooks. Flat World Knowledge (www.flatworldknowledge.com) offers free online textbooks and also sells print-on-demand softcover textbooks, audio textbooks, and low-cost ancillary or supplemental materials, such as MP3 study guides, online interactive quizzes, and digital flashcards connected to each book. Using an open-content, Web-based collaborative model, the CK-12 Foundation (http://ck12.org) is pioneering the idea of free FlexBooks that are customizable to state standards.

Digital books on mobile devices will move a significant chunk of learning out of traditional classroom settings. Hundreds of thousands of free e-books are now available online. You can search for them at places like Google; Many-Books.net (http://manybooks.net); LibriVox (www.librivox.org); the World Public Library (http://worldlibrary.net); the Internet Archive (www.archive.org); Bookyards.com (www.bookyards.com); and other e-book sites. Ironically, the majority of the top 25 best sellers on the Kindle are actually free (Kafka, 2009). We have entered the era of free books.

Real-Time Mobility and Portability

Mobile learning is the current mantra of educators. More than 60,000 people around the planet get mobile access to the Internet each hour (Iannucci, 2009), with 15 million people subscribing each month in India alone (Telecom Regulatory Authority of India, 2009). Also, if just one percent of the 85,000 applications for the iPhone (Marcus, 2009) are educational, thousands of possible learning adventures are at one's fingertips. It's possible to access grammar lessons, language applications, Shakespearean plays or quotes, physics experiments, musical performances, and math review problems with a mobile phone.

Online classes and course modules as well as teacher professional development are now delivered on mobile devices. As mobile learning advocate John Traxler (2007) points out, mobile professional development options are especially important in developing countries in Africa.

Mobile learning is not restricted to phones, of course. Laptops, iPods, MP3 players, flash memory sticks, digital cameras, and lecture recording pens all foster mobile learning pursuits as well as greater learning engagement. Educators need to thoughtfully consider where, when, and how to use such devices.

For instance, rather than ban mobile technologies, school officials might encourage students to record lectures with their pens or digital devices and listen to them while studying for quizzes and final exams. Or teachers might make available snippets of content that students can download to their mobile devices—such as French grammar lessons or quick guides to concepts in the study of chemistry, the human nervous system, or cell biology (Bonk, 2009).

Digital books on mobile devices will move a significant chunk of learning out of traditional classroom settings.

When we think about mobile learning, we often just think of a mobile learner. But the deliverer of the learning might also be mobile. With the Web, our learning content might come from a climb up Mount Everest, expeditions to the Arctic or Antarctic, research at the bottom of an ocean, NASA flights far above us, or sailing adventures across the planet.

Michael Perham (www.sailmike.com) and Zac Sunderland (www.zacsunderland.com), for instance, each blogged and shared online videos of their record-setting solo sailing journeys around the globe. Amazingly, they each completed their adventures last summer at the tender age of 17. I could track their daily experiences and post comments in their blogs. They were my highly mobile teachers. I also learn from Jean Pennycook, a former high school science teacher who now brings scientific research on penguins in the Antarctic to classrooms around the world (see www.windows.ucar.edu/tour/link=/people/postcards/penguin_post.html).

Trends in the Open World

Given these myriad learning opportunities on the Web, you might wonder what is coming next. Here are some predictions.

■ *Free as a book*. Digital books will not only be free, but readers will also be able to mix and match several of their components. E-books and classrooms will increasingly embed shared online video, animations, and simulations to enhance learning.

■ *The emergence of super e-mentors and e-coaches*. Super e-mentors and e-coaches, working from computer workstations or from mobile devices, will provide free learning guidance. As with the gift culture that we have seen in the open source movement over the past two decades, some individuals will simply want to share their expertise and skills, whereas others may want practice teaching. Many will be highly educated individuals who have always wanted opportunities to teach, coach, or mentor but who work in jobs that do not enable them to do so. Those with the highest credibility and in the most demand will have human development or counseling skills (perhaps a master's degree in counseling); understand how to use the Web for learning; and have expertise in a particular domain, such as social work, nursing, accounting, and so forth.

■ *Selecting global learning partners.* Peers don't need to live down the street;

they could be anywhere on the planet. Tools like Ning (www.ning.com) and Google Docs and resources like ePals (www.epals.com) and iEARN (International Education and Research Network; www.iearn.org) make global interactions ubiquitous. Global peer partners will form mini-school communities and unique school-based social networking groups. Projects might include learning how to cope with natural disasters, engaging in cultural exchanges, designing artwork related to human rights, exploring the effects of global warming, and learning about threats to animal habitats.

Peers don't need to live down the street; they could be anywhere on the planet.

■ *Teachers everywhere*. Soon students will be able to pick their teachers at a moment's notice. Want a teacher from Singapore, the Philippines, the United Kingdom, or Israel? They will be available in online teacher or mentor portals as well as preselected and approved by local school districts or state departments. Some will be displayed on a screen as students walk into school; students might consult this individual during a study hall period or review session.

■ *Teacher as concierge*. The notion of a teacher will shift from a deliverer of content to that of a concierge who finds and suggests education resources as learners need them.

■ *Informal = formal*. Informal learning will dramatically change the idea of "going to school," with a greater percentage of instructors being informal ones who offer content, experiences, and ideas to learners of all ages. Such individuals will include explorers on expeditions, researchers in a science lab, and practitioners in the workplace.

■ *International academic degrees*. Consortia of countries will band together to provide international education using online courses and activities with the goal of offering a high school or community college degree.

■ *Dropouts virtually drop back in*. The U.S. government will offer free online courses for high school dropouts and those needing alternative learning models (Jaschik, 2009). Such courses, as well as multiple options for learning, may lure students back to pick up a secondary or postsecondary degree.

Interactive technology enhancements will appeal to teenagers and young adults savvy with emerging tools for learning.

■ *The rise of the super blends.* As schools are faced with continued budgetary constraints and with the plethora of free courses, learning portals, and delivery technologies available, blended learning will become increasingly prevalent in K–12 education. Determining the most effective blend will be a key part of effective school leadership.

■ *The shared learning era*. In the coming decade, the job of a K–12 teacher will include the willingness to share content with teachers in one's school district as well as with those far beyond. Teachers will also be called on to evaluate shared content.

■ *Personalized learning environments*. Open educational resources (OER) and technologies like shared online videos, podcasts, simulations, and virtual worlds will be available to enhance or clarify any lesson at any time (Bonk & Zhang, 2008). For example, Wendy Ermold, a researcher and field technician for the University of Washington Polar Science Center, conducts research in Greenland and in other northern locations on this planet. While out on the icebreakers or remote islands, she listens to lectures and reviews other OER content from MIT, Stanford, Seattle Pacific University, and Missouri State University to update her knowledge of physics and other content areas. The expansion of such free and open course content options will personalize learning according to particular learner needs or preferences.

■ *Alexandrian Aristotles*. Learners will emerge who have the modern-day equivalent of the entire ancient library of Alexandria on a flash memory stick in their pocket or laptop. They will spend a significant amount of time learning from online tools and resources, will be ideal problem finders and solvers, and will set high personal achievement standards.

Open for Business

The world is open for learning. In addition to blended learning, e-books, and mobile learning, we are witnessing an increase in learner generation of academic content, collaboration in that content generation, and customization of the learning environment at significantly reduced costs and sometimes for free.

The 10 openers I suggest push educators to rethink models of schooling and instruction. They are converging to offer the potential for a revolution in education—which is already underway. EL

[1]For a full discussion of the We-All-Learn framework, see my book, *The World Is Open: How Web Technology Is Revolutionizing Education* (Jossey-Bass, 2009).

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Curtis J. Bonk is Professor of Instructional Systems Technology at Indiana University. He is the author of *The World Is Open: How Web Technology Is Revolutionizing Education* (Jossey-Bass, 2009) and coauthor, with Ke Zhang, of *Empowering Online Learning: 100+ Ideas, for Reading, Reflecting, Displaying, and Doing* (Jossey-Bass, 2008). He blogs at TravelinEdMan (http://travelinedman.blogspot.com); curt@worldisopen.com.

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GROSSMONT-CUYAMACA
COMMUNITY COLLEGE DISTRICT

Education Master Plan
Information Submission Form

The GCCCD is starting a year-long process to develop an Educational Master Plan that will serve as the blueprint for our future. The Educational Master Plan is a long-range, comprehensive document intended to guide institutional and program development at both the college and district levels. The priorities established in the Educational Master Plan will serve to guide College and District decisions about growth, development and resource allocation.

As the first step in this planning process, everyone in the GCCCD community (faculty, staff, students and community members) are invited to identify and submit information sources to be reviewed for the trend analysis in one of six taxonomy areas - society, technology, economy, environment, politics, and education. We are not asking you to do new research - only to identify information you already have or that you encounter during the search period (March 21 - April 25) and bring it to the attention of the Scan Teams for review.

Please feel free to submit as many of these forms as you would like. Please answer the following questions for each submission:

1) What is the document we should review? : DISTANCE EDUCATION ACCESSIBILITY GUIDELINES For Students with Disabilit

2) Author: Distance Education Accessibility Guidelines Task Force

3) Source: California Community Colleges, Chancellor's Office

4) Which of the following taxonomy areas does it fit into? (Please select only one):

- ☐ Society
- ☒ Technology
- ☐ Economy
- ☐ Environment
- ☒ Politics and Legal Issues
- ☐ Education
- ☐ Other:

5) Relevance: To help and support faculty to make sure their online classes are in 508 compliance. Presently, the Online Teaching a

6) Page / Section: all of it

7) **Add Attachment/Hyperlink Here**: http://www.htctu.net/dlguidelines/2011%20Distance%20Education%20Accessibility%2

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Questions: lynne.davidson@gcccd.edu *Research, Planning and Institutional Effectiveness*

Educational Master Plan

Information Submission Form

1) Title: Emerging Trends in Online Accounting Education at Colleges

2) Author: Cory Ng, CPA

3) Source: Pennsylvania CPA Journal

4) Taxonomy Area:

- [ ] Society
- [ ] Technology
- [ ] Economy
- [ ] Environment
- [ ] Politics and Legal Issues
- [x] Education
- [ ] Other: ______

5) Relevance: Emerging academic fields

6) Page / Section: ______

7) Link to document: ______

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8) Attach Document Here: [ ]

Emerging Trends in Online Accounting Education at Colleges

By Cory Ng, CPA

Convenience and flexibility are often cited as the primary advantages of taking courses online. Those with busy work schedules or considerable family obligations can pursue higher education online without having to be on campus at a set time. According to one study, the growth rate for online enrollments was 21 percent in 2009, compared with a less than 2 percent growth rate for the overall higher-education student population.1 The same study found that about 39 percent of higher-education students take at least one course online. That was nearly 5.6 million students in the fall of 2009.

Accounting programs at colleges and universities across the country are offering more online courses, in some cases entire degree programs. For example, in fall 2010, the University of Minnesota, Crookston, launched a bachelor's degree in accounting that is offered entirely online. Washington State University offers a degree in business administration, with a major in accounting, delivered completely online.

Student Perceptions of Online Accounting Education

One area that could influence either growth or resistance to online education is how courses are perceived by students with regard to effectiveness as compared to traditional courses. One study examined two undergraduate accounting courses and one graduate accounting course delivered entirely online. The researchers used a leading class-capture web service (the ability to record audio and video of a class session for a digital format) integrated with a learning management system in delivering the course content. According to the study, about 75 percent of students in the two undergraduate courses said the online course was as effective, or more so, than a traditional course. All the students in the graduate course indicated that online delivery was as, or more, effective than a traditional classroom course.2

Online Accounting Homework Systems

Given increasing enrollments in online education, it is important that accounting educators become aware of the emerging trends and technological advances in delivering accounting courses over the Internet. One recent technology that has emerged is the online home-work system. Some well-known text-book publishers, such as Wiley and Pearson, now offer online accounting homework systems that are integrated with accounting textbooks. According to Jacob C. Peng, "The online home-work system allows professors to use Internet technology to implement homework problems that students are able to complete online. Because this system is automatic, students may receive their graded homework almost instantly and master the materials through repetitive practice."3

Educator Perspective on Online Accounting Education

To gather input on an educator's thoughts on the strengths, weaknesses, and opportunities of online accounting education, I interviewed Alan Davis, CPA, associate professor of accounting at the Community College of Philadelphia.

With regard to the strengths of an online accounting program, Davis explained that online education has a great deal of flexibility and freedom, allowing students to take courses without the typical constraints of time and location. "I've already had a student in the military who was stationed in Germany take one of my courses, even completing course work while his unit was out on maneuvers," Davis says.

Going forward, he foresees evolving technology – especially video technology – adding greater advantages, with video-conferencing as a substitute for the classroom environment. "I can see a 100 percent online class using regularly scheduled video-conferencing as a replacement for on-campus meetings," Davis says. "It's only a matter of time until the technology becomes widely available, economically attainable for students, and is accepted by the students as standard when purchasing their computers."

There are weaknesses, of course. The top concern Davis points to is the time lag, or turn-around time, inherent in online education, particularly when students have questions for which they want answers right away. "In an online environment, immediate responses are few and far between," Davis explains. "Having to wait for a response, even though turn-around time is usually less than 24 hours, can result in the student becoming frustrated with a topic, skipping some material, or moving ahead with false assumptions."

Another challenge is that there is no way to be sure who is doing the online course work. "We trust that it's the named student, but how do we know for sure?" Davis asks. "It's always been said that what you get out of something depends on what you put into it. Never more true than in online education."

Public Law 110-315 (United States Higher Education Opportunity Act, 2008) attempts to address this concern. It directs accreditation agencies to require colleges and universities to have a process to establish that the student who registers for an online course is the same student who participates in the course.

Conclusion

The demand for online accounting education will likely grow. As such, it is important that accounting educators understand the emerging trends in online education and adapt courses to satisfy a student population that demands more flexibility in the delivery of accounting education.

1 Elaine Allen and Jeff Seaman, "Class Differences: Online Education in the United States, 2010," Babson Survey Research Group, November 2010, p. 2

2 Michael P. Watters and Paul J. Robertson, "Online Delivery of Accounting Courses: Student Perceptions," Academy of Educational Leadership Journal*, Volume 13, No. 3, 2009, p. 54*

3 Jacob C. Peng, "Using an Online Homework System to Submit Accounting Homework: Role of Cognitive Need, Computer Efficacy, and Perception," Journal of Education for Business*, May/June 2009, p. 263*

Cory Ng, CPA, is an accounting instructor at the Community College of Philadelphia and a member of the Pennsylvania CPA Journal *Editorial Board. He can be reached at cng@ccp.edu.*

The author gratefully acknowledges Alan Davis, CPA, associate professor at the Community College of Philadelphia, for his efforts in producing this article.

Educational Master Plan

Information Submission Form

1) Title: Absent Students want to Attend Class via Webcam

2) Author: Young, Jeffrey

3) Source: Chronicle of Higher Ed Vol. 57, Issue 22

4) Taxonomy Area:

- [ ] Society
- [x] Technology
- [ ] Economy
- [ ] Environment
- [ ] Politics and Legal Issues
- [ ] Education
- [ ] Other: ______________________

5) Relevance: Multimedia/distance learning

6) Page / Section: ______________________

7) Link to document: ______________________

<u>or</u>

8) Attach Document Here: [ ]

Title: Absent Students Want to Attend Traditional Classes via Webcam. By: YOUNG, JEFFREY R., Chronicle of Higher Education, 00095982, 2/4/2011, Vol. 57, Issue 22

Database: Academic Search Premier

Absent Students Want to Attend Traditional Classes via Webcam

Contents

Professors already welcome their guest speakers using this same technology

INFORMATION **TECHNOLOGY**

IT WAS just 30 minutes before class when Thomas Nelson Laird, an assistant professor of higher education at Indiana University at Bloomington, got the e-mail from a student: "I can't make it to class. Can you beam me in by Webcam?"

"I thought, I don't know if I can do that," the professor says. He looked at the clock and thought about the time it would-take to rig up a link via Skype or some other video-chat system. He had used the **technology** before, though, so he figured, Why not?

Professors across the country are facing similar questions. Webcams are ubiquitous, and students are accustomed to using popular services like Skype to make what are essentially video phone calls to friends and family. Recognizing the trend, this month Skype unveiled a service for educators to trade tips and tricks, called "Skype in the **classroom**."

Professors also frequently bring in guest speakers using the **technology**, letting students interact with experts they otherwise would only read about in textbooks.

Mr. Nelson Laird's course, on diversity in education, has about 20 students in a circle. So on one seat, he set a laptop with a built-in Webcam for the missing student, who could not make it because of a snowstorm. It worked--the student even gave a five-minute presentation, her face displayed on the laptop screen and Projected on a screen at the front of the room. But the professor noted that he had squandered five to 10 minutes of class time in setting up the connection, with a program called Adobe Connect.

The scenario was a first for Mr. Nelson Laird, and he says he hasn't yet thought out what his policy will be should a flurry of such requests occur. "Am I willing to do this occasionally? Sure," he told me this month. "But I'm not going to set this up every week."

Exactly how often professors fire up Webcams in their **classrooms** is hard to figure. The most recent data from the Faculty Survey of Student Engagement shows that about 12 percent of professors said they had used videoconferencing in their teaching. Mr. Nelson Laird helps lead the annual survey, which was conducted in the spring of 2009, of about 4,600 faculty members at 50 American **colleges** and universities.

As that number grows, will videoconferencing change the dynamics of traditional **classrooms**?

TALKING HEADS

Perhaps no **classroom** professor has experimented more with videoconferencing in a single course than Paul Jones, an associate professor of journalism and mass communication at the University of North Carolina at Chapel Hill.

In his fall 2009 course on virtual communities, he brought in a guest speaker via Skype nearly every week. That let his students interact with some of the leading scholars and authors on the topic--including Fred Turner, an associate professor of communication at Stanford University, and Howard Rheingold, who has written many books on Internet culture--who would have been unlikely to make the trip down to speak in person.

The guest speakers did not have to offer prepared remarks. Instead they were asked to simply make themselves available for questions from students during their Webcam appearances. In advance, students were required to use their Webcams to record short videos about the visitors' ideas.

The guests would view the responses ahead of time, on YouTube or some other videosharing site, to see what the students were most interested in.

"It's a bargain for these guys," says Mr. Jones, referring to the guest speakers. "They don't have to prepare a talk, and they get to interact with really smart students who are familiar with their work--and they don't have to travel."

Mr. Jones chose not to record the guests' video appearances themselves, or open them to the public. "I wanted the speaker to feel free to say whatever the hell they wanted," he says.

When I visited the University of Virginia last year, I saw a Skype guest speaker in action. Siva Vaidhyanathan, a professor of media studies there who frequently explores new educational **technology**, had agreed to give a half-hour talk via Skype to a friend's class at the University of Wisconsin at Madison's library school, and he let me sit in. A few minutes before he was to appear, he headed to his faculty office, logged onto Skype, and donned a headset. A Webcam built into his monitor broadcast his image, and thanks to a camera on the other end, he could see the **classroom** full of eager students. He spent a few minutes on prepared remarks, and then took questions. Afterward, he joked that his friend now owed him a beer, or else a guest lecture in return.

In his own courses, Mr. Vaidhyanathan cashes in on those favors. During one recent class session he linked in Jeff Jarvis, an associate professor of journalism at the City University of New York. "I get to talk to students I wouldn't have otherwise talked to,'" Mr. Jarvis told me. "I've done this probably a dozen times at least. You're in for 30 minutes, and you're out. The obligation is so minimal that it makes it easier to say, What the heck?"

NEW CHORE FOR PROFESSORS

There are some downsides to **classroom** videoconferencing.

The **technology** does not always work, although it is far more reliable than it was just a few years ago.

The first time Katherine D. Harris, an assistant professor of English literature at San Jose State University, tried inviting a guest speaker via Skype, she could not get the video to work, despite help from one of the university's tech-support staff members. Students in the course, "Digital Literature: the Death of Print Culture?" could hear the guest but not see him. Sometimes the audio would cut out as well, which made it harder for them to concentrate.

Would she do it again? Only if she knew technical help was close at hand. "It's almost easier to do it in person because you don't have the **technology** mediating everything," she says. "There's just so much to handle and take care of rather than just going to pick someone up."

Even letting students participate via videoconference has its drawbacks.

"I want to throw out this caution," says Scott Johnson, director of Illinois Online Network, the online division of the University of Illinois. "Unless the professor is committed to personally supporting and facilitating these ad hoc accommodations and provisions, and willing to carve out class time to set up and maintain the provisions, this is a moderately dangerous road.

"My issue is that the creation of an on-demand condition of readiness for any **technology** is not feasible for the majority of the faculty of many institutions. If the institution has educational technologists on staff it is critical to enlist their assistance for the present and future if this **technology**-friendly teaching climate is going to be sustainable."

The concern reminds me of a scene in the 1985 film Real Genius. A series of scenes shows a **classroom** at an elite university. Early in the semester, all the students are in their seats, attentively taking notes. As the term wears on, more and more students have left tape recorders in their seats, since they're too busy to make it. Finally, recorders fill every desk, and the professor, too, is absent--replaced by a reel-to-reel machine playing his recorded lecture. On the board reads the message: "Math on Tape Is Hard to Follow: Please Listen Carefully."

Some level of phoning it in might be helpful, but professors will have to decide how far to go in accommodating their students' desire for convenience--and their own.

PHOTO (COLOR): Paul Jones (far left) takes frequent advantage of Skype videoconferencing to invite guest speakers to his mass-communications classes at the U. of North Carolina at Chapel Hill Among them are (from top) Danah Boyd, a fellow at Harvard U.'s Berkman Center for Internet and Society; Fred Turner, an associate professor of communication at Stanford U.; and Howard Rheingold, author of several books on virtual communities.

PHOTO (COLOR): Danah Boyd

PHOTO (COLOR): Fred Turner

PHOTO (COLOR): Howard Rheingold

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By JEFFREY R. YOUNG, **College** 2.0

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Educational Master Plan

Information Submission Form

1) Title: IT 2008: The History of a New Computing Discipline

2) Author: Barry Lunt, J. Ekstrom, Han Reichgelt, Michael Bailey, and Richard LeBl anc

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The IT model curriculum represents an excellent starting point toward understanding more about IT as an academic discipline.

BY BARRY LUNT, J. EKSTROM, HAN REICHGELT, MICHAEL BAILEY, AND RICHARD LEBLANC

IT 2008: The History of a New Computing Discipline

THE EARLY 1990S saw the emergence of the Internet from the environs of the technical cognoscenti into the dot-com world with an interface for the masses. Additionally, the personal computer had reached the point that essentially everyone in all enterprises had one, and used it heavily. The increased complexity and importance of computing technologies for the success of organizations and individuals led to a growing need for professionals to select, create, apply, integrate, and administer an organizational IT infrastructure. Organizations typically filled these positions using individuals with widely varying backgrounds whose educational experiences often provided poor preparation for the demands of the position. The skill sets needed for the new breed of network and system administrators were not provided by the more algorithmically and analytically oriented computer science programs of the time. Moreover, information systems programs, with the business education requirements of their accreditation bodies, were equally unwilling or unable to include the technical depth required.

In response to this new educational need, programs arose such as those from Purdue University and Pennsylvania College of Technology, which were called Information Systems (IS) and Computer Science (CS) respectively, but were something else entirely.

These programs, and others like them, had sprung up independently and spontaneously to satisfy the needs of employers for workers with skills in networks, distributed systems, and beginning in the mid-1990s, the Web. By the peak of the dot-com boom in 2000, there were at least 17 institutions around the U.S. that had or were forming programs with similar characteristics, and which were most commonly called "Information Technology." The largest of them was at Rochester Institute of Technology (RIT) in Rochester, NY, with over 600 undergraduate students, as well as a sizable master's program.[19]

» key insights

- **The five main academic programs in computing—computer engineering, computer science, information systems, information technology, and software engineering—have distinquishing characteristics as well as commonalities.**
- **The detailed process of accreditation covers a wide array of factors that are essential for quality assurance in higher education.**
- **IT is unique among the computing disciplines in that it emerged in response to a specific educational need rather than as result of the emergence of a set of research quuestions that were not covered sufficiently by existing disciplines.**

On the national level, other factors were developing that also contributed to the emergence of the IT discipline. The Computing Sciences Accrediting Board (CSAB), which had long been the primary accrediting body for CS education, was joining with ABET, which accredits engineering and technology programs.[21] Within ABET both the newly formed Computing Accreditation Commission (CAC) and the Technology Accreditation Commission (TAC) had noticed the emerging IT programs, and were wondering under which commission IT would best fit.

It was in this lively environment that a group was formed that would guide IT through the period of defining its own model curriculum, its place with respect to the other computing programs already extant, and its own accreditation criteria. The Society for Information Technology Education (SITE) was formed in December 2001, with participation from 15 institutions with programs that could be considered to be IT programs. SITE later became SIGITE (a special interest group of the ACM) in the summer of 2003.

At this first meeting in December 2001 (the Conference on Information Technology Curriculum, or CITC-1), committees were formed to formulate accreditation criteria and a model curriculum; and a Delphi study was conducted to determine which topics the participants thought should be covered in an IT program.[18] At this meeting, the community also started work on a succinct definition of the discipline of IT, an effort that eventually cumulated in the following definition:

"IT, as an academic discipline, is concerned with issues related to *advocating for users* and meeting their needs within an organizational and societal context through the *selection*, *creation*, *application*, *integration and administration* of computing technologies."

Another conference was planned for the following April and the momentum continued through CITC-2 (April 2002), CITC-3 (September 2002), and CITC-4 (October 2003), which was also

SIGITE 2003.

Establishing the Discipline

Several early papers sought to justify the existence of the discipline. One of these surveyed course offerings by discipline and tabulated emphasis by counting hours required in several areas. Several related disciplines were included in this study (see Figure 1). The courses required in each of these disciplines were grouped into seven categories: Business; electronics and signals (Electr & Signals); computing hardware (Hardware); interpersonal communications (Interpersonal Comm); networks, Web systems, and databases (Net, Web, Databases); physics, math and chemistry (Phys, Math, Chem); and Software. The data was gathered from publicly available documents (usually university catalogs) describing the requirements of each program. Twelve institutions were studied, each with at least two of the disciplines of interest.

Figure 1 shows that each of the seven disciplines studied is unique. Management Information Systems (MIS) is the only discipline with over half of the required courses in the category of business. Computer Engineering is the only discipline with over 25% of the required courses in the category of Electronics & Signals. Computer Science is the only discipline with nearly 40% of the required courses in the category of Software. Of greatest interest in this context is the fact that IT is the strongest in the Net, Web, Databases category, with a strong presence also in the Software category. The key point of this figure is the IT discipline was found to be unique and there appeared to be some consensus already as to the subareas that made up the IT curriculum.

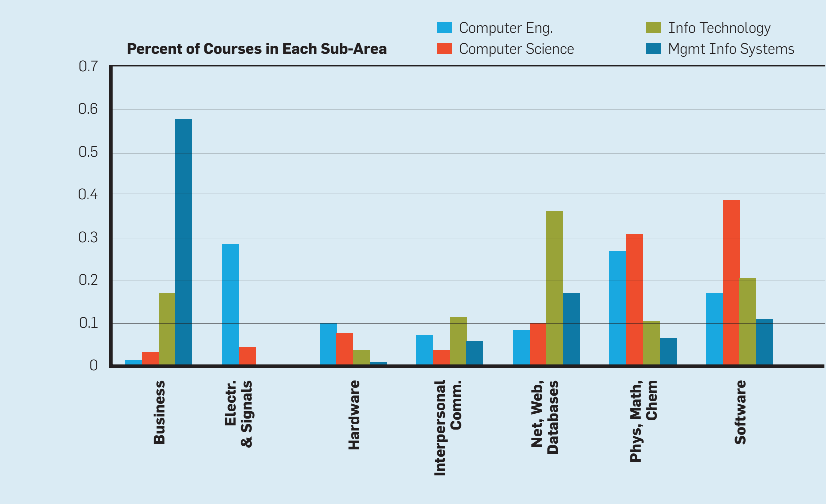
Computing Accreditation Background

From the start, accreditation was important to all the participants of CITC. The accreditation committee formed at CITC-1, and began work toward formulating accreditation standards. CITC-1 included one attendee who was specifically invited because of her strong affiliation with ABET, and the desire to have those views represented at the initiation of the efforts to establish IT as an academic discipline (see the sidebar "Accreditation.").

At CITC-3, the question of which ABET commission to use was put to a plenary vote: Should IT accredit through ABET CAC, or through ABET TAC? ABET had assured us they would honor our decision, and it was ours to make; they would not force us either way. Both commissions had their proponents in the membership, and opinions were voiced openly. When the vote was taken, about three-quarters of the membership preferred to go with ABET CAC (hereafter referred to as CAC). It was also decided to make this a binding vote; all members of SITE (later SIGITE) who sought accreditation would seek it through CAC.

This decision led CAC to restructure their accreditation criteria to consist of a set of general criteria for all computing programs, augmented by three sets of discipline specific accreditation criteria for computer science, information systems and information technology. Several IT programs have since been accredited. Both the general and the IT-specific accreditation criteria may be found at: http://www.abet.org/forms.shtml#For_Computing_Programs_Only.

Figure 1. A comparison of programs in computing (derived from Lunt et al.[18]).



Overview of Model Curriculum Process

The effort to write the IT model curriculum started at CITC-1 with the establishment of an IT model curriculum committee. Initially, the committee consisted of 15 individuals and soon grew to a group of 24 computing educators. It became clear it would not be feasible for a group of this size to write an IT model curriculum, and so a writing committee of seven people was appointed; that committee included three of the authors of this article. Over the course of the next two years, this writing committee was responsible for producing the various drafts of the IT model curriculum, and for soliciting and receiving input from the full curriculum committee. In addition to reviewing the various drafts produced by the writing committee, many of the members of the curriculum committee were responsible for significant parts of the curriculum document.

Principles. At SIGCSE in February 2003, a birds-of-a-feather session was organized to discuss the work on accreditation and curriculum in IT. Several members of the writing committee participated in that discussion and a set of guiding principles emerged that remained constant throughout the entire process.

1. The model curriculum would be developed in the context of the Computing Curricula project. (http://www.acm.org/education) The Computing Curricula project was a collaboration between the ACM, AIS (Association for Information Systems) and IEEE Computer Society and aimed to produce model curricula for all computing disciplines, as well as an overview volume to describe the relationships among the different curricula (Joint Task Force for Computing Curricula, 2005).

2. The curriculum should be coordinated with the accreditation criteria in a clear and consistent fashion.

3. The curriculum should be organized so it would have some longevity. It was clear a curriculum that needed to be revised every two years would be of limited utility to institutions wishing to use the model to create an IT program.

4. The curriculum should be flexible and the required body of knowledge should be as small as possible. Even though IT programs are similar in many ways, there are many differences, reflecting the origins of the programs and the diverse constituencies the programs have been created to serve. It was felt the community wanted a curriculum that would provide guidance without too many constraints.

5. The curriculum should reflect the relationship of IT to the other computing disciplines. The IT discipline exists in an ecosystem of computing and business disciplines and as the integrator of components and deliverer of systems to serve all of these constituencies' needs and to prepare professionals to perform in this environment.

6. The curriculum should reflect those aspects that set IT apart from other computing disciplines. Even though IT programs are similar to other computing programs, there are features that make IT distinct. The model curriculum needed to clearly express the unique character of IT as a discipline.

Information technology was unique among the computing disciplines accredited by ABET CAC in that it formulated accreditation criteria before it finalized a model curriculum.

Inputs into the IT Model Curriculum

The committee used several inputs to drive the development of the curriculum. The first major input was the Delphi study done at CITC-1 and validated by similar studies done with other constituencies, such as the advisory boards of participating IT programs.[18] The work of the accreditation committee and the evolution of the criteria in ABET were also continuously evaluated during their development. In addition, the evolving work of the Computing Curricula project (see the accompanying sidebar "Computing Curricula 2005") was a significant influence on the model curriculum. Coordination between the writing committee and the accreditation committee and the computing curricula committee was made possible because each of these other committees included some members from the writing committee. Another significant input was the ongoing research of the SIGITE community as represented by published articles and the on-going discussions in the annual conferences.

Key documents referenced often throughout the development process of the IT model curriculum included:

- CC 2001: Curriculum Guidelines for Undergraduate Degree Programs in Computer Science.
- Computing Curricula 2005: The Overview Report .
- CE 2004: Curriculum Guidelines for Undergraduate Degree Programs in Computer Engineering.
- IS 2002: Curriculum Guidelines for Undergraduate Degree Programs In Information Systems.
- SE 2004: Curriculum Guidelines for Undergraduate Degree Programs In Software Engineering (SE 2004)
- The Profession of IT: Who Are We?[8]
- The Profession of IT: The IT Schools Movement[9]

The ABET Criteria

The principle that the IT model curriculum should be a blueprint to create programs that could be accredited led to a second important source of inputs to the IT model curriculum formulation process, namely the Computing Accreditation Commission of ABET. IT was unique among the computing disciplines accredited by ABET CAC in that it formulated accreditation criteria before it finalized a model curriculum. In both CS and IS, a model curriculum existed long before the formulation of accreditation criteria.

The most recent ABET CAC accreditation criteria, formulated with considerable input from SIGITE, distinguish between General Criteria and Program Criteria. The intention is that any program in computing must meet the general criteria to be accredited, while specific computing programs, such as programs in computer science, must also meet the relevant program criteria, assuming there are any. Currently, there are program specific criteria for computer science, information systems, and information technology.

CAC's general criteria require programs seeking accreditation to formu-

Accreditation

From the first meeting in Provo, the IT education community has been interested in pursuing accreditation for its programs. It is therefore not surprising that there has been a constant interplay between efforts to formulate an IT model curriculum and to formulate accreditation standards. In order to understand this interplay, some background on accreditation is needed.

Accreditation is essentially a quality assurance mechanism for higher education. Accreditation assures that a program or school meets a set of independently specified quality criteria.

There are two types of accreditation in the U.S., namely institutional or regional accreditation and specialized accreditation. Institutional or regional accreditation applies to the institution as a whole. An example of a regional institutional accreditation organization is the Southern Association of Colleges and Schools (SACS, http://www.sacs.org/). Specialized accreditation, on the other hand, applies to subunits in academic institutions. Some specialized accreditation agencies, such as the Association to Advance Collegiate Schools of Business (AACSB, http://www.aacsb.edu/) accredit certain units within a college and, hence by implication, all programs offered in that unit; other accreditation agencies accredit specific programs.

The specialized accreditation agency most relevant to computing is ABET Inc. ABET accredits programs in applied science, computing, engineering and engineering technology. It works through four commissions (see the accompanying figure).

STRUCTURE OF ABET FOR COMPUTING PROGRAMS

ABET formulates accreditation criteria with the help of professional societies and after a long and deliberative process. For most accreditation criteria, ABET has a single lead society which is, among other things, responsible for suggesting accreditation criteria, although there may be cooperating societies. For example, the lead society for Civil Engineering is the American Society of Civil Engineers.

CAC is an exception in that it has a single lead society (CSAB) for all its programs. CSAB is itself an umbrella organization for the ACM (http://www.acm.org/), the Association for Information Systems (AIS, http://home.aisnet.org/) and the IEEE Computer Society (IEEE-CS, http://www.computer.org). CSAB is also the lead society for software engineering, although programs in software engineering are accredited by ABET EAC.

The last 10 years or so have seen a significant shift in the way in which accreditation criteria are formulated. Initially, accreditation criteria were input-based. As a result, accredited programs tended to be very similar and there were few programs that were adapted to the specific needs of their constituencies.

Most accreditation agencies therefore moved to outcomes-based accreditation criteria. Programs are now expected to formulate, after consultation with their constituencies, a set of program educational objectives, describing the career and professional accomplishments they want to prepare their graduates for. The program derives from these a set of program outcomes, which are descriptions of the skills that graduates must have as they graduate from the program and that prepare them to achieve the program educational objectives. The program then designs a curriculum that allows students to acquire the program outcomes. Programs must also establish a systematic process to assess to what extent graduates achieve the program educational objectives and program outcomes, and to use that data to improve the program. For more details, see Reichgelt and Yaverbaum.[22]

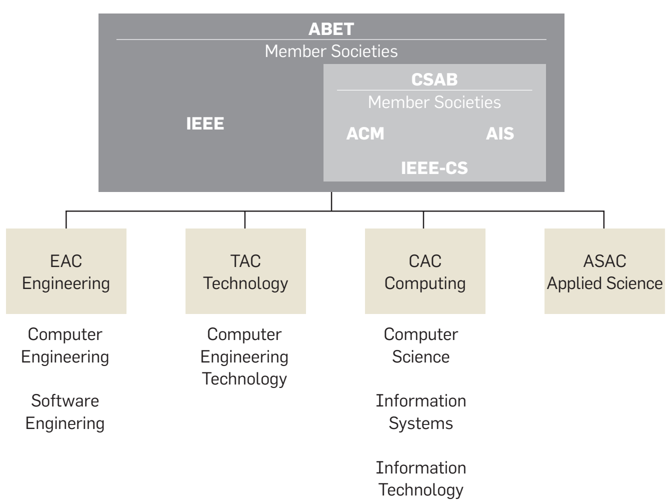
The shift to outcomes-based accreditation criteria within ABET took place in the late 1990s and was led by the engineering community. In CAC the change was led by IT. There were three reasons for this.

First, the early meetings of the IT education community were attended by representatives from ABET and faculty members who had been active in ABET TAC. Since ABET had decided it wanted to move away from input-based accreditation criteria, there were subtle hints that ABET would prefer outcomes-based accreditation criteria.

Second, a number of the individuals who were involved in the formulation of IT accreditation criteria were convinced of the superiority of outcomes-based approaches. For example, one of the co-authors of this article co-wrote a paper in the late 1990s extolling the virtues of using program outcomes in curriculum design, although the paper did not appear in print until much later.[5] One of the advantages of an outcomes-based approach to curriculum development is that it provides a better basis on which to resolve differences of opinion about what ought to be included in a degree program.

The third reason the IT education community adopted an outcomes-based approach was more pragmatic. Although there was some level of agreement on what should be included in an IT program, there were significant disagreements as well, and the feeling was it would be extremely difficult to reach agreement on an input-based set of accreditation criteria. For example, early on there was an ongoing debate on the need to have some faculty members with a Ph.D. By moving away from an input-based approach to accreditation, the community felt it could essentially avoid such issues from stopping us achieve our goal of getting to a set of accreditation criteria.

Structure of ABET for computing programs.



late program educational objectives, defined as *statements that describe the career and professional accomplishments that the program is preparing graduates to achieve*, and program outcomes, defined as *statements that describe what students are expected to know and be able to do by the time of graduation*. In addition, a program is required to have a documented assessment process in place to determine the extent to which its graduates meet the program educational objectives and program outcomes. The results of this assessment process must then be used to improve the program. Many of the other accreditation criteria ask institutions to show the curriculum is designed to enable students to achieve the program outcomes and that the program has sufficient resources, including faculty, institutional support, lab and library resources, and so on, to allow students to achieve the program educational objectives and program outcomes.

In many ways, program outcomes are central when it comes to accreditation. While the actual attributes of graduates included in the current version of the CAC accreditation criteria are different in format from the ones used by the IT model curriculum committee, there has been no significant change in their content.

There were two main reasons for choosing an outcomes-based approach. The first was that ABET was moving in this direction for all programs accredited. The second was that, based on current educational practice, outcomes are more useful than inputs.

The current CAC general criteria list a number of attributes that graduates of any computing program are expected to have at the time of graduation, namely:

- An ability to apply knowledge of computing and mathematics appropriate to the discipline;
- An ability to analyze a problem and identify and define the computing requirements appropriate to its solution;
- An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs;
- An ability to function effectively in teams to accomplish a common goal;
- An understanding of professional, ethical, and social responsibilities;
- An ability to communicate effectively;
- An ability to analyze the impact of computing on individuals, organizations, and society, including ethical, legal, security, and global policy issues;
- Recognition of the need for and an ability to engage in continuing professional development; and
- An ability to use current techniques, skills, and tools necessary for computing practice.

The IT criteria specify several additional attributes that graduates from an IT program must achieve. The additional attributes in the IT criteria are:

- An ability to use and apply current technical concepts and practices in the core information technologies;
- An ability to identify and analyze user needs and take them into account

Computing Curriculum 2005

The CC 2001 Joint Task Force made an important early decision to focus on producing curriculum recommendations only for computer science and thus promoted the idea that there should be a series of curriculum volumes, each produced by a committee with expertise in one particular computing discipline. Their report recognized the need for some sort of unifying document: "Once the individual reports have been completed, representatives from all the disciplines will come together to produce an overview volume that links the series together." An earlier draft suggested this overview would include the general principles underlying the specific disciplinary reports, thus serving as something of a common preamble.

By late 2002, the IS volume had been completed and the projects that eventually produced the computer engineering and software engineering volumes were well underway. The leaders within the education communities in ACM, IEEE Computer Society, and AIS decided it was important to proceed with creation of what came to be called the Overview Report, even though all of the volumes were not yet finished. A first meeting of the task force appointed to produce the report was held in early 2003. This group was composed mostly of people who had worked or were working on at least one of the initial four curriculum volumes. Representatives from the IT curriculum project were also included.

The first challenge facing the Overview Report task force was finding a way to aggregate a view of the computing discipline as a whole from the parts described by each of the individual volumes. Because each of the committees that wrote the volumes had a unique disciplinary perspective, their treatments of the various topics included in their bodies of knowledge were not consistent, even as to the terminology they used. Much effort by subgroups of the task force went into going over comparable topic areas from different volumes item by item in order to develop a shared understanding of terminology and outcome expectations across the volumes.

The other driving challenges were identifying the audience for whom the Report was being written and deciding what material to include. The original concept from CC 2001 was that the Overview Report was being written for people who would read and use the curriculum volumes, but this perspective seemed too narrow. The Task Force ultimately concluded the Report, or at least sections of it, should be relevant to higher-level administrators in universities and even to anyone wanting an understanding of how the various computing disciplines matched up with career choices.

The content of the Overview Report follows from these decisions. It includes some history about the evolution of computing education and a prose description of each of the five disciplines, along with graphical depictions of the areas with the "problem space" of computing occupied by each. These depictions are certainly inexact and, even somewhat stereotypical, but they have proven to be very effective at succinctly communicating the similarities and differences among the disciplines. The report also includes detailed charts comparing typical curricula and student outcomes across the disciplines, along with related commentary on career implications of disciplinary choices. It concludes with a chapter on "Institutional Considerations" intended to shed light on issues related to the creation and administration of multiple computing degree programs.

Because of declining enrollment in computing programs, the task force was very concerned with communicating to students and those who influence them about opportunities in computing. Realizing the Overview Report was not at all suitable to fill this need, much discussion went into finding a way to distill the relevant information into a form that would be an effective marketing tool. After publication of the report, some of the members of the task force contributed to the creation of the *Computing Degrees & Careers* brochure available for download from the ACM Web site (http://www.acm.org/).

in the selection, creation, evaluation, and administration of computer-based systems;

- An ability to effectively integrate IT-based solutions into the user environment;
- An understanding of best practices and standards and their application; and
- An ability to assist in the creation of an effective project plan.

In addition, the IT-specific accreditation criteria provide additional guidance on the curriculum by listing a number of topics that must be covered in an IT program, including the core information technologies of human computer interaction, information management, programming, networking, Web systems and technologies, information assurance and security, system administration and maintenance, system integration, and architecture. As will become evident later, the list of topics was strongly influenced by the IT model curriculum.

The Computing Curricula Project

A third significant input into the curriculum process was the Computing Curricula Project, and in particular the CC 2001 document and later, "Computing Curricula 2005: The Overview Report" The IT community decided that the curriculum should not be organized around courses, in the way in which the model curriculum for Information Systems is primarily organized,[15] but around smaller units. There was a wide variety of IT programs and it was felt this diversity was welcome, especially in an emerging discipline such as IT. Organizing the model curriculum around a set of courses could stifle innovation, so it was decided to organize the curriculum around *Knowledge Units* structured into *Knowledge Areas*. A *Knowledge Area* was thus a particular disciplinary subfield, and a Knowledge Unit was a thematic module within a *Knowledge Area*.

Knowledge units consist of a set of topics and a set of learning outcomes, divided into *core* outcomes and *advanced* outcomes. The *core* outcomes are those that committee members could agree that *every* IT student should achieve. There is no expectation that every student achieves all advanced outcomes, but there is an expectation that every graduate from an IT program achieves some of the advanced outcomes. Which *advanced* outcomes are covered depends on the preferred emphasis of the student and the flavor of the IT program that he or she is enrolled in (such as networking, security, Web systems, among others).

During the period of intense work on the model curriculum from 2003 to 2005, there was a lot of evolution going on in many individual IT programs. During that evolution, faculty of the BYU IT program published several papers documenting their thinking and their changes, in the hope that the community could use this experience and thinking in their own programs.[10,11,12,13] In 2002, they observed that in networking the theoretical underpinning, course outline, and even the text were the same for both the CS and IT version of this course, but the major difference was the labs were needed to provide the student outcomes.[11] Over the next three years several papers were published that documented work in the community to develop IT curriculum. Of particular note was the work of Charles Reynolds and the staff at the U.S. Military Academy.[2,23,?] The were building on each other's work and the impact of the collaboration was significant on the evolution of the model curriculum. A consensus developed around the ideas that the focus of IT was at the integration points of the various technologies and that there were some pervasive themes that were common to almost all IT programs. These ideas became common threads in much of our work. The pervasive themes that emerged were:

- User centeredness and advocacy;
- Information assurance and security;
- The ability to manage complexity through abstraction and modeling, best practices, design patterns, standards, and the use of appropriate tools;
- Extensive capabilities for problem solving across a range of information and communication technologies and their associated tools;
- Adaptability;
- Professionalism (life-long learning, professional development, ethics, responsibility); and
- Interpersonal skills.

In the spring of 2004 the writing

> **"The 2008 version of the IT model curriculum has been thoroughly reviewed, has come about as a result of input from multiple institutions, with great support from the ACM, with input from the ACM, ABET, and the IEEE Computer Society."**

committee met in Williamsport, PA, and resolved several issues, including what to call "integrative programming." Additionally, committee members were not satisfied with the organization of the security knowledge area. Immediately after the meeting, one of the writing committee (Ekstrom) participated in the IAEGC[16] certificate program at Purdue sponsored by the NSA. This program strongly influenced the Information Assurance and Security (IAS) component of the model curriculum. Since IAS is a complex topic that touches every part of IT, a way was sought to organize the concepts so that it would be simple enough to introduce to a freshman and yet sufficient for advanced courses. While at the IAEGC program, Corey Schow of Idaho State University delivered a lecture in which he claimed to teach IAS in an hour. He used the cube diagram from Machonachy et al.[20] and really did provide a solid overview of IAS understandable to a freshman. A version of the IAS knowledge area was written and vetted with the other participants and faculty of the IAEGC program. Thus the IAS component of the curriculum was directly derived from the work of that community.

Integrative Programming. One of the more significant insights that developed during the writing of the model curriculum resulted in the creation of the knowledge area "Integrative Programming." The writing committee kept seeing some topics that were in the Programming knowledge area, but these topics seemed to be distinct from the programming taught in CS programs. It was soon realized that what needed attention were several programming concepts which had been added to the Programming knowledge area.

When looked at more carefully, it was realized that these topics represented programming concepts unique to the IT academic discipline, and that the element they all had in common was that they dealt with integrative programming—programming that pulled together larger and perhaps disparate programs or code segments, permitting them to share functions, data, security features, and so forth. Scripting is an essential part of integrative programming. Once it was realized that

Figure 2. The IT Body of Knowledge with core topics italicized.

The Information Technology Body of Knowledge

ITF. Information Technology Fundamentals (25 core hours)
- *ITF. Pervasive Themes in IT (17)*
- *ITF. History of Information Technology (3)*
- *ITF. IT and Its Related and Informing Disciplines (3)*
- *ITF. Application Domains (2)*

NET. Networking (22 core hours)
- *NET. Foundations of Networking (3)*
- *NET. Routing and Switching (8)*
- *NET. Physical Layer (6)*
- *NET. Security (2)*
- *NET. Network Management (2)*
- *NET. Application Areas (1)*

HCI. Human Computer Interaction (20 core hours)
- *HCI. Human Factors (6)*
- *HCI. HCI Aspects of Application Domains (3)*
- *HCI. Human-Centered Evaluation (3)*
- *HCI. Developing Effective Interfaces (3)*
- *HCI. Accessibility (2)*
- *HCI. Emerging Technologies (2)*
- *HCI. Human-Centered Software Development (1)*

PF. Programming Fundamentals (38 core hours)
- *PF. Fundamental Data Structures (10)*
- *PF. Fundamental Programming Constructs (10)*
- *PF. Object-Oriented Programming (9)*
- *PF. Algorithms and Problem-Solving (6)*
- *PF. Event-Driven Programming (3)*

IAS. Information Assurance and Security (23 core hours)
- *IAS. Fundamental Aspects (3)*
- *IAS. Security Mechanisms (Countermeasures) (5)*
- *IAS. Operational Issues (3)*
- *IAS. Policy (3)*
- *IAS. Attacks (2)*
- *IAS. Security Domains (2)*
- *IAS. Forensics (1)*
- *IAS. Information States (1)*
- *IAS. Security Services (1)*
- *IAS. Threat Analysis Model (1)*
- *IAS. Vulnerabilities (1)*

PT. Platform Technologies (14 core hours)
- *PT. Operating Systems (10)*
- *PT. Architecture and Organization (3)*
- *PT. Computing infrastructures (1)*
- PT. Enterprise Deployment Software
- PT. Firmware
- PT. Hardware

IM. Information Management (34 core hours)
- *IM. IM Concepts and Fundamentals (8)*
- *IM. Database Query Languages (9)*
- *IM. Data Organization Architecture (7)*
- *IM. Data Modeling (6)*
- *IM. Managing the Database Environment (3)*
- *IM. Special-Purpose Databases (1)*

SA. System Administration and Maintenance (11 core hours)
- *SA. Operating Systems (4)*
- *SA. Application s (3)*
- *SA. Administrative Activities (2)*
- *SA. Administrative Domains (2)*
- *SIA. Project Management (3)*
- *SIA. Testing and Quality Assurance (3)*
- *SIA. Organizational Context (1)*
- *SIA. Architecture (1)*

IPT. Integrative Programming & Technologies (23 core hrs)
- *IPT. Intersystems Communications (5)*
- *IPT. Data Mapping and Exchange (4)*
- *IPT. Integrative Coding (4)*
- *IPT. Scripting Techniques (4)*
- *IPT. Software Security Practices (4)*

SP. Social and Professional Issues (21 core hours)
- *SP. Professional Communications (5)*
- *SP. Teamwork Concepts and Issues (5)*
- *SP. Social Context of Computing (3)*
- *SP. Intellectual Property (2)*
- *SP. Legal Issues in Computing (2)*
- *SP. Organizational Context (2)*
- *SP. Professional and Ethical Issues and Responsibilities (2)*
- *SP. History of Computing (1)*
- *SP. Privacy and Civil Liberties (1)*

MS. Math and Statistics for IT (38 core hours)
- *MS. Basic Logic (10)*
- *MS. Discrete Probability (6)*
- *MS. Functions, Relations and Sets (6)*
- *MS. Hypothesis Testing (5)*
- *MS. Sampling and Descriptive Statistics (5)*
- *MS. Graphs and Trees (4)*
- *MS. Application of Math & Statistics to IT (2)*

WS. Web Systems and Technologies (22 core hours)
- *WS. Web Technologies (10)*
- *WS. Information Architecture (4)*
- *WS. Digital Media (3)*
- *WS. Web Development (3)*
- *WS. Vulnerabilities (2)*
- WS. Social Software

Total Hours: 314

Notes:
1. Order of Knowledge Areas: Fundamentals first, then ordered alphabetically.
2. Order of Units under each Knowledge Area: Fundamentals first (if present), then ordered by number of core hours.

these topics belonged together, they were grouped in a separate knowledge area and then the new knowledge area was fleshed out.

The Final Product

Much more transpired between the first posting of the model curriculum on the ACM Web site and its final version in November 2008, but the details of that period are of minimal importance here. The main point is the 2008 version of the IT model curriculum has been thoroughly reviewed, has come about as a result of input from multiple institutions, with great support from the ACM, with input from the ACM, ABET, and the IEEE Computer Society. It has taken its place alongside the other curricula recommendations on the ACM Web site (http://www.acm.org/education/curricula-recommendations).

The five pillars of an IT academic program are: databases, human-computer interaction, networking, programming, and Web systems.

Broad Goals of an IT Program

Again, from the model curriculum:

"IT programs aim to provide IT graduates with the skills and knowledge to take on appropriate professional positions in Information Technology upon graduation and grow into leadership positions or pursue research or graduate studies in the field. Specifically, within five years of graduation a student should be able to:

1. Explain and apply appropriate information technologies and employ appropriate methodologies to help an individual or organization achieve its goals and objectives;
2. Function as a user advocate;
3. Manage the information technology resources of an individual or organization;
4. Anticipate the changing direction of information technology and evaluate and communicate the likely utility of new technologies to an individual or organization;
5. Understand and for some to contribute to the scientific, mathematical and theoretical foundations on which information technologies are built; and
6. Live and work as a contributing, well-rounded member of society."

The IT Body of Knowledge. Figure 5-1 on page 27 of the model curriculum details the "IT Body of Knowledge" as reproduced in Figure 2.

Conclusion

IT is unique among the computing disciplines in that it emerged in response to a specific educational need, rather than as a result of the emergence of a set of research questions that were not covered sufficiently by existing disciplines in the way in which, for example, cognitive science emerged as a separate discipline in the 1970s and 1980s. However, as the field matures, the community is gradually starting to broaden its focus to include research questions as well as educational concerns (see for example, Reichgelt,[22] Ekstrom et al.,[13] and Cole et al.[6]).

Much of this is strongly influenced by the 2008 version of the 4-Year IT Curriculum volume, which provides an excellent introduction to the academic discipline of IT, along with recommendations for the content and delivery of an IT curriculum. This curriculum volume represents the best efforts of many individuals from many academic institutions and professional organizations. It increases to five the number of computing programs that have formally defined curricula, as outlined in the CC 2005 document. It has received wide exposure both nationally and internationally, and has already had a significant impact on many computing programs both in the U.S. and abroad. It should serve a useful role throughout its lifetime. C

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Educational Master Plan

Information Submission Form

1) Title: ISTE 2010 Five Developing Themes

2) Author: Henry Thiele

3) Source: www.techlearning.com/ blogs/31198

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5) Relevance: Technology Trends

6) Page / Section: ______________________

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ISTE 2010

Five Developing Themes

www.techlearning.com/blogs/31198

By Henry Thiele

I attended EduBloggerCon, the Constructivist Consortium, the opening events, and more at ISTE '10, and through my interactions there, I have begun to see some themes developing in the conference:

1 It has been a rough year. Between budget cuts, leadership challenges, and the increasing responsibilities associated with technology in schools, everyone was mentally exhausted heading into the conference. Excitement about changing practices and adding resources to schools has been tempered by budget concerns.

2 We have some pretty big decisions looming about how we are going to handle an influx of personal mobile computing devices into our society. With the iPad, the new iPhone, Android devices, and the continued growth of netbooks, there are a lot more discussions of how we are going to respond to this trend as schools. These conversations center on network infrastructure, policy, instructional strategies, and preparing teachers for this change.

3 Digital divide. The changes described in number 2 are starting to show how ugly the digital divide is becoming. The gap between those able to have the world's information in their hands and those unable to is a growing social problem. When connectivity is factored in along with access to hardware, the difficulty becomes greater and more complex.

4 Assessment: Many educators are struggling more with assessment and its design. It seems that most agree with attaching some form of accountability to assessment. But nobody has quite figured out how to do it. It is becoming apparent, however, that technology will have to be involved in whatever solution does present itself, if for efficiency if nothing else.

5 Personalizing education: More people are talking about making teaching and learning more personal, saying that education has to be tailored to each individual. There is a lot of frustration and confusion about how to make this happen when we are still working in an environment designed to "press out parts" rather than create individual masterpieces.

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Education Master Plan
Information Submission Form

The GCCCD is starting a year-long process to develop an Educational Master Plan that will serve as the blueprint for our future. The Educational Master Plan is a long-range, comprehensive document intended to guide institutional and program development at both the college and district levels. The priorities established in the Educational Master Plan will serve to guide College and District decisions about growth, development and resource allocation.

As the first step in this planning process, everyone in the GCCCD community (faculty, staff, students and community members) are invited to identify and submit information sources to be reviewed for the trend analysis in one of six taxonomy areas - society, technology, economy, environment, politics, and education. We are not asking you to do new research - only to identify information you already have or that you encounter during the search period (March 21 - April 25) and bring it to the attention of the Scan Teams for review.

Please feel free to submit as many of these forms as you would like. Please answer the following questions for each submission:

1) What is the document we should review? : Beyond Productivity: Information Technology, Innovation, and Creativity

2) Author: National Research Council of the National Academies

3) Source: Washington, DC: National Academies Press, 2003

4) Which of the following taxonomy areas does it fit into? (Please select only one):

- [x] Society
- [ ] Technology
- [x] Economy
- [ ] Environment
- [ ] Politics and Legal Issues
- [x] Education
- [x] Other: Arts & Culture

5) Relevance: Information technology and creative practices (ITCP) as a bridge to social and economic development

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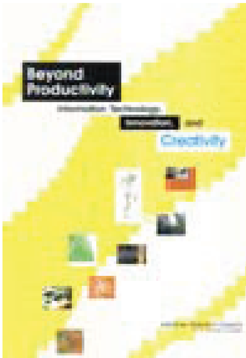
Free Executive Summary



Beyond Productivity: Information, Technology, Innovation, and Creativity

William J. Mitchell, Alan S. Inouye, and Marjory S. Blumenthal, Editors, Committee on Information Technology and Creativity, National Research Council

ISBN: 978-0-309-08868-8, 268 pages, 7 x 10, paperback (2003)

Computer science has drawn from and contributed to many disciplines and practices since it emerged as a field in the middle of the 20th century. Those interactions, in turn, have contributed to the evolution of information technology – new forms of computing and communications, and new applications – that continue to develop from the creative interactions between computer science and other fields.

Beyond Productivity argues that, at the beginning of the 21st century, information technology (IT) is forming a powerful alliance with creative practices in the arts and design to establish the exciting new, domain of information technology and creative practices—ITCP. There are major benefits to be gained from encouraging, supporting, and strategically investing in this domain.

Summary and Recommendations

Creativity plays a crucial role in culture; creative activities provide personal, social, and educational benefit; and creative inventions ("better recipes, not just more cooking") are increasingly recognized as key drivers of economic development. But creativity takes different forms at different times and in different places. This report argues that, at the beginning of the 21st century, information technology (IT) is forming a powerful alliance with creative practices in the arts and design to establish the exciting new domain of information technology and creative practices—ITCP. There are major benefits to be gained from encouraging, supporting, and strategically investing in this domain.

INFORMATION TECHNOLOGY AND CREATIVE PRACTICES

Alliances of technology and creative practices have often emerged in the past. In the 19th century, for example, optical, chemical, and thin-film manufacturing technologies converged with the practices of the pictorial arts to establish the new domain of photography. Then, photographic technology became further allied with the practices of the performing arts, giving rise to the domain of film. The cultural and economic consequences of these developments have been profound. The emerging alliance of information technology with the arts and design has, this committee believes, even greater potential.

ITCP has already yielded results of astonishing variety and significant cultural and economic value. These results have taken such forms as innovative architectural and product designs, computer animated films, computer music, computer games, Web-based texts, and interactive art installations, to name just a few. They have developed from individual, group, and institutional activities; the processes by which they have been produced have spanned both the commercial and not-for-profit worlds and the formal and informal economic sectors. The products of ITCP have begun to appear in many different countries, in ways that reflect cultural, economic, and political differences.

IT has now reached a stage of maturity, cost-effectiveness, and diffusion that enables its effective engagement with many areas of the arts and design—not just to enhance productivity or to allow more efficient distribution, but to open up new creative possibilities. There is a highly competitive race for leadership in this domain. The potential payoffs from success in the near- and long-term futures are enormous: billion-dollar industries, valuable exports, thriving communities that attract the best and the brightest, enriched cultural experiences for individuals and communities, and opportunities for global cultural visibility and influence.

By definition, there is no formula for creativity. But there are effective ways to invest in establishing conditions necessary for ITCP, in overcoming impediments, and in providing incentives. Furthermore, there are ways to recognize and reward creative contributions and to derive social benefit from them. In appropriate combination, these measures can add up to powerful strategies for encouraging, supporting, and reaping the rewards of ITCP. Development along with implementation of such strategies is the challenge addressed by this report.

MULTILEVEL STRATEGIES FOR ITCP

ITCP can be engaged at multiple levels—by individual artists and designers who deal with IT tools, media, and themes; in the structuring and management of cross-disciplinary research and production groups working in the ITCP domain; in directing educational and cultural institutions with interests in ITCP; at the level of regional development strategy aimed at fostering ITCP clusters; as an aspect of national economic and cultural policy; and in multinational collaborative efforts. All of these levels are important, and there are cross-connections among them. There is, therefore, considerable advantage in coordinated, multilevel strategies for encouraging, supporting, and benefiting from ITCP.

PROVIDING NEW TOOLS AND MEDIA FOR ARTISTS AND DESIGNERS

Individual artists and designers have experimented with IT since its earliest incarnations. Artistic exploration of the possibilities of computer graphics, for example, now extends back more than 30 years, and 40 years for computer music. As IT has matured and been assimilated into the mass market, the IT tools and media available to artists and designers have become both more diversified and more affordable. There are popular, standardized tools for performing such tasks as creating, editing, and distributing images, audio, and text; there are variants on standard tools customized to the needs of particular artists or designers; and there are highly specialized, purpose-built tools used by nobody but their creators.

To a software developer or an information services manager, it might seem that the keys to ITCP are simply equipment and software—developing and providing access to standard, commercial IT tools for artists and designers. This perspective is useful as far as it goes, and it can provide a good way to get started with ITCP, but in the long run it is an insufficiently rich or flexible one. We make our tools; then our tools make us.[1] Furthermore, software tools encode numerous assumptions about the making of art and design—precisely the sorts of presuppositions that truly creative practitioners will want to challenge. And the more software tools emphasize ease of use or familiar metaphors, the more they must depend on restrictive assumptions in order to do so. Such tools not only must be available, but they also must be objects of critical reflection; they must be open to adjustment and tweaking, they must support unintended and subversive uses—not just anticipated ones—and they must not be too resistant to being torn apart and reconceived. If creative practice can develop the powerful spaces and tools that it needs, like the electronic easel or electronic studio, these spaces and tools could help transform or enlarge the metaphors, spaces, and tools (office, desktop, files) that the rest of us have to work with.

The relationship between IT professionals and artists and designers will be of limited value if it is conceived simply as one of software (or hardware) producer and consumer. It should, instead, be one of flexible and thoughtful collaboration in which the roles of software designer and user are not rigidly distinguished. The advances made by IT researchers may suggest new forms of art and design practice,

[1]Inspired by Marshall McLuhan, 1954, "Notes on the Media as Art Forms," *Explorations* 2 (April): 6-13.

while the questions raised by artists and designers may provide new ways of thinking about IT—ITCP work challenges the boundaries of traditional disciplines. Modular, reusable and recombinable code elements may support critical reconceptualization more readily than closed, proprietary software products. Open source development may provide better opportunities for cross-disciplinary collaboration, customization, and reconceptualization than tools developed and marketed as protected intellectual property—no matter how powerful and attractive those tools may be.

PROVIDING OPPORTUNITIES TO DEVELOP ITCP SKILLS

In general, ITCP depends on opportunities for learning across multiple disciplines—some mix of the arts and design plus IT concepts and tools. The growing numbers of artists and designers becoming skilled programmers or hardware developers, like the smaller number of computer scientists and technologists engaging seriously with the arts and design, demonstrates that this is feasible. But it is not easy: Colleges and universities focus mostly on established disciplines, and the cross-disciplinary programs that do exist vary widely in their institutional support, effectiveness, and quality.

Like other professionals, artists and designers can do more with IT if they become deeply conversant with its capabilities and limitations. Achieving that result requires far more than training on standard tools, and it also demands an ability to understand tools and media critically—in cultural and historical context. Such critical thinking about tools is much less typical of education and training in IT, a difference that contributes to the asymmetric participation of artists and computer scientists in ITCP. To date, it seems that artists and designers have made greater efforts to engage IT seriously than computer scientists and technologists have made to acquire deep understanding of creative practices in the arts and design. It is easier to find designers who can program than programmers who can design, or composers comfortable with signal processing than specialists in signal processing who can compose or perform at high levels of proficiency. This imbalance could change, with outreach to the computer science community and interest in ITCP among those who provide funding and other incentives and rewards.

Although motivated individuals can and do acquire complementary IT and arts or design skills, significant ITCP work can also be produced by cross-disciplinary partnerships between computer scientists and artists or designers. This approach has the advantage of requiring that fewer skills be mastered by individual team members, and it is often essential for large projects, but there are some inherent difficulties. Progress in collaborative ITCP requires effective dialogue between artists and designers and IT professionals. Differences in professional culture, styles, and values, as well as communication problems, can confound effective collaboration. Yet there are strong traditions of successful cross-disciplinary collaboration in architecture (particularly as computer-aided design/computer-aided manufacturing (CAD/CAM) technology plays an increasing role), in film production, and in the creation of video games, and there have been some successful pairings of artists and technologists to produce visual works, performances, and installations.

CREATING ENVIRONMENTS THAT SUPPORT ITCP

ITCP work can be done in many different places. And the diversity of venues matters, since each type of venue represents different tradeoffs and provides different combinations of opportunities, constraints, and comparative advantage. So an effective ITCP development strategy is likely to be a multivenue one.

ITCP venues may occupy physical or virtual spaces, be large or small, range from loosely organized collectives to formal programs, and be either free-standing or connected to established institutions. Specialized exhibitions, performance festivals, presentation and lecture series, conferences, Internet forums, and display and performance sites have all played important roles in the growth of ITCP communities. By contrast, mainstream arts and design organizations—museums, galleries, arts and design fairs, arts and design publishers, and so on—have played a lesser role, although they have begun to embrace ITCP more as the products of ITCP have played a larger cultural role and as these products have developed in quality and interest.

Much pioneering exploration of ITCP has taken place in studio-laboratories, which build on the tradition of earlier centers of cross-disciplinary research and education in the arts, design, and new technology of the time, such as Germany's Bauhaus in the pre-World War II years, the postwar New Bauhaus in Chicago, and the Center for Advanced Visual Studies established by Gyorgy Kepes at the Massachusetts Institute of Technology (MIT) in the 1960s. MIT's Media Laboratory has been among the largest and most visible, and it has generated affiliates in Europe and Asia. However, the Media Lab's combination of substantial laboratory and human resources with an atelier style of research and education, building on a consortium of industry funders, is difficult to replicate outside the context of a leading research university with strong industrial connections. Some universities, such as Carnegie Mellon University, have formed special cross-disciplinary centers that undertake ITCP, and several arts schools, such as the California Institute of the Arts and the Art Center College of Design in Pasadena, have transformed their curricula to incorporate

IT, yielding numerous focused ITCP activities. Some film schools have shifted their emphasis from traditional to digital production and distribution technologies, and most architecture and design schools have supplemented or supplanted drawing boards with CAD. Several universities have begun to develop cross-disciplinary study programs in aspects of ITCP. But a key challenge, particularly in times of tight finances, is to find effective ways to fund these programs—and to frame them in ways that are pedagogically sound and appropriately adaptive to the continuing evolution of ITCP.

In Canada and Europe, and emerging in Asia and Australia, major efforts are under way to develop standalone, government-backed ITCP centers. Such centers are typically conceived of as instruments of arts and cultural policy, rather than as equivalents of national research laboratories. This is an arena in which the United States lags. In principle, such centers can provide considerable flexibility and freedom of intellectual direction. On the down side, they are vulnerable to changes in government spending priorities, they can lose the very independence that makes them attractive if they shift to executing contracts from industry, and they are usually less able to draw effectively on the laboratories and human resources of large universities.

The technology required for ITCP can be expensive, and ambitious ITCP productions can require major funding. Given the breadth of ITCP, some funding is available through commercial channels. It normally requires close engagement with popular culture and mass audiences, with all the constraints and opportunities that this implies. This path is illustrated by the film and entertainment industries—these ITCP pioneers overcame difficulty and expense and now can produce major commercial successes. A focused example is the flourishing video game industry, a direct outcome of the rise of ITCP. It obviously would not be possible at all without the necessary IT, and its products define a new art form that also resonates with the general public. It has found some highly innovative ways to combine centralized research, development, and marketing with large-scale open-source strategies, and it has evolved unique distribution strategies.

Operating on a small scale and often producing innovative work through commissions from enlightened patrons is another group of players that straddle the boundary between commerce and the arts: Independent architectural design, product design, graphic design, and music and video production houses now make extensive use of IT tools and media, and they frequently have IT specialists on staff. In some cases, this amounts to little more than straightforward use of standard, commercial tools. But more adventurous and innovative houses have seized the opportunity, through IT, to open up some exciting new domains. This is particularly evident in the move of architects into CAD/CAM design and construction—with the resulting emergence of new architectural idioms—and the move of graphic designers into work that is more interactive.

Much important ITCP work occurs outside the marketplace. In addition to academic efforts, individual, independent artists and designers, operating mostly on a small scale, are responsible for a crucial segment of ITCP. By virtue of their independence, they are well positioned to provide perspectives that challenge mainstream thinking and to engage industry as catalytic outsiders who can instigate new ways of thinking about products and processes. Many forms of traditional art production, such as painting and writing, are labor-intensive and modest in their requirements for investments in technology, but ITCP is often much more capital-intensive. This increased need for capital presents a chronic problem for independents; they often operate on a shoestring, struggle to get access to technology and expertise, and must make whatever technology investments they can manage from project-by-project funding. They usually depend on some mix of the gallery and patronage structures of the art world, arts foundation grants, and relationships with sympathetic educational institutions and corporations.

ITCP activity in all of these venues tends to cluster geographically. Fostering such clusters—with a vital mix of commercial, non-profit, academic, design and production house, and independent practitioner activity—can play an important role in regional economic development. There can be major direct benefits to local economies, and indirect (but potentially even more important) benefits in the form of better design and higher levels of innovation distributed over many sectors of the economy.

In addition, by its very nature, ITCP lends itself to efficient electronic connection of scattered islands of activity. Writers and photographers can submit their work electronically to distant publishers, architects can form geographically distributed design and construction teams, film studios in Hollywood can link electronically to postproduction houses in London or animation shops in Korea, and so on. That capability for connectivity is leading, increasingly, to multinational ITCP alliances and organizations. Such a capability can be particularly important in contexts—such as in developing nations—where the local culture supports some unique ITCP cluster and electronic connectivity adds value to that cluster by providing wider access to resources and markets. It is also important in contexts—such as those of Australia, New Zealand, and Singapore—where small but highly educated populations, combined with the effects of distance, make concentration on high-value, immaterial, information goods and services particularly attractive.

FOSTERING THE CULTURE OF INFORMATION TECHNOLOGY AND CREATIVE PRACTICES

Providing new tools and media for artists and designers, providing opportunities to develop ITCP skills, and creating environments that support ITCP are all necessary to form thriving ITCP clusters, but they are not in themselves sufficient. It is also essential to foster the culture of ITCP—the flow and exchange of ideas among those engaged, the development of a sense of intellectual community, the representation of ideals and values, and the recognition and validation of outstanding work.

The academic environment, in particular, is central to the future of ITCP. That is where talent is cultivated, and that is where research and practice of various kinds can take place largely without market strictures. At present, a gulf exists between computer science and the arts and design. Although some computer scientists bridge that gulf—and contribute considerably to ITCP—that activity often happens outside their department. Although some arts departments have been skeptical of "new-media" programs, in general the arts and design on campus have welcomed ITCP more than have computer science departments. The lack of welcome from computer science departments reflects a lack of appreciation of ITCP's potential to contribute to the advance of computer science as a field, as well as concern about already tight curricula. At the same time, arts and design departments on campuses and arts schools have sought to internalize ITCP facilities and to develop their own research and teaching programs in ITCP. The situation echoes earlier efforts to formalize computer science as a field, establish a theoretical foundation for it, and provide it with some level of autonomy from its predecessor and sister fields. But it is important to explore the potential for constructive interaction between the arts and design and computer science before universities—and practitioners—conclude that "parallel play" is the way to go.

Building academic clusters is a nontrivial challenge. Not only are there cultural differences among the constituent disciplines, but there are also significant differences in expectations for funding, use of time, use of graduate students, definitions of what is acceptable work, and so on. Special centers, seminars, and other venues are being tried on campuses, a kind of institutional experimentation that is vital to developing ITCP. They help to frame and sustain ITCP projects. The time is ripe for academic experimentation with ITCP, from course content and curricula to institutional options and incentives.

Education, collaboration, funding, and professional advancement all depend on how ITCP is received. Because ITCP spans so many activities, there is feedback from the commercial space and popular culture—a powerful reinforcement on the design end—and there is more ambiguous feedback through academic institutions (faculty and administrators); publications, exhibitions, performances, and prizes, as well as those who select for them; and funders of research and the arts.

Because the field of ITCP is young and dynamic, ITCP production is hard to evaluate. Traditional review panels—representing funders; owners and managers of conventional display, performance, or publication outlets; and those making personnel decisions at academic institutions—may be hampered by their members' ties to single disciplines and the absence of a time-tested consensus about what constitutes good work in ITCP and why. This problem is typical of new fields drawing from multiple disciplines, albeit aggravated by the contrast between computer science and the arts and design. It is offset somewhat by a flourishing array of conferences and other forums, in both virtual and real space, that provide a sense of community and an outlet as well as feedback. Effective evaluation, validation, and recognition of ITCP work are essential for this domain to progress. Building on traditions in the arts and design, prizes can be powerful for stimulating and recognizing excellence in ITCP.

A NEW FORM OF RESEARCH

ITCP can constitute an important domain of research. It is inherently exploratory and inherently transdisciplinary.[2] Concerned at its core with how people perceive, experience, and use information technology, ITCP has enormous potential for sparking reconceptualization and innovation in IT. In execution, it pushes on the boundaries of both IT and the arts and design. Computer science has always been stimulated by exposure to new points of view and new problems, which are ever-present in the arts and design. Because of the breadth of use to which artists and designers put different forms of IT, and because they typically are not steeped in conventional IT approaches, artists' and designers' perspectives on tools and applications may provide valuable insights into the needs of other kinds of IT users. The needs and wants of artists and designers can suggest new ways of designing and implementing IT. Engaging their perspectives is a logical extension of recent trends in cross-disciplinary computer science research.

Recently, for example, artists and designers have brought new concerns to the design and implementation of sensor systems, distributed control systems and actuators, generative processes and virtual reality, and the Internet and other networks. Their interests in performance and in engaging the public present challenges for system interactivity; their interests in improvisation present new opportunities for exploring human-machine interaction. Although artists and computer scientists have long interacted in such spheres as computer graphics and music, almost any form of IT may be adopted or adapted for uses in the arts and design. This flexibility of purpose parallels the plasticity of the computer itself—and that helps to explain why artists' concerns may motivate new combinations as well as new forms of IT.

It is important to recognize, however, that serious ITCP research goes beyond appropriation of established IT concepts and techniques for artistic or design purposes, or use of straightforward examples

[2]In transdisciplinary ITCP work, artists and designers interact as peers with computer scientists, a model that is described in detail in Chapter 4.

drawn from the arts and design to demonstrate the potential applications of new IT. It requires drawing on deep understanding of *both* IT and the arts and design to formulate scientifically interesting new questions in ITCP, and to see the subtle cultural implications of relevant new science. Issues arising from the arts and design have motivated challenging and important domains of computer science and technology research, such as three-dimensional geometric modeling and scene rendering directed at the practices and needs of designers and animators. Sometimes arts-oriented researchers raise cultural, social, ethical, and methodological questions for computer scientists that would not be obvious in a more narrowly focused technological context. Conversely, outcomes of computer science research may challenge artists and designers to rethink their established assumptions and practices (rethinking that includes an evolution from artifact creator to process mediator), as when architects engage the possibilities of curved-surface modeling and associated CAD/CAM fabrication techniques, or when photographers ponder the differences in the roles of digital and silver-based images as cultural products and as visual evidence. And there are areas, such as augmented reality, tangible computing, lifelike computer animation of characters, and user-centered evaluation of computer systems, that are probably best regarded as the joint outcomes of questions posed and investigations conducted by computer scientists and by artists and designers. These developments suggest that the value of ITCP lies not just in the capacity of each field to answer questions posed by the other, but also in the opportunity for each field to gain fresh, sometimes uncomfortable, perspectives on itself.

MAKING ITCP HAPPEN

The broad scope of ITCP implies that it derives funding from both commercial activity—notably in design and entertainment contexts—and non-profit activity. The latter is where support is particularly uncertain yet essential, since it is in non-profit contexts that much experimentation takes place and some of the broadest public, participant access becomes possible. The hybrid nature of ITCP tends to confound its funding. In the United States, exploratory and productive work in the arts and at the non-commercial frontiers of design is likely to be funded by private philanthropy, while in computer science the leading funders of basic research are government agencies, often in support of specific agency missions. Computer science research grants are larger (by an order of magnitude) than grants (or prizes) typically available to artists—and they tend to be tied to the advances in scientific knowledge or the specific kinds of applications of concern to their funders.

Advancing ITCP requires new approaches to funding. A first step is recognition by both the arts and computer science patrons that topics in ITCP are legitimate; next must come support for exploration of the intersections between IT and the arts and design, and with that support for new kinds of technical and social and intellectual infrastructure for undertaking and providing access to ITCP. Those new approaches, in turn, may require new skills and participants in funders' decision-making processes. Grant program definitions should specifically embrace ITCP, but without that, progress in ITCP will depend on grant seekers' ingenuity in influencing program definitions and relating their ideas to existing programs.

In addition to monetary support, ITCP depends on resolving concerns about intellectual property rights. Not only does ITCP feature a broad range of content and a broad range of expression, but its production can also involve creative reuse or adaptation of previously generated content or expression. It also requires attention to the archiving and preservation of IT-based works, both those of a fixed nature and those designed to change through interactivity or other factors.

The rise of ITCP and the process of contemplating its future point to the need for better data on arts-related activities and trends. Although imperfect, the data available on scientific and technical research is better than that for arts activities. The lack of good data hinders effective planning and policy making.

RECOMMENDATIONS

Realizing the potential of ITCP requires actions on many fronts—by individuals, organizations, and funders of different kinds. The benefits will accrue broadly—in multiple sectors of the economy, geographic regions, and disciplines. Other efforts already address the roles of established arts institutions—museums, galleries, theaters, and so on—in relation to IT-based art works and performances. This report concentrates its recommendations on those most responsible for nurturing the talent and the explorations that are the essence of ITCP. The recommendations below build on discussions in the body of the report, which explores the ecology of creative practices and the components of the strategies through which ITCP can thrive.

FOR EDUCATORS AND ACADEMIC ADMINISTRATORS

1. Support the achievement of fluency in information technology (IT), and the development of critical and theoretical perspectives on IT, by arts and design students through the provision of suitable

facilities, opportunities for hands-on experience with IT tools and media, and curricula that engage critical and theoretical issues relating to IT and to information technology and creative practices (ITCP).

2. Support educational experiences for computer science students that provide direct experience in the arts and design, critical discussion, and formation of broader cultural perspectives—not merely as semi-recreational enrichment, but at a sufficiently challenging level to raise hard questions about the social and cultural roles both of science and technology and of the arts and design.

3. Foster exploration of ITCP through incentives and experimentation with a range of informal (e.g., workshops and seminars) and formal vehicles (e.g., centers, awards)—in particular, by building firmly and boldly on demonstrated local (and often small-scale) strengths and productive relationships already in place.

4. Support curricula, especially at the undergraduate level, that provide the necessary disciplinary foundation for later specialization in ITCP.

For Foundations, Government Agencies, and Other Funders

5. Allocate funding not only to support work by specialists in established and recognized areas of IT and of the arts and design, but also to foster collaborations that open up new areas of ITCP.

6. Structure proposal review processes to encourage not only continued development of established and recognized areas of IT and of the arts and design, but also higher-risk, longer-horizon efforts to develop ITCP.

7. Provide program managers with more time and leeway to learn about new fields and new kinds of grantees; encourage mobility among grant makers, artists, designers, and computer scientists.

8. Develop a new grant-making category for tool (instrument) building, emphasizing designs that are extensible and tools that provide support for improvisation, and for providing broad access to the resulting tools. Expand research program support for work in aspects of distributed control, sensors and actuators, video and audio processing, human-computer interaction, information retrieval, artificial intelligence, networking, embedded systems, generative processes, and other technological areas that are critical to advancing ITCP, with a particular focus on arts-and-design-inspired applications of these technologies that extend beyond conventional uses.

9. Factor infrastructure and archiving and preservation needs into grant levels because this support is essential to enable future work in ITCP.

10. Support the establishment of new prizes for excellence in ITCP and the development of curated Web sites for its display or performance.

11. To support policy decision making, underwrite a better knowledge base—ranging from the history of ITCP to the details of who is doing what, where, when, and how—that parallels the knowledge base in scientific and engineering fields.

12. Underwrite research on the formation of creative clusters and the role that ITCP can play in promoting regional development.

13. Provide support for the creation and maintenance of networks of organizations (composed of participants from academia, industry, and cultural institutions) involved with ITCP.

For Industry

14. Seek opportunities to develop new products and services relating to the growing field of ITCP and to participate in the formation of ITCP clusters.

15. Pursue relationships with centers of ITCP activity, and seek opportunities to engage artists and designers who can contribute to the development of ITCP products and services.

For the National Academies

16. Organize a symposium series on Frontiers of Creative Practice (paralleling the Frontiers of Science and Frontiers of Engineering series) to bring together a cross section of young artists, designers, scientists, and technologists working within ITCP.

Committee on Information Technology and Creativity

Computer Science and Telecommunications Board
Division on Engineering and Physical Sciences

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

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Preface

Computer science has drawn from and contributed to many disciplines and practices since it emerged as a field in the middle of the 20th century. Those interactions, in turn, have contributed to the evolution of information technology: New forms of computing and communications, and new applications, continue to develop from the creative interaction of computer science and other fields. Focused initially on interactions between computer science and other forms of science and engineering, the Computer Science and Telecommunications Board (CSTB) began in the mid-1990s to examine opportunities at the intersection of computing and the humanities and the arts. In 1997, it organized a workshop that illuminated the potential, as well as the practical challenges, of mining those opportunities[1] and that led, eventually, to the project described in this report. Ensuing discussions between CSTB staff and people interested in the intersection of computing and the humanities or the arts, notably Joan Shigekawa of the Rockefeller Foundation, a participant in the 1997 workshop, culminated in a grant from the Rockefeller Foundation to study information technology and creativity (see Box P.1 for the statement of task).

This report should be read with two conditions in mind: First, it is, by design, a record of the project, filled with descriptions, observations, conclusions, and recommendations intended to motivate and sustain interest and activity in the rich intersection of information technology (IT) and the arts and design. Second, in this book form it cannot possibly convey the exciting possibilities at that intersection. Instead, it presents examples and pointers to sites on the World Wide Web and in the physical world where that intersection can be observed and experienced. We urge the reader to treat this report as a

[1]See *Computing and the Humanities: Summary of a Roundtable Meeting*, published in 1998 by the American Council of Learned Societies, one of three collaborators with CSTB in organizing the workshop.

BOX P.1
Statement of Task

A series of discussions among a cross section of the arts community and experts in computing and communications will be organized. These discussions will crystallize new ways of conceptualizing joint opportunities and new approaches to the arts (and/or IT [information technology]). They will explore what would make the most conducive environment for IT-arts exchange on an ongoing basis, considering physical and virtual options. They will address possible mechanisms to sustain the discussion, such as funding and institutional support. Finally, they will culminate in both a coherent description of potential futures and an agenda for action, action that bridges the different communities as well as action most appropriate for one or another.

primer and guidebook and to seek out instances of IT and creative practices—ITCP—directly.

COMMITTEE COMPOSITION AND PROCESS

The study committee convened by CSTB featured an unusually eclectic group of individuals (see Appendix A for biographies of committee members). Characterizing most (or all) of them as experts on particular subjects would only begin to suggest the talents of this group. Collectively, the committee had expertise and experience in the intersections of information technology and music, the visual arts, film, and literature and in art history, architecture, cultural studies, and many of the technologies pertinent to ITCP. The committee did its work through its own deliberations and by soliciting input from a number of other experts (see Appendix B for a list of those who briefed the committee). It met first in August 2000 and five times subsequently in plenary session. Additional information was derived from reviewing the published literature, monitoring selected listservs and Web sites, and obtaining informal input at various conferences and other convenings. During the editorial phase of the study, facts were checked for accuracy with either authoritative published sources or subject experts.

The diversity of this committee made it a microcosm of some of the communities it hopes to influence with this report. That diversity posed challenges in the conduct of this project that will be echoed in attempts to learn from it: Conversations among people with different training and professional experience can be confounded by jargon and prejudices as well as by differing knowledge bases—even when those people share interests. The completion of this report attests to the potential for technologists and artists to find common ground, not only in undertaking creative work, but also in contemplating options for making such work easier to undertake and more widespread. But finding this common ground sometimes proved to be a formidable challenge.

The productive interaction among committee members was captured in some of their career developments during the course of this project. Chris Csikszentmihalyi, for example, left Rensselaer Polytechnic Institute to join John Maeda at MIT's Media Lab. Michael Century left McGill University for Rensselaer Polytechnic Institute. Natalie Jeremijenko was hosted by Jim Crutchfield for a month's professional visit at the Santa Fe Institute. And John Maeda was inspired by the project to build "a new online Bauhaus." These and other developments attest to the dynamism and creative energy of the people who have been exploring the intersection of IT and creativity.

Although the report refers to several companies, products, and services by name, such reference does not constitute an endorsement by the committee or the National Academies. The committee did not evaluate any product or service in sufficient detail to allow such an endorsement.

ACKNOWLEDGMENTS

The committee is particularly grateful to Joan Shigekawa of the Rockefeller Foundation for initiating this study. She approached CSTB with a conviction that the time was right for a conversation among people of different backgrounds about how to enhance and sustain the intersection of information technology and creative practices. We appreciate her guidance and support through the study process, including her participation in two committee meetings, occasional relay of useful information, and continuing demonstration of interest in the process and the eventual results.

In addition, we would like to thank those individuals who provided valuable inputs into the committee's deliberations. Those who briefed the committee at one of our plenary meetings are listed in Appendix B. Others who provided us with important inputs include Bill Alschuler (California Institute of the Arts), Howard Besser (New York University), Shari Garmise (Consultant, Washington, D.C.), Samuel Hope (National Office for Arts Accreditation), Sharon Kangas (Center for Arts and Culture), Anna Karlin (University of Washington), Ruth Kovacs (The Foundation Center), Joan Lippincott (Coalition for Networked Information), and Laurens R. Schwartz (Consultant, New York City). We would also like to acknowledge those organizations that hosted committee meetings: the American Institute of

Graphic Arts, New York University, Stanford University, Pixar Animation Studios, and the Massachusetts Institute of Technology.

The committee appreciates the thoughtful comments received from the reviewers of this report and the efforts of the National Research Council's report review coordinator. The review draft stimulated a comparatively large volume of comments, many of which provided additional reference material, relevant anecdotes, and observations to bolster or counter the committee's earlier thinking. The comments were instrumental in helping the committee to sharpen and improve this report. In particular, Simon Penny of the University of California at Irvine provided an unusually extensive and thoughtful set of comments that served to improve the quality of this final report.

Finally, the committee would like to acknowledge the staff of the NRC for their work. Alan Inouye served as the study director with overall staff responsibility for the conduct of the study and the development of this final report; his effort to bring the report to completion was exceptional and demanded far more of his time than anticipated. Marjory Blumenthal, director of the CSTB, provided essential guidance and input throughout the study process, drafted and edited a number of sections of the final report, and was both helpful and patient in bringing the committee process to a successful conclusion. Margaret Marsh Huynh had primary responsibility for the administrative aspects of the project such as organizing meeting logistics; her efforts made a particularly complicated and demanding process run smoothly. Consultants Laura Ost and David Walczyk generated initial drafts of several sections of the report; Ms. Ost also edited several chapters. Susan Maurizi edited the manuscript for publication. David Padgham and Jennifer Bishop provided research assistance; Ms. Bishop also created several of the original figures that appear in this report (including the cover design). The committee also thanks Janet Briscoe, Janice Sabuda, and Brandye Williams of the CSTB, and Claudette K. Baylor-Fleming and Carmela J. Chamberlain of the Space Studies Board for their support of the committee's work.

William J. Mitchell, *Chair*
Committee on Information Technology and Creativity

Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Anna Bentkowska, Conway Library, Courtauld Institute of Art,
Howard Besser, New York University,
Sandra Braman, University of Alabama,
Donna Cox, University of Illinois at Urbana-Champaign,
Robert Denison, First Security Company,
Steve Dietz, Walker Art Center,
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Paul Kaiser, Independent Artist, New York City,
Alan Kay, Hewlett Packard Company,
Clifford Lynch, Coalition for Networked Information,
Simon Penny, University of California at Irvine,
Bill Seaman, Rhode Island School of Design, and
Mark Tribe, Rhizome.org.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Edward Lazowska, University of Washington. Appointed by the

National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

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