From books to ebooks: A new chapter for learning

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Abstract

Mobile technologies are changing the way we engage and interact with information and the way we learn. This paper explores the ebook technologies, particularly, the new relationships and interactions they afford and how these can be harnessed to enhance the learning experiences of first year university students. The paper highlights the importance of the user experience – engagement and interaction – in relation to the need for students to 'invest something of themselves' in the learning process. The focus of the paper is on the design, development and evaluation of an interactive *ibook* application on the subject of computer architecture. Results suggest that the ibook, presented here as a complex and multi-facetted learning space, has the potential to tackle some of the documented difficulties students are experiencing with the subject and enhance their learning experience.

Keywords Mobile learning, ibook application, ebook, user experience, spatial learning experience, interaction, multimedia, engagement

Introduction

As mobile technologies continue to develop and integrate into our lives, they bring with them a new generation of learner experiences. These new experiences are changing the way we interact with information and the way we learn. In this paper we explore these mobile technologies, in particular the ebook application, and the way educators and researchers are starting to use them as learning technologies. Moreover, we will also explore the new relationships and interactions that they allow users to form; how we can design and programme these technologies to further evolve the learner experience. During the past few years books in a variety of

electronic formats have been developed (i.e. ebooks). The emergence and growth in mobile technologies has instigated the development of numerous applications to amuse and aid users in their everyday lives. iBook are a particular 'app' related to the Apple brand of technologies that are now also used to enhance learning. The focus of this paper will be on research in the design and development of an interactive *ibook* application on the subject of computer architecture. Its main contribution lies in the insights the research provides into how ibook applications might take the traditional textbook to a new interactive level. How its new and stimulating interaction and multimedia capabilities can be programmed to encourage and motivate first year university students into becoming active learners.

Mobile technology and the learner experience

The term 'user experience' (UX) has been used in the HCI sphere for quite a while now. Since the late 1990's, it has slowly been taken to the foreground of HCI discussions and become an increasingly important issue for designers and developers. Traditional HCI has equated high quality with the absence of problems. However, Hassenzahl & Tractinsky (2006) highlight the importance of UX for HCI and use an apt analogy to highlight that a quality experience entails more than solving problems: the absence of illness equals health, but there is much more to wellbeing than the absence of sickness. In the same way, there is a crucial role for the design of the user experience in the future design of education. HCI should be 'contributing to the quality of life by designing for pleasure rather than for absence of pain' (Hassenzahl & Tractinsky, 2006, pg. 91-97).

Without a doubt, mobile technologies (and the user experiences they afford) have a role to play in the future of education, in that they have huge potential to transform and rethink the ways in which we interact with learning materials. They afford a certain level of stimulating interaction and multimedia capabilities that have the potential for arrays of non linear multisensory and contextual learning experiences. In fact, ebooks and other emerging applications produced for mobile devices are promoted as tools that through interaction enhance and support problem solving and deeper understanding of learning problems. This interaction involves both the structural and functional, as well as the ethical and aesthetic qualities of the mobile learning material and the technology. Therefore, in terms of designing for mobile learning experiences, it is prudent to think deeply about the relationship between the mobile technologies and their attributes, and the learning experiences that we want them to provide (i.e. how these attributes actually work together?).

Focusing on Hassenzahl's pragmatic and hedonic model (2003), each attribute/ property has its own individual agenda; a problem or set of problems to solve, within the bigger agenda of building a UX. The researchers of this paper, envision a parallel process in the learning experience to find, shape and solve individual problems in cognitive, affective, pedagogical, and social dimensions of learning. At the same time find, shape and solve the collective problem of these properties and their inter-relatedness to optimize the learning experience (Carroll & Kop, 2011). In relation to learning, Carroll & Kop (2011) highlight that applications for mobile devices need to

approach the design of interaction in terms of what learning experiences it can afford and support.

Ultimately, the aim of using mobile applications is to give users a certain amount of control over their learning experiences (Carroll, Kop & Woodward, 2008). As highlighted, one of the strengths of a digital ebook would lie in its capacity for engagement: 'It seems to afford a learning at-the-time-and-place that it is needed format, which could bring greater context and relevance to the learning' (Thomas et al., 2012). The term engagement has often been associated with the idea of flow, which is suggested by Csikszentmihalyi & Robinson (1990, pg.7) as *'the deep involvement in and effortless progression of the activity'.* Lessiter et al. (2001) use words like 'drawn in', 'involved', and 'enjoyed' to describe one's sense of engagement. A quality learning environment facilitates that learners are being drawn into the learning activity and then involves learners in the creation of new thoughts, feelings and impressions to feed into and create their own learning experience. Moreover, in harnessing this sense of engagement in mobile learning devices, the critical 'interaction' issue lies in how well we exploit human's natural abilities, how well we can stimulate all the human senses, not only the visual ones. Indeed, interaction has become more than a set of physical devices (i.e. mouse, keyboard, and screen) or a set of virtual devices (i.e. dialog boxes, scroll bars and menus). Instead it is defined by the ways in which it fits into our environments and our lives (Dourish, 2004). Not fully understanding this big picture is one of the factors that keeps designers and developers from 'really solving problems holistically and designing total-system solutions that deeply meet our target users [learners]'(Rohrer, 2011). The question then is: How do we build applications and endow them with a unified meaning and purpose? How do we design and develop mobile learning applications to nurture the human presence and new ways of absorbing, visualising and fully understanding the learning material?

The material and human presence in learning

This is what Fenwick (2010) highlighted when she called for the re-framing of 'the thing' in learning. She acknowledged the age-old educational traditions, in which education and learning materialize in the interaction between teacher and learner. Since Antiquity, communication and dialogue have been seen as the crucial components to learning. Dewey's philosophy saw communication as the most important aspect in making people what they are. 'It is because people share in a common activity, that their ideas and emotions are transformed as a result of and in function of the activity in which they participate' (Biesta, 2006, 17-19). Garrison and Anderson (2003) in their Community of Inquiry Model emphasised that collaboration with others will support learning. This collaboration is 'nourished through exchanges, mutual contributions, confrontations, and negotiations that provoke within the person certain interrogations and stimulate new learning through carrying out new activities' (Jézégou, 2010, p.3). Moreover, Gur & Wiley (2007) emphasised the need for genuine dialogue in the learning process. Furthermore, Walters & Kop (2009) emphasised the need for participants in the learning process to 'invest something of themselves' in the process, for it to be a human experience, not a mere assimilation

of information, but ‘a journey into the unknown’, supported by human interaction and feedback from others (Walters & Kop, 2009, p. 282).

Fenwick, however, takes note of the influences of technologies on learning and the emerging socio-material approaches in learning theories such as Complexity Theory, Actor-Network Theory and Cultural –Historical Activity Theory, which emphasise ‘the material world is treated as continuous with and in fact embedded in the immaterial and the human’ (Fenwick, 2010, pg.105). A new emphasis on the material and its rightful place within the learning experience is important at a time when the place of technology in learning and education is becoming more prominent.

Fenwick’s stance has additional meaning for the development of the material in learning as the material needs to be seen in harmony with and embedded within the immaterial and human. This means that the user experience with technology has to be understood as multi-facetted and should be seen as referring to something larger than usability or one of its dimensions, such as satisfaction or attitude; the overall impression, feelings, and interactions that a user has with a product or service. It means that design has become about creating experiences beyond just functional products and services as indicated by McCarthy & Wright (2004). It is about creating products that encourage relationships with individuals; experiences that connect on an emotional and value level (Shedroff, 2009).

Ebook: a complex and multi-facetted space for learning

‘Books constitute such an integral element of our society – both reflecting and shaping its culture – that it is hard to imagine life without them.’(Kurzweil, 2001)

Over the last seven hundred years the book has amused, educated, informed, stimulated and entertained. It is the result of our human physiology and how we see and experience the world but also like our human physiology, it is true to say that the book is subject to change. This contingency to change makes it a very complex and sophisticated technology. In 1968, Alan Kay, came up with the idea of the *Dynabook* – a portable interactive personal computer which was as accessible as a book; since then we have seen some major turning points in the evolution of the book, for instance from paper to screen. However, in terms of learning, it has only been in the last few years that the focus has been on the e-textbook and its potential for learning. As Lawson (2011) points out ibook applications are transforming the way in which we assimilate and absorb information providing a greater level of accessibility to people on a global scale. Indeed, ebooks have become increasingly popular over the last two years where they have targeted a diverse age range from educating young children in the classic storytelling’s of Alice in Wonderland (Dahlquist, 2010) to a more mature captive audience in educating people on the damaging effects of Climate Change with the interactive i-book from Al Gore (Lee, 2011). Through new and exciting interactions, the ebooks are slowly starting to tap into the capabilities of our human senses and in doing so, starting to explore the

many ways of absorbing information and learning. Books are not only about reading text anymore!
People reach an understanding of the world through the reading of images, static and moving, as opposed to just the reading of words. As a result it is very important for us to be able to read images. Visual literacy is the ability to see, to understand, and ultimately to think, create, and communicate graphically (Thibault, 2003). As Kress and Leeuwen (1996, p.1) highlight it is important to understand a visual grammar which *'describes the way in which depicted people, places and things combine in visual statements of greater or lesser complexity and extension'*. In terms of the ebook, this grammar is made up of a number of visual elements as well as audio elements and it is the readers' interaction with these elements in conjunction with the interactivity possibilities of the medium and the context of the subject that results in an effective reading and understanding of learning material.

However, for attention to be attracted to the object, a set of conditions needs to be met, in the sense that the object must contain a set of challenges that engage the interpretative skills of the beholder and the environment must encourage a centring of attention on the object and a screening out of distractions (Csikszentmihalyi & Robinson, 1990). For example, when we look at the traditional book, when one reads a book for pleasure one experiences an unforced concentration that transports one to another place (Nell, 1988). The reader is drawn into the world of the book with its own sense of time that in many ways screens out the real world and its distractions. In the visual experience, as in the learning experience, there is a difference between passive reception and active perceiving (Arnheim, 1969,). As we look around a room, everything we see is there without having to do anything to produce it. We receive this information passively. It just exists, but when we start to be attracted to certain objects, to feel certain emotions and intuitions, to want more information, then we start to interact and become actively involved. As with learning, '*we never look at just one thing; we are always looking at the relation between things and ourselves*' (Berger, 1977, p.9).

To build an ebook, we need to assemble this grammar, based on information, into a coherent structure. As Devereaux (2004, p.6) states: '*when we read novels, we read them as if the text is organised in a certain way. We read it as organised so as to allow us to ask certain questions'*. This coherent structure, known as the narrative *' is the organisation of experience, which draws together many aspects of our spatial, temporal and causal perception'* (Branigan, 1992, p.4). The interesting and new facet that the ebook adds to this narrative is that it is a complex and multi-facetted *space for learning.* It offers a spatial experience of accessing multimodal information which opens the door to many different modes of interpretation such as thought, feeling, sensation, intuition, and culture as a means to 'engage' in the learning.

Networked learning and connectivism

The educational system has evolved over centuries and interactions by learners and educators as "human beings", not as "cogs in the wheels" of computer systems have been at the centre of the educational paradigm until recently. In educational

institutions information and resources would be provided by librarians and validated by educators, and this age old tradition has been extended through Web-based open and informal online networks, in which learners interact with knowledgeable others outside the formal educational setting.

Linear – spatial experience of accessing information

This web-based networked experience is quite different from the linear structure in formal education, in which the educator uses books and course notes, characterized by linearity of information. Students might flip through pages of books and move backwards and forwards in the book, but this is nothing compared to the interaction available to learners in a networked environment and in ebooks with their digital format, which are currently emerging. In these, hyperlinks provided by others will take learners outside the class room and expand horizons and learning journeys, as learners can make choices about desired resources with the click of a button. It is no longer the traditional source of knowledge, the university, that takes a prominent position in the information behaviour (Pardo & Kloos, 2011) of students, but the learners themselves who are in the driving seat and make choices on the intricate web of nodes on networks that supply their information. The learning environment is no longer linear, but it has become spatial. It has become a kaleidoscope of possibilities and choices and if we think of the human pathway through information as a narrative, one would argue that, like most narratives, a structure is needed which encourages the viewer to interact and pick up the relevant narrative cues.

Yet, unlike narratives in films or books, the content of a course might no longer represent a linear storyline but rather be a space to be explored, as is for instance the case in Massive Open Online Courses (Carroll & Kop, 2011). Ryan researched Virtual Reality (VR) and claimed that VR narratives are not very different from traditional narrative patterns in that one fixed story could emerge in many different ways, depending on how the participant interacts and what path is chosen through the environment (Ryan, 2001). One might argue that the same is happening in the choice of pathways through learning resources. The challenge for education institutions clearly will be who validates the knowledge and information obtained (Bouchard, 2011). But from the perspective of the learner, it opens up new possibilities to follow their interest and to enhance their learning. Institutions might get involved in developing the spatial narratives themselves, for instance by creating ebooks, in which some structure is provided by the institution, but that also include options for learners to follow their own pathway through resources of their choice.

Research methodology

Background of the ibook development

We decided to carry out research into the capabilities of ibooks and how these might enhance the student learning experience, through interaction and engagement, in addition to using written documents in the teaching of first year students in computer science.

This research was funded by the University of South Wales' CELT (Centre for Excellence in Learning & Teaching) Innovation in Learning and Teaching Grants (2012 – 2013) to explore the interactive ibook technology for Higher Educational (HE), and in particular the teaching of the subject of computer architecture – chapter 1 the 'fetch-execute cycle'. As Bem (2003) highlights, there is a worldwide need for better pedagogical methods and tools when it comes to the teaching of the subject of computer architecture. In fact, research shows that H.E. students have difficulties grasping a base knowledge of Computer Architecture (Cassel et al., 2003), (Mirmotahari et al., 2003), (Yehezkel et al., 2011). Our premise was that 'Interaction' might play an important role in enhancing the 'computer architecture' learning experience (Thomas et al., 2012). Moreover, that investigating how new learner-content interaction might be harnessed with the subject in order to encourage students to think deeply about the information they encounter. In detail, to research how the enhancement of an overall learning experience of the subject could help in further development of a quality learning environment.

Developing Interaction, learning and the ibook application

As the first component of the research, an ibook application has been developed using a Learning, Research and Development Framework. The framework was developed in earlier research and is based on Design-based Research Principles (Carroll & Kop, 2011). The Framework has also been used as guidance in the design of the ibook infrastructure to harness a learner-content interaction within the subject of computer architecture (Carroll & Kop, 2011). In conjunction with this, the ibook application adopts a three-levelled structure based on Barthes' Narrative Structure Model (1974). The functions level (section 3 of the ibook) is where the most basic components of the narrative exist. The actions level (section 2 of the ibook) focus on the components and their relationships. The third level (section 1 of the ibook), the narration level, gives us an overview of the 'fetch-execute cycle' (i.e. the overall setting for the cycle). The aim of this is to provide a versatile yet reasonably controlled structure for the ibook; to create a balance between the user's exploration of the content and then the ibook's ability (i.e. interaction) to support this exploration.

As Anderson (2003) highlights, deep and meaningful learning takes place when student-content interaction is supported at a high level and when students are personally active in the interaction, actively engaged with the content. To facilitate this high level of interaction, the researchers designed interaction with the content through many different channels. In detail, interactivity was offered by a range of multimedia (i.e. video, interactive animation, interactive graphics, interactive keynote presentations and interactive quizzes) that were integrated in the ibook (Carroll et al, 2013). For example, video was used to actively engage students with the subject by providing them with different opportunities to effectively break down some of the difficulty surrounding the computer architecture components and the relationships between them. In addition to the video, interactive animation was also used in the book to attempt to detail, define but most importantly bring to life each

component involved in the fetch execute cycle and to animate each step involved in the process. Interactive graphics, Interactive keynote presentation and an interactive review were also all used to encourage the learner to move away from surface learning and to inspire them to interact and fully absorb the material.

Study

This study investigated the Computer Architecture ibook application, particularly in terms of interaction and its potential to enhance the learning process and the understanding of the subject of Computer Architecture. A total of 14 participants (13male and 1female) took part in the study. Their ages ranged from 18 to 50 years and they were all recorded to be studying and/ or had studied the subject of Computer Architecture. For the study, each participant was shown the Computer Architecture ibook application and then asked to explore the ibook application individually for five minutes. After this, each participant was asked to complete a questionnaire to collect quantitative data on their experience and thoughts related to the potential of the ibook application for the enhancement of their learning. In conjunction with this, several open ended questions were asked to provide insight into their perceptions of the ibook on their own learning experience of the subject of Computer Architecture.

From the data collected, it is clear that the majority of participants had a positive view on the potential of the ibook application to effectively enhance their understanding of the Computer Architecture topic. As one student (Participant 1), summed it up… 'this would make a good learning tool for students as it is much more interactive than powerpoint slides and encourages the user to interact with the information on the screen'. In terms of learning, the feedback was very positive with several participants indicating that the ibook application had lots of potential to help them in their learning of the subject:

- I think the ibook computer architecture app is useful as an education tool as it explains all you need to know about the subject with words, images and quizzes. (Participant 5)
- I think that this application would be very useful in lectures and labs. It will help the end user understand the subject or the current topic. (Participant 7)
- It is a very creative app that can be easily used in class room sessions (Participant 12)
- I think it is good to use in lectures because it is easy to use and has good features on it. (Participant 13)
- Yes, I think it will do very well as a lecture notes and learning material. (Participant 14)

When used effectively, technology can play a role in stimulating curiosity (Arnone et al., 2011). In fact, curiosity is a term often associated with intrinsic motivation and has great potential to enhance student learning (Pluck & Johnson, 2011). During this study, when asked if they thought the videos and interactions would stimulate their curiosity and interest to learn more about computer architecture, the majority of

participants (85%) said that it definitely would. Figure 1, shows that the overall experience of the book was very positive.

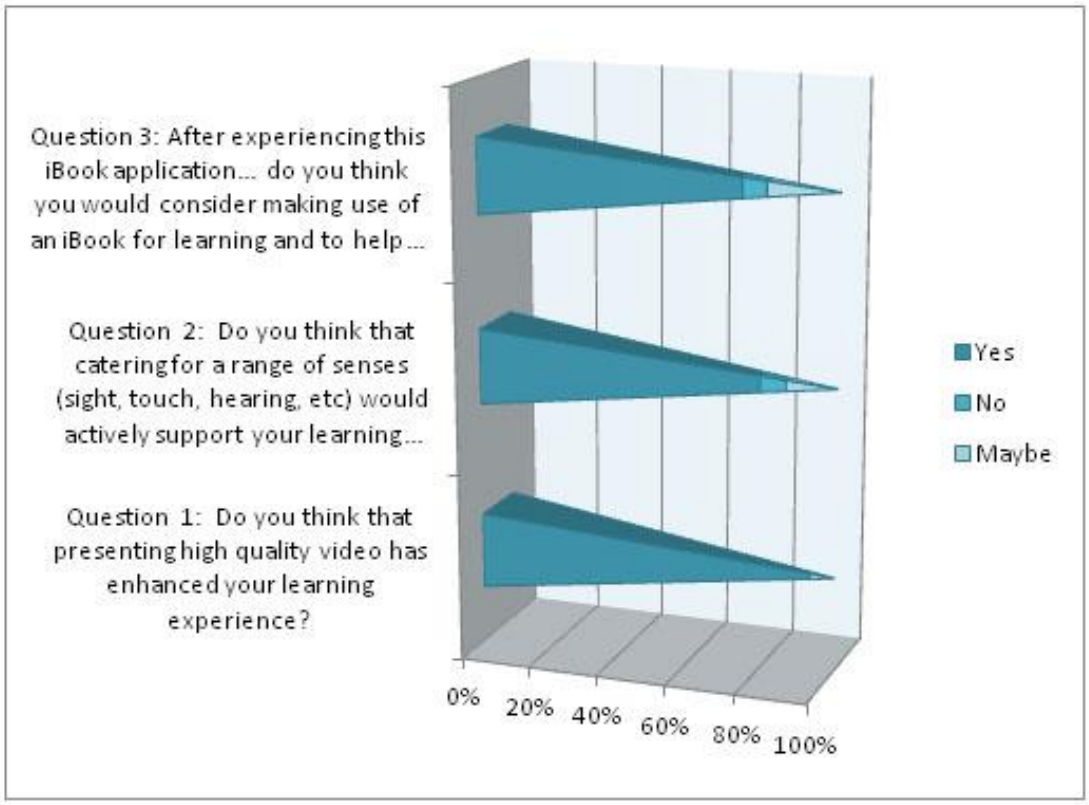

Figure 1 Feedback from study

As Arnone et al. (2011, pg. 182) highlight 'technology can play a role in triggering and addressing personal, situational, and contextual factors that support autonomy and competence and engender active, deep learning'. However, in terms of how the ibook application actually enhanced their learning, participants had different ideas. Some highlighted issues related to the different interactions, particularly the use of different media (i.e. graphic, animation, video etc). Others said that it was the interactive quiz at the end of each section which enhanced the learner's confidence in their learning.

- The app was very easy to use and brief enough to profile all the information necessary (Participant 3)
- Good interactive features to keep user engaged in topic…Uses different memory techniques (sound, picture, interaction) to aid learning (Participant 4)
- I think this app can be used in a lecture as it gives sufficient knowledge of the subject and allows you to test your knowledge through pictures/ videos and quizzes. (Participant 5)

- After using the app I have found it very informative. The app consisted of various components such as interactive diagrams and videos. The videos were very informative and interactive. (Participant 7)
- The app does enhance my knowledge on the subject. The review questions at the end is a good idea. (Participant 9)

Indeed, the use of online assessments (e.g. interactive quiz) is an important aspect of learning new material (Jacobs, 2005). When asked specifically about the ibook review of a section (i.e. interactive quiz after each section), the response was varied. 64% of participants indicated that the facility to go back and check/ redo answers was too flexible and stated they would prefer a little more rigidity. 36% of the participants liked the open book nature of the review and felt it was a good way of refreshing the material before a big exam etc. Only, two participants questioned its ability to completely enhance the learning of computer architecture as they perceived it to be merely a revision tool and would have preferred different levels of questions and interaction for the application to be effective in reaching a deeper level of learning.

Discussion

When comparing this ibook experience to that of the traditional computer architecture textbook, in terms of the actual design and learning, the feedback from many students suggested that it was well structured and completely flexible with an engaging level of interactivity. One student mentioned for instance that the changing of the learning process to one which is more interactive is beneficial to their learning (participant 4). Another student noted that more interactivity would encourage people to read and learn more (participant 5) and that the use of video makes the topics more interesting (participant 8). Even though the sample of students giving feedback on the use of the ibook in the research was small, this study has given us an insight into the ibook application and its potential to teach complex subjects. It showed that with a complex subject like Computer Architecture, it is important to actively engage students with the subject by providing them with a flexible approach to effectively break down some of the difficulties surrounding the computer architecture components and the relationships between them. As Scragg (1991) highlights it is crucial (in terms of computer architecture) to provide students with ‘cognitive hooks’ to enable them to relate the new material to that of previous knowledge/experiences; he believes that these connections will add much value to their learning experience. As we have seen, it is also essential to establish a coherent narrative structure within the ibook which encourages the learner to interact and pick up these ‘cognitive hooks’ as they explore the learning material. From the study, it is clear that by presenting the learning material across a coherent yet flexible and spatial structure in a range of multisensory formats, that students are encouraged to use different memory techniques to aid their learning (Participant 4). As previously discussed, the emphasis on the material and its rightful place within the learning experience is essential, as the research results suggest students found the ibook a useful education tool as they were provided with everything they needed to know

about the subject framed through many different interactions with words, images and quizzes (Participant 5). Through interaction (i.e. video, animation and interactive quiz etc.), several participants perceived that the multifaceted nature of the ibook application has the potential to help them (i.e. instil them with a curiosity) to engage with the content and in doing so, it seems 'invest something of themselves' in the learning process.

Conclusion

The basic principles of computer architecture play a role in the core of most H.E. Computer Science education. Without a solid understanding of computer architecture most computer science students will have a fragmented knowledge of how a computer operates (Bem, 2003). Therefore, from the start, the aim of this research has been to address some of the conceptual challenges surrounding the student's understanding and learning of the subject of computer architecture. Throughout the research project, the key in engaging students was the triggering of the student's inner motivation for learning; using mobile technology and in particular interactions and spatial multisensory experiences, in order to intrinsically motivate students to become active learners who seek to understand and learn. By breaking away from descriptive chapters/ lesson plans of the traditional Computer architecture text book and injecting learner-content interaction as well as intellectual engagement back into the learning of the subject, the study has shown that the ibook has the potential to address some of the difficulties students are experiencing with the subject. As we have seen, interaction and engagement were two terms used in participant reflections on their experience of using the ibook application. As one student says 'I think ibooks will change the way we learn primarily due to its interactive nature. It is much easier to learn when you can interact with your knowledge source'. By giving students access to an engaging, interactive and flexible educational ibook application that allows them to 'invest something of themselves' in the experience, the researchers believe that an opportunity is created to reshape not only the learning but also the teaching of Computer Architecture on a global scale.

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