Technology, Pedagogy and Digital Production:
A Case Study of Children Learning New Media Skills

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Abstract

This article presents an analysis of data from a project which investigated children and young people's learning of digital cultures in informal settings in Britain. The project aimed to build links between young peoples' leisure and learning experiences, by engaging with the content and styles of learning connected with digital cultures in homes and community centres. The focus of this article is on a computer games making course for young people age 9 – 13. The article looks specifically at issues around technology and pedagogy. Questions are raised about types of software used with this age range, and the article includes a discussion of the models of learning which describe young people's interactions with digital cultures.

Introduction

With production tools coming bundled as standard software on computers, and new open source software providing further easy access to production activities, many young people are producing digital texts in different forms. Increasingly, educators are recognizing the potential for digital media production to meet different learning styles, motivate students and address important social and cultural aspects of children and young people's learning. Research has considered various educational projects, ranging from recording and editing movies with three year-olds (Marsh, 2004; Nixon and Comber, 2005) through to integrating blogs and wikis into classroom activities (eg. Williams and Jacobs, 2004; Désilets and Paquet, 2005; Merchant, 2006). Furthermore, whilst media studies educators and researchers have been immersed in teaching literacies connected with media for many years, researchers in the field of 'new literacy studies' have considered how to address different languages and processes in new forms of text (Kress, 2003; Lankshear and Knobel, 2003). The challenge being presented to educators is not only to consider where to integrate media production in the curriculum, but also how and

what to teach in relation to media production skills. Studies of practices in secondary schools in the UK have described how teaching digital production is raising questions of pedagogy; for example, considering macro-level languages for different media genres, reflecting on issues of aesthetics, addressing different learning styles through different elements of digital media production, and considering when intervention is needed and when technology can scaffold learning (Reid et al., 2002; Burn and Leach, 2004).

One of the difficulties for educators is the way debates in relation to children and digital media obscure issues around learning and technology, and therefore create contradiction and confusion concerning pedagogy (Buckingham, forthcoming). Debates have different and sometimes contradictory ways of constructing learners and the learning environment (Facer et al., 2001). Popular discourse which positions children and young people as being at risk from the dangers of digital technology imply that technology needs to be carefully taught and controlled, as children and young people are unable to learn the correct and safe way to use digital technology on their own. In complete contrast are discourses around new technologies which position children as ready learners and technology as offering endless easy-to-use resources for worthwhile learning. This latter view of children as 'natural cyberkids' overlooks many aspects of learning and digital technology, not least the socio-cultural aspects of learning or the possibility that there might be a developmental progression of skills related to learning new technologies.

These debates are echoed in the various pedagogical approaches to children and digital technology. The model of learning known as 'constructionism', developed by Papert and colleagues at MIT (see Kafai and Resnick, 1996) in relation to children learning Logo, a simple a computer programming language, has elements of the 'natural cyberkid' discourse mentioned above. In this theory children are positioned as innately inquisitive, thus making computers a natural playground for exploring and developing their minds. Researchers working with Logo and similar programming packages for children (Papert, 1993; Kafai and Resnick, 1996; Hoyles et al. 2001) see learning as a process which is not as linear and sequential as strict developmental models would describe. In studies which draw on constructionist models of learning, children are described as learning

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programming through their exploration of software. This is a recursive process, as Goldstein and Pratt write, 'As learners become familiar with the tools, they become aware of new opportunities and utilities of those tools. Through using the tools, the learners re-construct their understanding of them. This shapes the way that the learners think about their solution to the problem and the problem itself' (2001, p. 2). Here the focus is not on the cognitive potential of a learner, but rather the context of learning and the processes involved in constructing something - an object or a theory, for example. It is through a process of self-directed learning, expressing ideas and testing them out, that learners construct meaning.

On the other hand, popular pedagogies found in many schools are based on linear developmental models that define levels which children progress through given the appropriate environment. Cognitive constructivist models recognise the role of the learner as actively making sense of learning environment, progressing through developmental stages as they interact within learning environments. The work of Vygotsky (1962) discusses the role of verbal interactions in learning. Social constructivism, a model of learning based on Vygotsky, emphasises the important role of a more able peer or teacher ~~who is scaffolding learning and acting within~~ in assisting a learner's development. Using Vygotsky's terms, each child actively participates in learning within his or her 'zone of proximal development'~~.~~, that is, the distance between the real and potential levels of development. According to Vygotsky, as the child engages in his or her learning, and with assistance, modelling of actions, and pointing out of discrepancies, particularly through verbal interactions, the child internalises desired actions. Bruner (1987), whose work is based on Vygotsky, used the term 'scaffolding' to describe the interactions whereby structures are put in place to support the learner in mastering a task. Importantly, scaffolding must build on a learner's existing schema in order for new information to be understood and for the learner to be able to apply, synthesise or generalise beyond given information. Effective scaffolding, then, occurs within the learner's zone of proximal development and is gradually withdrawn (or 'faded') as an action becomes internalised.

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One of the most explicit examples of how these theories have been applied to the teaching of media is in the British Film Institute materials (2000, 2003) which divide media education skills into different developmental levels (referred to in the materials as stages in 'becoming cineliterate'). The BFI materials are based on a constructivist notion of learning and teaching: children progress through a sequence of stages of development, and as educators we can recognise and help develop the knowledge and skills that are required at each stage. One of the questions raised by the BFI materials concerns evidence for the stages and skills outlined in the teaching packs. How do we know what knowledge and skills are involved in 'becoming cineliterate', and more importantly, are knowledge and skills developed in the order which is prescribed in the packs? More research is needed, particularly in the area of media literacy, to see how children develop skills, what skills and knowledge are being developed and the role of formal education in this process.

Finally, with the learning of digital technologies taking place in informal settings such as homes, there has been considerable interest in contextualising learning and looking at different styles and forms of learning (Lave and Wenger, 1991; Coffield, 2000; Gee, 2004). Lave and Wenger's concept of 'situated learning' considers learning as a type of social interaction, rather than a cognitive activity. In this theory, members of a 'community of practice' are brought together by a common activity centring on an area of knowledge. Because the community is built on common activity, learning involves relationships, the construction of an identity in relation to the community and the development of particular practices (shared ways of doing things). Using the term 'legitimate peripheral participation', Lave and Wenger examine ways learners join a community of practice on the periphery and gradually move toward the centre of the community as they become involved in the practices of that community. This concept has been applied to the learning digital technology and cultures in spaces such as social networking sites, as young people immerse themselves in the language, skills and discourses of communities online (Davies, 2006; Leander and Frank, 2006). The research in this area often celebrates online learning and collaboration; however, one might want to ask about power relations which are enacted in these environments, how

relations of inequity are being rehearsed rather than challenged, and what happens when a member of the community does not want to take on the identity on offer or wants to challenge the practices of the community. Again, further research into the social contexts of the learning environment needs to be considered.

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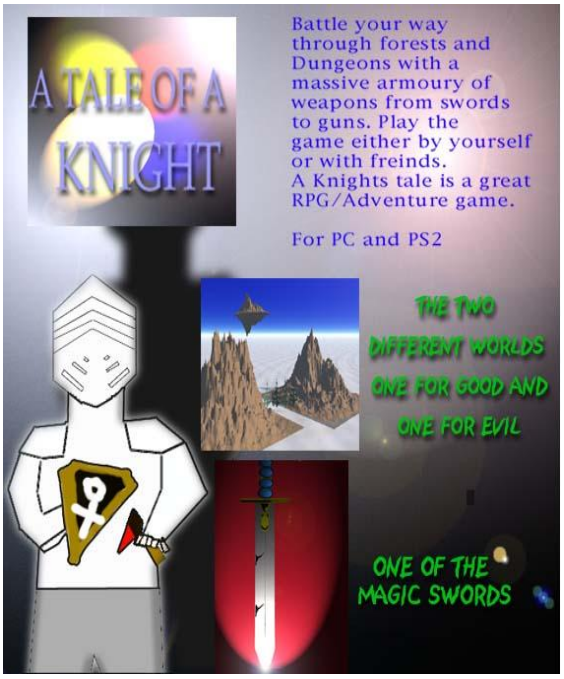
The study discussed in this article, 'Shared Spaces: Informal Learning and Digital Cultures', was designed as a way of engaging with and examining some of these discourses surrounding learning and digital cultures by looking at how children and young people use digital technologies in more 'informal', out-of-school settings. Its aim was to develop ways for schools to engage with the new knowledge and experiences digital culture can offer young people, as well as drawing on the informal styles of learning which characterise young people's out-of-school experiences with technology. The research was based on what is now a typical media education premise: as children spend time engaging with digital cultures, they learn how to be proficient in these domains 'informally' and that in addition to this proficiency, they build up a substantial amount of knowledge about these media and experiences, however this knowledge only exists informally – as a sort of latency (Buckingham and Sefton-Green 1993). This research project was established to examine how this presumed reservoir of informal knowledge might be accessed and whether it could be transformed by being applied in *production-based* situations.

The data was collected at an informal education and arts centre in north London which runs various arts activities on weekends for the young people from low income families. This article focuses on one curriculum initiative established on the project, a games making class for children age 9-13. After a brief description of the class and the study, the article discusses issues around technology and pedagogy which are highlighted by the study. The article argues that current approaches (constructionism, constructivism and communities of practice) are all helpful in explaining learning in relation to technologies. However, each approach also ignores many factors in learning, leaving open questions about pedagogy and digital technologies.

The study – learning and making games

The games making class which will be discussed in this article was established with the aim of seeing how game *production* could be used as a way of engaging with young people's experiences of playing computer games. The games class had ten participants (all boys from mixed socio-economic backgrounds), and it ran over the course of one academic year, meeting Saturday mornings for two hours. The tutor was a games player herself, and worked freelance as a graphic designer and software instructor. The class had four elements: analysis and critique of games, designing games and game products, learning software and creating games projects. The poster in Figure 1 demonstrates different elements of the course.

Figure 1. 'A Tale of a Knight' advertisement



Specific elements of the poster will be discussed throughout this article, therefore I will elaborate briefly on the purpose and production process here. Three boys produced this poster, approximately one-third of the way through the course. The boys used two pieces

of software – Photoshop to compile the poster and to create the text, knight and sword; and Bryce 3D for the image of the two worlds. Each boy produced a different image for the poster and then they combined their images and composed the text and final composition together. The poster was included early in the sequence of activities of the class to give the participants a project to which they could apply their skills (graphic design, analysis of game images and genre, and learning of software) and as a way of developing ideas and images they would be using for other projects later in the course.

The researcher (the author of this article) was present for all the sessions of the course, taking field notes, collecting voice recordings of various interactions, helping with basic skills and collecting visual images created by the participants. Individual semi-structured interviews were conducted with the participants and the tutor at the end of the course. The observations and recordings of interactions provided particularly useful data in relation to different pedagogical models – for example, capturing moments when the tutor working one-on-one with a participant to talk through a particular problem with a design, when the experiences of the participants as games players entered conversations, and when trial and error approaches to the software were used by the participants. The interviews were used as a way of clarifying and adding to the observations and the visual data by discussing the learning that occurred (evaluation of software in terms of learning, strategies they tried when working with software, recommendations for a similar class, evaluation of different components of the class).

The analysis in relation to this class focus on how young people learn in relation to new media, what 'informal learning' looks like in practice, and how young people move from being 'consumers' to being 'producers'. Although the class was taught in an informal learning setting, there was a mixture of formal instruction and content and informal interactions and knowledge. The posters as well as the final games projects required use of professional production software (Photoshop for editing images, Flash for animating and making interactive elements, and two 3D software packages). This aspect of the course raised questions about our original aim of looking at informal learning, because the software skills were actually being taught in a formal way (see Sefton-Green, 2003).

As indicated in the introduction, the premise of the research was that young people were learning digital cultures outside formal school settings, possibly incorporating new forms and styles of learning. During the analysis phase, it became clear that several different models of learning were relevant in explaining the data. The analysis, therefore, mapped out the different data components in terms of theories of learning discussed in the introduction. For the purpose of this article, the focus will be on how different models of learning explain these varying components of the learning environment, and specifically how models work in relation to digital media. The next section of this article discusses issues related to pedagogy and technology, including how the study relates to the various debates and models of learning outlined in the introduction. The article ends with an analysis of problems which arose in relation to the software being used in the games class.

Technology and pedagogy

As described in the introduction, the 'natural cyberkid' discourse constructs young people's relation to new technology as unproblematic. In this view, through access to digital technology (with or without instruction) young people will learn to use powerful software that will allow them to do many creative things (as well as develop various useful skills). There is an implicit assumption that pedagogy is not important, and therefore the role of teachers in learning new technology is not discussed. However, difficulties encountered on the games class (which will be discussed in the next two sections) point to a need to consider pedagogy. If software requires formal instruction, not just trial and error, in order for it to become a creative tool for young people, then pedagogical issues arise. If there is a series of developmental stages in relation to learning technology, then pedagogy needs to be considered. And finally our goal of accessing young people's knowledge as consumers of games through particular pedagogical means needs to be examined.

The tutor had a basic plan which involved a series of sequential activities and constant application of theory and knowledge through practice. The tutor engaged the kids in critical analysis of computer games they play. She taught the software step-by-step to the

whole group and then gave individual help. She used her own experience of gaming and using software to model and give advice, and she tried to make connections between practice and theory by referring to games when the boys were learning software. These are all characteristics of what one might describe as good teaching. However, the boys did not learn as much as the tutor thought they would, and so she modified her goals. The important question is why the boys did not learn as much as the tutor had planned.

Some of the problems relate to the characteristics of informal educational settings (eg. erratic attendance). Various factors endemic to informal education made it hard for the tutor to plan lessons and teach them in a sequential, orderly way. However, the tutor thought the difficulties in learning were also due to the boys: they were not working hard enough, they were not committed to the projects and they did not spend time practising using the software. In her opinion the boys would have learned if they had shown more interest – an opinion which strikes a chord with the 'natural cyberkid' discourse mentioned earlier.

The constructionist model discussed at the beginning of this article would suggest that if the participants had more time with the software they would have developed their skills by applying what they already know, trying new ideas and skills, and then adjusting their ideas and understandings. Some of the observational data can be explained using this model. For example, in Photoshop the boys used their previous knowledge from any basic drawing software (Paint, Kid Pix, etc.), and they found it easy to use certain tools to alter to images. They could use simple drawing skills to get started fairly quickly, and the filters (available in familiar pull-down menus) gave the boys ways to make their hand-drawn images look more sophisticated. Using simple filters, Lawrence (age 12) gave his hand-drawn sword in Figure 1 dramatic lighting effects (the background, the glinting tip, and the sunspots). The pull-down menus were scaffolding Lawrence's learning: he was familiar with this type of interaction and therefore was able to experiment with different functions in Photoshop to produce his image and develop his concept of graphic design – in this case, how to create a dramatic effect.

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However, Jordan (age 9) struggled even with the basic drawing tools, as is evident in his drawing of the knight in Figure 1. He found the concept of layers difficult, and he only used the pencil tool on the software, changing the colour and thickness but nothing else. When Jordan was taught to use other tools, he was not able to 'take on board' what he was being taught, indicating that perhaps the teaching and software were too advanced for him. For example, Jordan wanted his knight's armour to look shiny, so he was shown how to change the lighting and opacity (see the bottom part of the knight). Jordan then forgot to save the changes that he had made, and when he tried to repeat what he had been taught (the same day) he was unable to proceed. Of course there were other circumstances which could have been affecting the Jordon's learning (for example, lack of practice time during the week and erratic attendance), and therefore it is difficult to say if the teaching or software were generally too advanced. If Jordan were shown again how to change the lighting, and if he practised it several times over the course of a week, then he probably would have had more success.

Another obvious factor in looking at Lawrence and Jordan's learning was their age and previous experience. Lawrence was older and had more experience with and access to digital production activities than Jordan. Lawrence said he used computers at home and school, and he was able to list software he used (Cubaris and VST); whereas Jordan did not mention using computers at school, could not name any software he used and only mentioned using computers for playing games and accessing the internet. Lawrence's previous experience meant he was experimenting with the software on a different level than Jordan; in fact, the software scaffolded Lawrence's learning more effectively because it built on his previous experience. However, we might also ask whether there is a biological developmental factor affecting the different skills of drawing, conceptualising image, and understanding software. This is, does the fact that Lawrence is older than Jordan also contribute to different levels of engagement?

Using the constructionist model, the key is finding the right 'construction material', in this case, finding software which will allow exploration and application of previous knowledge. Kafai and Resnick (1996) analyse learning in relation to Logo-based

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software and argue that learning depends on both the structure of the software and the developmental stage of the user. Similarly Gee (2004) argues that structures on gaming software scaffold learning, providing progressively more challenging tasks to the player. However, as observed in the games making class, novices are unable make use of the structures until they are at the appropriate stage in their learning process (for example, when they realise that things need to be organised in a particular way).

Using a Vygotskian ~~terms~~model of learning, the problem with the tutor's instruction was that she did not find out where the boys were, in terms of software skills, and so she did not build on their knowledge and engage with them within their zone of proximal development. Some of the instances of learning which almost 'jumped' out as significant moments happened at opportune moments when the learners where just at the level where they could take on new knowledge, and when the instruction was building on what they already knew. For example, when the boys tried to do something such as changing the size of their background or making curved lines, they would often figure out a way to achieve the effect, but generally it was not the most effective or efficient way. When the tutor then showed them a better way to achieve the effect, her instruction was maximised. At these times, the learners were able to incorporate that particular skill into their schema and apply it to new situations. There was a context for the instruction both in terms of the purpose and the tools (the boys had a goal and had already tried some tools to achieve their goal). This data suggests that scaffolding by a teacher or more knowledgeable tutor/peer is crucial to the learning process.

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However, there were other times in the games class when the tutor spent significant amounts of class time giving one-on-one help, trying to scaffold the learning, but in doing so she created a situation in which the boys were often waiting before they could receive help. During that waiting time they were repeatedly trying to figure out how to do something, to the point of frustration. This strategy was thus counter-productive. A model of learning based on scaffolding perhaps indicates that time and energy (and ultimately enthusiasm) is wasted if instruction does not happen in the right way at the right time. More importantly, if a learner's schema or scaffold is not extended, the

learner is unable to use new information and generalise beyond given information. That is, learners are unable to construct new ideas if the given information is not based on existing understandings and perspectives. This points to the importance of choosing software which is flexible in terms of space for more advanced students to progress, but also structured in a way which will allow independent exploration along side instruction and guidance.

The use of 3D software in the games class illustrates problems with using particular kinds of software, and also opens up questions about other models of learning. As can be seen in the image of 'the two different worlds' in Figure 1, the class had access to Bryce 3D, and they also used Poser for creating 3D images of people for their final projects. For most of the boys the 3D software required almost no instruction, so they were able to explore the software, achieving instant satisfaction with very little effort. The software offered what seemed to them to be major progress towards a game, and they could use the software independently to create images. However, because the images looked so sophisticated, the boys were too intimidated to use other programs for drawing. The most significant problem with using the 3D software was that it was hard to import and manipulate in other programs (Photoshop and Flash). The game production which the tutor had imagined involved creating images and then assembling, animating and making elements of the images interactive. Combining images from different programs complicates this production process. Even the posters (assembled in Photoshop) included many imports from various sources which needed to be formatted and arranged, and this assembling required one-on-one instruction. This instruction often did not result in them mastering the concept or procedure (for example, the boys were not able to do the formatting independently after the one-on-one help).

However, although skills may not have been learned, the tutor was introducing the boys to the world of graphic work on professional software, much in the way Lave and Wenger (1991) discuss situated learning through 'peripheral participation'. The tutor would regularly give general advice such as 'try to leave as many windows open as you can', 'try to label each layer with a name that describes what's on it'. She also made

general conceptual statements; for example 'the machine allocates memory to every single application, so it will run much quicker if you close applications you're not using'. She used technical terms such as bitmaps, jpegs, tweening and megabites and discussed concepts such as layering, different types of files and relevance of file sizes. There is an enormous body of skills, knowledge, concepts and discourse that needs to be learned here. As the tutor used the discourse the boys gradually developed an understanding of the field (especially the older boys). At the end of the year, when Lawrence was asked about the most difficult part of the course, he said, 'you need to be consistent…getting different files right and making sure they're small sizes but not too small'. In this statement Lawrence is demonstrating his broad understanding of working with different software packages which he gained through an immersion into this practice.

The games class was seen by the arts centre as a pilot project, and the class was repeated the following year with several revisions. A significant fact is that almost all the boys returned for a second year, and several new children joined, including two girls. This simple fact perhaps indicates that my interpretation of the level of frustration which the boys were feeling was overstated. I may have been looking for 'completed learning' at too early a stage. If this is the case then we must look for other models and styles of learning to explain the findings of this study.

Lave and Wenger (1991) argue that there needs to be a shift away from the concept of an individual learner and that notions of mastery and pedagogy must be decentred. They write, '[R]ather than learning by replicating the performance of others or by acquiring knowledge transmitted in instruction, we suggest that learning occurs through centripetal participation in the learning curriculum of the ambient community' (p.100). Gee's work (2004) similarly discusses the role of the social environment in learning, outlining the concept of 'affinity spaces' as places where people with similar interests and goals come together to share knowledge. Therefore, instead of looking at the individual skills that each boy developed (or failed to develop) in the games class, we could look at their learning as a process of interacting in a (pseudo-) games making environment in which they were gaining familiarity and learning to use the software through a gradual process

of experimentation. The fact that the majority of the boys returned the second year indicates that they were interested in developing the community, perhaps moving away from the periphery and developing an identity as an experienced media producer as new members joined the group.

Another non-sequential approach to learning is taken by researchers looking at computer game playing. Similar to the constructionist viewpoint, Gee (2004) argues that learning in game playing is effective because skills are acquired in the context of an activity rather than through abstract exercises. In our research and, one might propose, in the experience of anyone watching a child learning to play a computer game, there are few times when children will sit down and be given step-by-step instructions by a tutor or instruction booklet. Children start playing a new game with little instruction, and they learn as they play. Toni Downes (1999) argues that playing games is producing new styles and ways of learning. Downes writes, 'Within game playing the continued success of using the 'learning by doing' and trial and error approaches alter children's predisposition to learning and performing in similar environments…Importantly these computing environments, through their interactivity readily afford these approaches and therefore reinforce this pre-disposition towards exploratory modes of learning' (p.77). Looking at this description of learning, we could say that the boys on the games class did not need the sequential instruction of the tutor, especially as they were all avid game players who were accustomed to learning through trial and error. We were asking the boys to apply their skills and knowledge of playing as they engaged in digital production, but in expecting a linear model of learning we overlooking an important gaming skill – learning by doing.

One obvious question raised by the games course both during the pilot and the following year is whether it is possible to produce games with young people. The children were more successful the following year for various reasons (eg. Flash was the only software used, the community of learners was developing), however, the projects during the pilot and the follow-up year can not be classified as games. The fly-through introductions from the pilot year are actually animated narratives, not games. The aim of the study was

to engage with kids' knowledge of the games they play at home through the production of games, but we ended up focusing on learning software and discussing graphics. A course using alternative software (Logo or Stagecast) would focus on learning the logics of programming, and similar to our games class would miss out on engaging with kids' gaming experiences.

Issues raised by the use of professional software

As already mentioned, one of the major issues highlighted by the course concerns the choice of software, especially with this age range. Because professional software was being used, a large section of the course was spent teaching the software skills (e.g. constructing layers, using various filters in Photoshop, doing frame-by-frame animation in Flash). In the end, the final projects were hampered by the complicated nature of the software. There are other packages available such as Kid Pix, Hyperstudio or Stagecast which are produced for children. Using these packages would have resulted in different types of final projects. Stagecast, for example, is a game production software for children, but it can only produce platform games.

The choice of software used in the games class was intended to leave open possibilities for the boys to produce the type of game they wanted, based on their knowledge and preferences as gamers. However, the final projects were not interactive, as one would expect from a game, and in the interviews the participants indicated that they would have modified their game design to suit a particular piece of software (Flash), had they known how difficult the combination of software would be. Therefore, in practice the professional software actually limited the production of games because the software was so advanced, particularly when the packages were combined (e.g. 3D images from Poser were animated in Flash). Because the 3D software made it easy to produce images that are much more like the high-quality graphics in games that many kids like to play, the software started leading the designs of the final products. Paradoxically then, although the aim was for the boys to design a game (without being restricted by a determined design built into specific software packages), the end result was still that the software led to a particular type of product.

Both the tutor and the boys who were interviewed at the end of the course recognised that it would have been better to stick with Flash (which is two-dimensional) and drop the 3D software. Jake said, 'Flash makes it simpler; with other software you have to keep putting it into different files, whereas in Flash you can just animate it and make it and just run it'. In independent interviews, Jake and Lawrence said that Flash was their favourite software because 'it's quite easy to make cartoons, it's a really good drawing tool' and 'it's easy to muck about with it'. Jake said, 'I think you need to be taught the basic stuff but then you can learn the rest'. This is an important learning outcome for the boys, and certainly the tutor tried to persuade the boys to use more Flash, but they seemed to need to get the 3D images 'out of their system' and learn through experience. Furthermore, going through the difficult process of using 3D images led to an understanding of why games that they play cost so much and take so much time to produce. This is another important learning outcome when considering how to develop young people's understanding of digital media. It is also significant that the other boys (besides Jake) who had experience with Flash from the previous year did not use it in their projects, apart from when the tutor helped them. The skills they learned seemed difficult to apply to the task set (designing the animated introduction), and the software did not help to access their knowledge about high graphics games (which they were designing). The key finding here is that there was a mismatch between the task and the software available.

Several factors prevented the boys from reaching the point of being independent (they were not using the software apart from a couple hours a week, many were young and inexperienced with different software, they had little experiencing conceptualising graphics, and the tutor may have been using an approach that was not effective). The course introduced the boys to the software, but (unlike software designed specifically for young people) the software is not scaffolded enough to allow young users to explore and learn independently. The software does not have a beginning level which introduces concepts and allows the user to gradually learn more technical aspects. One of the questions this study raises is whether there should be a range of software which suits different developmental levels or whether software preference is more about the users'

learning style and mode of thinking. If we accept that software should have different developmental levels, this leads to questions about what cognitive skills are involved in using production software. Could we call the use of simple paint tools part of the first stage of development for young people using graphics programs, and if so what skills and concepts are being developed at this level? Is there a set of visual literacies that needs to be learned in order to use graphics programs? For example, in the image of the sword (Figure 1), how did Lawrence learn to conceptualise what he was imagining? With the image of the knight, when Jordan said he wanted the armour to be shiny, the tutor explained that he could 'give the appearance of shininess' through lighting and opacity. It is unclear in our study how this element of production, being able to imagine and then conceptualise a particular image or effect, is learned.

Conclusion

The study, perhaps, raises questions rather than providing answers. It is clear, however, that children and young people are experiencing various ways of learning through their consumption and production of digital cultures. Computer games, for example, can involve endless repetition, trial and error and risk taking in their consumption, as well as in their production, as this article has described. However, gaming can also involve careful scaffolding. When playing a computer game, the first level is easier than the other levels and sometimes includes auditory or visual hints on how to progress. Similarly, as described in this article, digital production requires some degree of scaffolding in order for users to make progress and avoid frustration. This is an important contribution to debates about which celebrate children's media production.

The problems encountered in the computer games making class as described in this article raise questions about the relationship between knowledge and production. For example, what kinds of knowledge are needed in order to engage in production, and how is that knowledge developed? Is it possible for young people to produce the games they themselves play, and if so would that production process engage in the critical analysis we are hoping for? As explained earlier, our aim was to use production as a way of accessing the boys' knowledge of games which they acquired through game playing, to

make that knowledge visible and somehow to involve a critical framing of that knowledge. Instead, what ended up happening was that the production tools disempowered the boys, making their knowledge of games fairly useless. Although the tutor continually reminded the boys that the high graphics videogames they play (Tomb Raider, Grand Theft Auto) involve many years of development and expansive budgets, the boys still had quite high expectations about what they could produce. This is an important contribution to the debate about the role of production in media studies. We need to find the tools which will allow us to empower students; tools which will make visible the embedded knowledge of their media culture. Furthermore, we also need to consider when to use a model of learning based on a developmental progression of skills related to production, or when to see young people as learning technology through immersion into the digital culture.

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