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Full Length Research Paper

Blended learning model in mechanical manufacturing training

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Blended learning is increasingly prevalent and it is vital for higher education and corporate trainers to create strategic plans focusing on blended learning techniques to benefit from this teaching and training model. A qualitative study was carried out using an interview technique with a trainer who applied a blended training model in a vocational organisation. The aim was to determine whether blended learning is effective in mechanical manufacturing training. The results indicate that blended learning can play a vital role in vocational training settings in educational organisations and workplaces. The approach can be used for vocational training based on skill development for manufacturing and production areas at any level. Implementation of a blended learning model in a very specific vocational education field (mechanical manufacturing) has demonstrated that the approach is very useful if designed well.

Key words: Blended learning, blended model, mechanical manufacturing, vocational training.

INTRODUCTION

Blended learning is gaining widespread acceptance on a global basis, but a generally accepted definition has not emerged yet. Scholars outside of education have approached the meaning of blended learning from a scientific angle, drawing on connections of the term to biology and botany. Sands (2002), for example, noted that since the word hybrid refers to the offspring of two different, genetically dissimilar parents, teaching and learning in this framework must also involve the successful joining of opposing parts – online and face-to-face methodology. Building upon this metaphor, Osguthorpe and Graham (2003, 227) described blended models as 'pedagogies that change according to the unique needs of learners. Those who use blended learning environments are trying to maximize the benefits of both face-to-face and online methods – using the web for what it does best and using class time for what it does best.' Therefore, according to the definition adopted here, blended learning is a hybrid that integrates traditional in-class sessions and e-learning elements (Reay, 2001; Rooney, 2003) in an attempt to combine the benefits of both learning forms. Graham (2006: 5) summarized three definitions of blended learning: (a) a combination of instructional delivery media; (b) a combination of instructional methods; and (c) a combination of online and face-to-face instruction. The third definition is the one adopted here since this is a more accurate reflection of the actual development of blended learning. The criticism that online teaching and learning environments lack many of the advantages of face-to-face environments has led to the notion of blended learning.

Blended learning has been described as integrated learning, hybrid learning and multi-method learning. However, the term blended learning is increasingly used in both academic and corporate circles. According to some authors, written language is the first example of a blended concept since it is a combination of language and paper. In this context, the printing press is the next stage. However, what we regard as blended learning here is the definition of the Flexible Learning Advisory Group (2004): blended learning comprises learning methods that combine e-learning with other forms of flexible learning and more traditional forms of learning, such as classroom training (Stockley, 2005). Bersin (2004) outlined the evolution of learning from the traditional classrooms of the 1950s through to the current

blended learning environment. The last stage is integrated blended learning, which includes web, video, audio, simulation and information and learning technology approaches. Blended learning in this sense is a recent online innovation resulting from the integration of technology in education. Advances in technology and changes in teaching and learning approaches (from teacher- to student-centred) facilitates the emergence of new models such as blended learning to come out. Watson (2008) suggested that blended learning involves a shift in strategy in three areas: from teacher-centred to student-centred learning, from limited to high-frequency interactions between students and resources and from intermittent to deliberate integration of formative and summative assessments.

In fact, educators have been preoccupied with integrating technology into the classroom for decades (Dziuban et al., 2004). Rapid changes in technology in this century have revealed that students have an enormous capacity for change, so educators should embrace 'the new digital reality of the online, computerized world' (Jukes, 2008: 6). According to Young (2002), 'Within five years, there will be lots of blended models such as students going to school two days a week and working at home three days a week. Another blended model is where a student takes five face-to-face courses at school and two virtual courses' (cited in Picciano and Seaman, 2009: 5). In 2002, Prof. Bourne stated: 'within five years, you will see a very significant number of classes that are available in a hybrid fashion …. somewhere in the 80 – 90% range' (cited in Young, 2002). Buckley (2002) and Barr and Tagg (1995) noted a paradigm shift in higher education leading to new models of teaching and learning. We are currently embracing rapid changes in Internet technologies that in turn suggest that blended learning should become an integral component of education (King, 2002).

DESIGN OF BLENDED LEARNING ENVIRONMENTS

Blended learning can occur at different levels of instruction: (a) at the activity level, when a learning activity contains both face-to-face and computer-mediated elements; (b) at the course level, which is the most common, where both face-to-face and computer-mediated activities are included as part of a course; (c) at the program level, when participants take both online and face-to-face courses in a program; and (d) at the institutional level, with organizational commitment to blending of face-to-face and computer-mediated instruction (Graham, 2006). When designing a blended learning environment, the first stage is allocation of some of the blended subject matter as face-to-face and some as online. The more common blending technique usually comprises 50% face-to-face activities in a classroom environment and 50% activities performed in an online environment (Osguthorpe and Graham, 2003) . According to Rossett and Frazee (2003), instruction tools and planning approaches are crucial components for successful blending, and all components of a particular instruction method must be appropriately combined. A blended model includes certain educational components. However, teachers have a wide range of options for blending and are not only limited to applications and activities previously known and used. Education might be a combination of formal and informal approaches, technology- and human-based activities, independent and enjoyable activities, or direct and exploratory materials. According to Reay (2001), blended learning is not just the addition of online materials to a conventional training environment; blended learning must be relevant and requires a holistic strategy that utilizes the best characteristics of all learning interventions. The methods and techniques selected should be appropriate for the subject. Successful implementation and use of blended learning requires an understanding of the strengths of different media, how learners engage in this type of learning process, how they use information from each different medium, and how they can handle online and traditional (face-to-face) teaching methods in a combined form (Mortera-Gutierrez, 2006). Three major components of blended learning that can be blended or mixed in face-to-face and online environments are learning activities, students, and the teacher. As reported by Osguthorpe and Graham (2003, 229): 'If balance and harmony are the qualities that are sought for in blended environment, one must first identify precisely what is to be mixed together.'

Garrison and Kanuka (2004: 97) noted that true blended learning lessons do not involve supplementation with the Internet two or three times a week, merely layering repetitive online content on top of face-to-face instruction, or dressing up old content in new clothes. In their estimation, blended learning is a 'reorganization and reconceptualisation of the teaching–learning dynamic'. Elements from e-learning or in-class sessions should not be included arbitrarily, nor should one form of learning simply accompany the other. There is no rule of thumb determining the percentage of online and in-class phases in the concept (Reimer, 2004). Some fields are better suited to in-class methods, whereas others clearly benefit from the use of new media (Lang, 2002). The decisive factor in developing blended learning concepts is to combine in- class and e-learning methods in a way that is appropriate to both pedagogy and current concepts of learning (Lang, 2002). Based on the practical question of how to blend, three categories for blended learning systems exist:

1. Enabling blends, which focus on addressing issues of access and convenience.
2. Enhancing blends, which incorporate incremental changes to existing pedagogy such as offering resources

and supplementary materials online while in a traditional face-to-face learning environment; and
3. Transforming blends, which facilitate radical transformation of pedagogy by taking full advantage of the capacity offered by technology (Graham, 2006).

According to Zukowski (2006), five emerging ingredients are important elements of a blended learning process: live events, self-paced learning, collaboration, assessment and performance support materials. Painter (2006) listed eight key steps to blended learning:

1. Prepare learners with essential skills and overall understanding to ensure success.
2. Inform learners about objectives, facts, and key concepts of the skills they are going to learn and explain the value of learning them.
3. Demonstrate procedures, principles, concepts, and processes so learners can apply the skills.
4. Provide learners with opportunities to practice newly learned skills and build long-term retention.
5. Evaluate learners' application of new skills and provide feedback.
6. Assist learners' transfer of learning.
7. Provide tacit support of peers, mentors, or experts.
8. Allow learners to work collaboratively as a community to solve problems.

Singh and Reed (2001: 2) characterized blended learning as 'optimizing achievement of learning objectives by applying the "right" blended learning technique to match the "right" personal learning style to transfer the "right" skills to the "right" person at the "right" time.' Each of these workplace definitions has the following features: (a) a focus on learning objectives rather than on the mode of delivery; (b) a respect for learning styles that can reach a broad corporate audience; (c) a desire to ease the overall competitiveness of the business organization and build a sense of community; (d) an attempt to make work and learning inseparable operations; and (e) embedding of learning in all aspects of the business from hiring to sales to product development. Although, it is essential for blended learning teachers to articulate their teaching philosophies, Kanuka (2008) argued that hybrid instructors must also be cognisant of three competing psychological impressions of technology and their impact on the field of blended learning: user determinism, social determinism and technological determinism.

MATERIALS AND METHODS

Study aim

The aim of the study was to elicit the opinions of trainers of mechanical manufacturing students regarding training on Computer Numerical Control (CNC) turning by blending face-to-face classroom and workshop activities with an Internet-based virtual training environment. Blended learning has been applied in higher education and workplace learning settings on a global basis and can lead to improved pedagogy, increased access and flexibility, and better cost-effectiveness (Graham, 2006). Mechanical manufacturing requires extensive use of technology, and training in this field should be based on the use of educational technology. Blended learning can be used to 'foster learning communities, extend training events, offer follow-up resources in a community of practice, access guest experts, provide timely mentoring or coaching, present online lab or simulation activities and deliver prework or supplemental course materials' (Bonk et al. 2006, 560). In the business world, the most important reasons for developing blended solutions include the ability to match learning styles, to create individually tailored solutions, to reduce class time; to improve the learning rate; and to exploit investments already made in re- usable training resources (Sparrow, 2003). In academia, the initial cost- saving argument for e-learning (Gayeski, 1998; Wilson, 1999) has recently been replaced with a more refined understanding of how to integrate technology into an overall learning strategy. The present study relates the technology used in manufacturing with the educational technology used for training in a blended environment. In this case, the role and function of a trainer in such an environment are of importance from the trainer's perspective. Rather than the opinions of the trainees (who are exposed to blended learning), the opinions of the trainer are significant in assessing the place of blended learning in a technical training lesson such as on CNC turning for mechanical manufacturing. This model can be regarded as a novel training and learning design. The opinions of a trainer who has used this model can help educators to determine what they should focus on and what they should omit.

Methodology

This study is based on a case at the Department of Mechanical Engineering, Technical Science College, Selcuk University, Konya, Turkey. In 2009, the college developed a virtual training centre for CNC (http://www.vtcforcnc.com) as part of an LdV Development of Innovation Project. The training centre was set up on the Internet for CNC training based on virtual aids. The author was involved in this project as coordinator and researcher. After the project was completed, the training tool developed was applied in the department as part of a blended learning model for CNC turning in a course on mechanical manufacturing delivered by a trainer who also worked on the project. The trainer had PhD qualification and was teaching mechanical manufacturing department for more than six years. The trainer was also involved in the mentioned project as trainer who helped the development process getting the feedback of trainees to form a well-balanced curriculum of CNC training. Until the time of the project, he was experienced in mechanical manufacturing training using face-to-face teaching in the class environment and workshop. The Turkish version of the CNC virtual training centre was added to training sessions, along with classroom and workshop techniques, for two semesters during the 2009–2010 academic years.

Qualitative research was then based on face-to-face in-depth interviews after the trainer had used blended learning for two semesters. According to Kvale (1983: 174), a qualitative research interview is 'an interview whose purpose is to gather descriptions of the life-world of the interviewee with respect to interpretation of the meaning of the described phenomena.' Data were collected during face-to-face interviews. The meeting room was quiet, comfortable, and free from outside distractions, which provided a good interview ambience. The author asked a series of open-ended questions ranging from general to specific points to obtain the interviewee's opinions, experiences and suggestions. Interviews were conducted by the author and were tape-recorded for accuracy after permission was obtained from the interviewee. Notes were also taken during

interview to check the questions and answers recorded for subsequent transcription. The information generated was coded and summarized for analysis and discovery. Transcripts were carefully read and the data were phrased and grouped into categories.

RESULTS AND DISCUSSION

Research on blended learning mainly focuses on the use and advantages of blended learning from the perspective of the students. The approach in the present study is different in that the focus is on a blended learning model used to train mechanical manufacturing students on CNC turning on a lathe using a virtual training centre in addition to face-to-face teaching in the classroom and practice in the workshop. Thus, the focus was mainly on application rather than theoretical information. The transfer of theory to practice is important. In this context, data obtained during interview were categorised.

From theory to experience and practice

The aim of the lesson was to teach programming rather than machine operation. If a student does not know multiplication tables, he cannot know how a calculator works. In the first stage, the codes to be used in CNC programming are learned. The virtual environment used as part of the blended model helped students to apply the programming commands during simulations and they then used these commands on an actual CNC lathe. Especially while teaching such cycles as G00-G01 and G02-G03 used for commands, the virtual environment contributed much to face-to-face teaching and workshop models. The students could make a product by putting what they learned from the virtual environment and theoretical information into practice on the CNC lathe. This also increased student enjoyment.

The professional skill of teachers regarding what to blend and how to blend is crucial and the aim and approach of the teacher who is to teach a lesson are determining factors. The trainer preferred the virtual training centre as an Internet-based virtual environment because this training tool has an ample amount of materials ranging from abstract to concrete for use in a blended environment. Blended learning was developed for its potential advantages in offering more education that is effective, convenience, and access to teaching–learning environments (Graham et al., 2003). Blended learning brings traditional physical classes with elements of virtual education together (Finn and Bucceri, 2004). According to Julian and Boone (2001): 'Blended learning solutions deliver a comprehensive learning experience using various methods (e.g., instructor-led training, CD-ROM, or e-Learning)'. Blended learning can bring together the best features of electronic and traditional classroom techniques to reinforce learning (Anderson 2001: 12). According to Osguthorpe and Graham (2003: 227): a 'blended learning environment is used to try to maximize the benefits of both face-to-face and online methods – using the web for what it does best, and using class time for what it does best.'

Chance to revise content and more engagement

The trainer found that some students were not as efficient as others were, in learning some cycles and commands. The trainer asked them to repeat the lesson at a different time to learn efficiently. The virtual environment helped them to repeat the lesson and provided the flexibility to learn outside of class. Thus, all students reached the same level when the trainer used a blended learning approach. Blended learning takes advantage of the power of technology to deliver training 'just in time', anywhere and at any time. It enables educators to deliver material to all students even if they are physically away from the classroom. If a student cannot attend a lesson, he or she does not miss the lesson or material. Thus, the trainer can provide students with the same materials and can present the same lessons. However, everything depends on the student's interest in the lesson. In a blended learning model, learning can be more focused, delivered bite-size, at any time, anywhere, there is no limit to distance reached, and time is flexible (Alvarez, 2005; Thorne, 2003). Kibby (2007) noted that one advantage of adopting a blended stance is the ease of course revision and speed of replacing activities that are often problematic in the live classroom.

Greater attendance and inquiry

Interestingly, the rate of absence was lower than before. The trainer observed that students were more enthusiastic about getting involved in training and learning more. The trainer believed that the blended learning model contributed much to this because it eliminated boredom and encouraged students more. Other advantages of blended learning are pacing and attendance. In most blended learning classrooms, students can choose to study whenever they wish. If a student is absent, she may view some of the missed material at the same time that the rest of the class does, even though she cannot be physically in the classroom. This helps students to stay on track and avoid falling behind, which is especially helpful for students with prolonged illness that prevents them from attending college. These self-study modules also allow learners to review certain content at any time for help in understanding a concept or to work ahead for those students who learn at a faster pace (Alvarez, 2005). In this model, learning materials are easily accessible and distance and time pose no problem (Alvarez, 2005; Thorne, 2003). Aycock et al. (2002) found that student engagement and interactivity increased in a

blended format. A blended learning environment integrates the advantages of e-learning with some advantageous aspects of traditional methods, such as face-to-face interaction.

Learning to learn

The students got the chance to learn as much as they wanted. Some students came to the classroom and workshop after they learned the content from the virtual environment used for this purpose. Students who were working in an office during the course greatly benefited from this model. Thus, students learned how to learn as part of a lifelong approach. Student readiness increased their motivation and that of the trainer. Even if some students could not be present at some training sessions, they completed their training using the Internet-based learning environment as a compensating tool.

Buckley (2002) and Barr and Tagg (1995) placed emphasis on student- centred learning paradigms, new technologies such as the Internet and personal computers, and new theories such as brain-based learning, cooperative learning and social constructivism that can be combined to form new learning models. Watson (2008) suggested that blended learning involves a shift in strategy in three areas: from teacher-centred to student-centred learning, from limited to high- frequency interactions between students and resources, and from intermittent to deliberate integration of formative and summative assessments.

Cooperation and socialisation

The trainer observed that students worked together and produced something based on cooperation. Learning together and producing together increased the communication among students and between the trainer and students. The trainer observed more socialisation during training. In this model, learners can interact with the tutor and their peers (Alvarez, 2005; Thorne, 2003). The results here confirm the findings of Dziuban et al. (2004:3) that blended learning represents a pedagogical approach in which the effectiveness and socialization of the classroom are combined with the technologically advanced learning that is possible through the online environment.

Eases for the trainer

Since the virtual environment has the necessary training tools, the trainer did not spend time in preparing this element of the lessons. A blended learning environment supports the trainer by presenting ready materials in the classroom and workshop environment. The trainer noted that students learned how to train themselves in a short time and a pleasing result was that he did not need to spend much time in controlling the students because of the blended learning approach. The students were so engaged in training that the role of the trainer was only to guide them rather than lecture on content.

More blended means more equipment

The trainer remarked that the number of CNC lathes was limited and this caused students to spend more time in practicing on the CNC lathe. It is clear that the number of training tools is important for a qualified learning environment.

The more, the fewer

The trainer complained about the number of students, approximately 40, in the training sessions. In his opinion, this number was possibly too high to apply to this model. When he tried to encourage all the students to engage in the same task at the same time, it took a longer time to use the blended model. He agreed that the more blended a model is, the fewer students should be involved.

Balance in blending

When the trainer used the Internet-based learning environment for longer periods, he observed that students got sleepy and bored. Trainers should find a balance in using each blended method to avoid student boredom. There is a need to be aware of students' concentration duration while teaching and learning. By combining online and face-to-face formats, educators can achieve the inherent benefits of both types of instruction through a good balance of virtual access to knowledge and physical human interaction in blended learning (Osguthorpe and Graham, 2003).

Conclusion

According to Brown (2003), blended learning has all the benefits of e-learning, including cost reductions, time efficiency and location convenience for the learner, as well as the essential one-on-one personal understanding and motivation of face-to-face instruction. Osguthorpe and Graham (2003) identified six reasons why institutions and faculty would see added value in creating blended learning environments: (1) pedagogical richness, (2) access to knowledge, (3) social interaction, (4) personal agency, (5) cost effectiveness and (6) ease of revision. These reasons are best understood when grounded in the benefits and challenges of blended learning

environments. Access to education is one of the key factors underpinning the development of distance education programs. Ease of access has become increasingly important as greater numbers of mature students with different external responsibilities seek additional training. Blended education environments are regarded as a way of increasing convenience while maintaining and balancing personal communication at the same time (Morgan, 2002; Collis et al., 2003). As indicated by research, there are several advantages when incorporating online learning into various blended solutions: learning can be more focused and delivered bite-size at any time and anywhere; learners can interact with the tutor and their peers; learning materials are easily accessible; different techniques can be utilized to maximize the benefits of various technologies; costs are lower; there is no limit to the distance at which learners can be located; and learning time is very flexible (Alvarez, 2005; Thorne, 2003).

Despite all the advantages, blended learning is a new concept of which e-learning is an integral part, and information is still being developed. Those interested in blended learning need to know where to obtain the right information. However, there is a limited perception of blended learning and therefore its potential is not well known (Thorne, 2003). The increasing prevalence of blended learning means that higher education and corporate training settings should focus on the creation of strategic plans and directions that use pedagogical techniques in blended learning (Bonk et al., 2006). The results reported here indicate that blended learning can play a vital role in vocational training sessions in educational organisations and workplaces. The approach is not only applicable to higher education. It can be used for any vocational training based on skill development at any level. The implementation of a blended learning model in a very specific field of vocational education (footwear design training) has yielded positive results. To identify other vocational areas in which blended learning models would be beneficial, further research with an emphasis on application and practice rather than theoretical knowledge is warranted.

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