International Journal of Research in E-learning
Vol. 3 (1), 2017, pp. 62–75

Maria Helenowska-Peschke
Poland

Blended Learning Model for Computer Techniques for Students of Architecture

Abstract

The article summarises two-year experience of implementing a hybrid formula for teaching computer techniques at the Faculty of Architecture at the Gdańsk University of Technology. Original educational e-materials – consisting of video clips, text and graphic instructions, as well as links to online resources – are embedded in the university e-learning educational platform. The author discusses not only technical constraints associated with the creation of e-materials and their deposition on the Moodle platform, but also associated didactic challenges, such as the evaluation of students' skills and real time communication.

K e y w o r d s: blended learning, multimedia instructions, computer graphics software

Introduction

Contemporary digital technologies have opened many possibilities for learning in the distributed environment. Created as a combination of traditional learning systems and distributed learning systems, blended learning has been identified as one of the strongest trends in higher education for a decade. At the same time, the benefits and challenges of various hybrid formulas have been closely observed by didactics theorists and practitioners for many years. A compendium manual entitled *Handbook of blended learning: Global perspectives, local designs* highlights and

provides targeted information on specific blended learning situations (Bonk & Graham, 2006). Nevertheless, transforming a qualitative existing university course into a hybrid formula, which takes advantage of the strengths of each environment and avoids its weaknesses, is a huge challenge. The issues specific to teaching material, functionality of an education platform, faculty students' preferences, and the teacher's work style must be carefully mediated and taken into account. According to Graham, "like any design problem this challenge is highly context-dependent with a practically infinite number of possible solutions" (Graham, 2006, p. 16).

The article provides the analysis of methodological and technical aspects of the academic subject called "computer techniques," successfully realised in the blended learning formula by means of the university educational platform. The subject is taught at the first year of study at the Faculty of Architecture at the Gdańsk University of Technology.

Didactic literature has identified various reasons behind the teacher's choice to design or use a blended learning system in their practice (Bonk & Graham, 2006, pp. 3–21). In the case of the discussed model for computer techniques, blended learning was chosen mainly for three reasons: improved pedagogy, increased access/flexibility, and easy revision availability. The hybrid formula was implemented in the 2016/2017 academic year and was completed by approximately 220 Polish and foreign students during a total of four consecutive terms. The original didactic e-materials, especially designed for the course participants, are also described in the paper, along with the results of the course evaluation.

The General Concept of the Model

The educational praxis seems to involve a great variety of blended learning formulas, implemented at different organisational levels. Peercy and Cramer claim that "successful hybrid teaching cannot be a mish-mash of traditional lecturing with some online content but rather a thoughtful re-design of course pedagogy, and meaningful interactions with students" (2011, p. 628). The discussed concept is designed on the basis of the author's personal long didactic experience in teaching computer techniques, as well as innovative educators and organisations in this arena, the principles of general methodology, and the methodology of teaching computer programmes. The changes applied neither to the objectives of the course, nor to the number of class hours or the placement of the subject in the curriculum. The author's hybrid model combines person-to-person interaction, self-paced learning, and learning-materials interactions that overlap in time as a part of the course. The online activities are not obligatory, thus the proportions of time spent

online versus in-class are not defined (the amount of laboratory time is not reduced compared to the traditional course). Since the lab classes already consisted of active learning exercises, minor changes were introduced for this part of the course.

Specificity of Teaching Content

There are two main purposes of education within the subject of computer techniques at the Faculty of Architecture. Firstly, the students are expected to gain the knowledge of computer application types used in architectural design and the latest trends in digital design. Secondly, they should master practical digital tool skills. Thus, as a rule, classes (15 students per group) are conducted in a computer lab equipped with high-end hardware and Internet access. The choice of the software has been dictated by widespread use in Polish architectural offices and ease of availability for students. AutoCAD and Revit are guaranteed free access for students, whereas SketchUp is an open source application, and Corel Draw Graphics Suite educational edition is relatively inexpensive.

The thematic scope in the first term of study (30 lab hours) covers: 2D vector drawing and 3D modelling skills, and post-processing of raster images, followed by the overview of the usage of digital and communication technology in architectural practice. The scope of teaching in the second term is focused on architectural visualisation skills, necessary for communicating design ideas to co-designers, industry, and potential customers. Teaching content also includes general information related to computer graphics itself, as well as a discussion on current trends in digital design (e.g., introduction to building information modelling) (see Appendix 1: Teaching content).

The limited number of teaching hours prompted the author to transform the course formula into blended learning in order to effectively teach content material to students with varied abilities and preferences. The Faculty of Architecture at the Gdańsk University of Technology is highly feminised. Approximately 80% of the 180 students enrolled in the department each year are female. Many women are reserved towards computerised classes, which can only be explained by stereotypes in their perception of self-efficacy and learned ineffectuality (this observation of the author seems to follow gender studies conclusions). Blended learning, with the possibility to learn at one's own pace, at the time and place one chooses, serves to reduce student stress during lab activities and helps in home assignments (Hibbert, 2014; Peercy & Cramer, 2011).

Didactic Principles

The selection of teaching methods, means, and organisation of the discussed blended learning formula is based on the following learning principles (Marius-Costel, 2010, pp. 26–32):

- *The principle of the conscious and active participation of students in the education process*. According to this principle, students participate effectively

in the didactic activity by drawing, modelling, or accomplishing graphical assignments during laboratory classes.

- *The principle of thorough acquisition of knowledge, skills, and abilities*. The difficulty of drawing tasks increases as students explore new options and build up their prior knowledge, for example, only after students gain knowledge of general construction, are they introduced to BIM software.
- *The principle of accessibility and individuality*. During laboratory activities participants listen to explanations and follow the image from a projector connected to a teacher's computer. Online content allows students to practise drawing/modelling exercises repeatedly at a convenient time.
- *The principle of connecting theory with practice*. This means that new programme features are introduced in the context of drawing tasks. The teaching material (the exercises) is implemented regarding topics closely related to architectural practice such as: virtual architectural models, architectural visualisation, architectural documentation, document publishing.
- *The principle of systematisation and continuity*. This principle is expressed by pointing out the analogy between the principles of descriptive geometry methods and the nature of a drawing/model generated in virtual space. Geometric terminology, such as orthogonal projection, contour line, perspective view, angle of view, isometry, etc., is in use here.
- *The principle of intuition*. This principle is emphasised through a series of examples leading to the same effects by the usage of different tools and drawing strategies, for example, creating a surface vs a solid model vs a mesh model.
- *The principle of reverse connection*. Feedback is provided twice. To begin with, computer software by nature provides a user with instant feedback – an executed command or an error message. Secondly, samples of accomplished tasks are published in an online course gallery, and students receive comments on their works (grades and grading rules are also provided online).

E-learning Materials

Information technology makes it possible to create complex and rich forms of multimedia instruction and communication. This requires a proper redesigning of traditional instructions or designing new e-materials from scratch. As Joanna Opoka points out, "Endless pages filled with text, diversified to a greater or lesser extent by graphics, are the transfer of media characteristic of another epoch of the printing age. And so, the 'multimedia lecture' is defined as a lecture recorded with a digital camera for students attending a meeting with a teacher" (Opoka, 2008, p. 126). As mentioned before, the discussed hybrid formula is based on the e-learning

university platform. The original teaching materials consist of video films, text and graphic instructions (displayed on the website or provided as downloadable materials in jpg, pdf, or exe formats), and direct links to online resources.

Technical and Methodological Issues

Video recordings play an important role in the author's concept of the blended formula. They provide teaching material in a more complete and efficient way than text-to-picture instructions would (Hibbert, 2014; Lamport & Hill, 2012). In fact, it is the continuous recording of screen activities that allows users to track the workflow of digital drawing/modelling. CamStudio, an open-source software that allows for recording video sequences from a computer screen and microphone sound, has been used for that purpose. CamStudio records all operations performed by the user – mouse movements, application launch, text input, etc.[1] The videos are split into relatively short, manageable parts, typically illustrating one problem (please refer to an exemplary video: https://youtu.be/tC4LIkwgIuk). The Moodle platform uses YouTube for managing video files. Due to the imposed file size limitation, course videos have text annotations (e.g., commenting on keyboard shortcuts), but no soundtrack. YouTube editor made it possible to remove frames with saved software errors or misuses. In total, there are more than 50 online videos displayed along with the content of the course lessons.

In addition, text and screenshots are used for explaining and illustrating a step-by-step execution of various commands (alike programme manuals). CAD software and graphics programmes, which are the basic teaching content of the course, are under constant development. A new version of AutoCAD programme, containing more advanced functions and interface lift, is released every year. During lab classes, the students use the AutoCAD 2016 version. However, they are often offered by AutoDesk to use the latest versions (now AutoCAD 2018) on their private computers. This discrepancy in software versions causes practical problems and necessitates a duplication of instructions.

Website Layout

The layout of the online content corresponds to the educational logic of the course schedule and is based on the platform functionality. The course site design is meant to provide a clear picture for the students of what is taught and should be learned during the course. A weekly format has been chosen for every term, resulting in 15 distinct parts for "computer techniques I" (one section for each week of the term) and 8 distinct parts for "computer techniques II" (the classes were held for 8 weeks). Each section consists of three or four parts, depending on the teaching context:

[1] In addition, CamStudio allows a user to convert standard avi files to a Flash animation (swf).

- the main teaching material covering theoretical and practical information provided as text, images, videos, instructional animations, links to other resources, for example, websites of architectural offices, architectural journal articles;
- the teaching aids for downloading, for example, building plans, textures for renderings, file templates, etc.;
- the content contributing to the main teaching material (e.g., dealing with more complex models or advanced, sophisticated tools), which is marked as for "enthusiasts"; and
- the link to upload assignments (e.g., checking exercise, homework).

In addition, the site includes private storage space for incomplete works which are not subject to verification, along with galleries of visualisations and other graphics tasks done by the students. The gallery is a motivating factor, as well as an element of a peer-to-peer learning strategy.

The whole content for each subject has been available from the beginning of the term. It created a context where the students were able to plan and work ahead, for example, to adjust their viewing schedules in response to the overall demands that were being placed on them. In the case of ERASMUS, the advantages go as far as choosing the topics they needed (foreign students usually followed different curricula at their master universities).

Hybrid Course Functioning

The specificity of computer techniques requires laboratory classes which are meant to be synchronous. Guided by the teacher, the students familiarise themselves with the workflow appropriate for various tasks, such as drawing, modelling, and post-processing in various applications. Software commands are introduced and discussed on the occasion in the context in which they appear in the creation process. During a lab live instruction, the image from the instructor's monitor is displayed by a projector on the wall screen. The students receive prints of floor plans, sections and elevations, along with dimensions, if needed. For visualisation purposes, the pre-prepared models of object geometry are sometimes provided. The workflow is at first only tracked by the students; then the task is performed along with the teacher at an imposed pace adapted to the complexity of the task (if necessary, the students receive individual support). At the end of the class, files are being uploaded to individual accounts on the platform for archiving and final evaluation. In principle, laborious obligatory tasks may be completed or corrected at home. Online teaching and learning content and tasks (which occurred as asynchronous) are made available for registered participants, but not required.

On the one hand, the existence of the online module takes off the time pressure from the teacher; on the other hand, it reduces the stress level during the lab class. These two advantages of the hybrid course design are repeatedly mentioned in the literature explaining the hybrid learning approaches (Karabulut & Jahren, 2016; Lamport & Hill, 2012; Peercy & Cramer, 2011).

Communication Issues

The Moodle platform adopted by the Gdańsk University of Technology does not allow teacher–students or student–student interactions in real time. Nevertheless, with additional communication via the platform, it has been possible to improve methodology, and to update and enrich the content to meet actual expectations and needs of the users. Looking from a teacher's perspective, an important advantage of the online part of the course has been the ability to rapidly distribute uniform or customised learning materials, attach grades and comments to students' homework, update a rating journal and schedules automatically, etc. From students' perspective, personalised feedback, such as notes on how to solve tool problems, practical and troubleshooting tips (provided with huge commitment from the teacher), have been an extra advantage compared to the traditional formula. For a practical reason (one teacher and 110 students enrolled on the hybrid course each term), there was no agreement between the students and the teacher regarding the time to answer e-mailed questions, which sometimes resulted in delayed communication. Because the Moodle platform does not provide communication close to the same levels of fidelity as in the face-to-face environment, the teacher's educational experience played an important role in verifying the credibility of home assignments authorship. Figure 1 shows students' renderings at different difficulty levels: basic and advanced options.

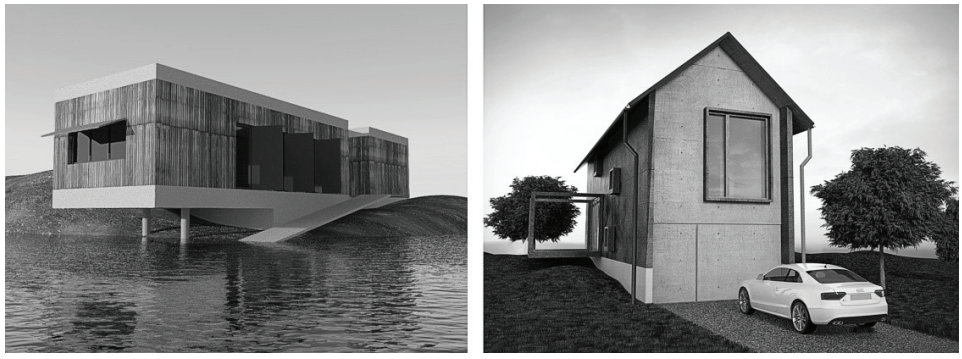

Figure 1. Left: basic rendering with Sunlight and Sky illumination only (Barbara Gwóźdź). Right: advanced rendering in V-Ray with HDRI Sky (Piotr Grabowski).

Course Evaluation

The analysis and evaluation of the discussed hybrid computer techniques course brought several findings corresponding to specific contexts and real life constraints. The evaluation of the blended learning formula for computer techniques was based on the analysis of quantitative data (such as students' grades and their website activity) and qualitative data (such as students' satisfaction, achievement of additional educational aims, and smoothness of the didactic process).

Evaluation Results

The summative evaluations discussed in this paper were collected in February 2017 (computer techniques I) and June 2017 (computer techniques II). Final assessments for each term included in-class exercises, home assignments, and practical skill tests (besides, some non-obligatory tasks were suggested). In the first term, the students had to complete four obligatory assignments and three practical skill tests (the maximum score for each task was 100 points, the minimum passing score was 60 points). The students' score results showed, to a great extent, that the level of their achievements was very satisfactory. The arithmetic average for total test results conducted during computer techniques I was 77 points. The average score obtained by the students for one of the home assignments (a house visualisation) was 92 points. Post-processing of the visualisation using Photo-Paint was not obligatory; nevertheless, 78% of the students performed the task, and the average score was 72 points. The summative evaluation of computer techniques I achievements showed that as much as 26% of the students received at least 91% of the requirements and only 5% reached the lowest scores range between 60 and 70 points (nobody failed).

In the second term, the students had to complete four obligatory assignments and one practical skill test (as before, the maximum score for each task was 100 points, the minimum passing score was 60 points). The final practical skill test was carried out at the end of the term, and the arithmetic average of it was 86 points. The summative evaluation of computer techniques II achievements showed that as much as 40% of the students received at least 91% of the requirements, and only 10% reached the lowest scores range between 60 and 70 points. Moreover, thanks to the education platform, the students managed to keep a deadline more often and submitted the projects on schedule during the term. Consequently, only 4% of the students failed to submit the work for evaluation at the end of June, and thus completed the course and received a final grade as required by faculty regulations. Compared to previous traditional courses conducted by the author, the number of failures decreased by 4 times.[2]

[2] Students who do not finish on time may still pass the course in the make-up exam session.

In the author's opinion, the achievement of educational aims was strongly confirmed by the students' behaviour indicating high motivation for learning, meaning that they generally were willing to improve their works even though they had already achieved 60 points. For example in the case of a digital model of chess figures (second term), only 14% of the students did not take advantage of the possibility to improve their work and stayed satisfied with the initial evaluation. Quite a lot of participants completed the complex non-obligatory tasks. The model of a round house (based on the design realised by Robert Konieczny) can serve as an example for the first term – 36 files were uploaded for evaluation (the video illustrating the modelling technique in SketchUp was viewed 131 times, and plans were downloaded by 69 students). During the second term, the challenging advanced night scene with artificial lights was likewise chosen by 35% of the users, although the day scene would be enough to receive a high grade (the video illustrating strategies for a night scene rendering in AutoCAD was viewed 101 times).

The online activities were not considered as a part of the students' grade but rather as an indicator of the students' satisfaction in the hybrid formula. The conclusions were drawn from the data such as viewing patterns or online attendance record provided by the Moodle platform. These tools have been available and used in the educational practice relatively recently (Hugo & Brennan, 2016). To evaluate the course, overall schedule viewing statistics can be derived from the online watch data. Figure 2 shows that the culmination of student activities concentrates around visualisation skills and indicates that students rarely watch content consistently on a week-to-week basis, yet rather adjust to the amount of work.

In turn, entry data show that not all students know how to take advantage of both ends of the spectrum (students often placed a greater value or emphasis on the face-to-face aspects of the educational experience).

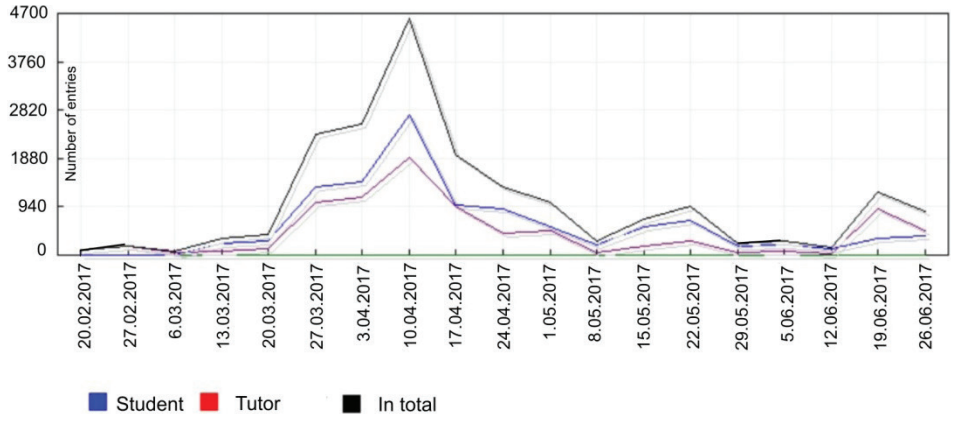

Figure 2. Computer techniques II entry statistics: students, tutor, in total.

S o u r c e: Own work on the Moodle platform.

With the online content delivered through YouTube, it was also possible to use the analytic package within YouTube. Videos had view numbers that in some cases were higher than the number of students, suggesting that some students watched the videos several times (see Appendix 2: Number of views).

Resources on the platform are still used by registered users (several months after the end of the term). In the faculty survey conducted after the end of the academic year, the course formula was evaluated by the students at the arithmetic average 4.9 (out of 5). To sum up, at the cost of increased demand on the instructor's time, the implemented hybrid formula has provided advantage over other teaching techniques for the participants in this study.

Conclusion

Higher educational institutions in Poland have recently called for a widespread implementation of technological innovations to respond to rapidly changing demands of the 21st century. The advantage of learning in the distributed environment is that this model provides opportunities for incremental changes to the methodology but does not radically change the way teaching and learning occur. In the discussed hybrid formula for computer techniques I and II, the teaching and learning of fundamental objectives are realised by traditional training (tutoring in a teacher-led laboratory). The goal behind implementing online content was to effectively teach content material to students with varied abilities and preferences, providing them with the material to deepen and broaden the range of acquired knowledge and skills, as well as to assist them in repetition and consolidation. This enabled learner-centred strategies, which in the school life reality are significantly hampered by time constraints. Online activities seem to indicate that many students succeeded in grasping that learning is an active process of constructing knowledge, rather than simply acquiring it. Computer graphics enthusiasts and those who show interest in developing skills beyond the content curriculum have gained motivation and support. Blended learning environments supported increasing learner maturity and capabilities for self-regulation. At the same time, it proved that some students at the beginning of the course were not prepared to use the educational platform in order to support their learning effectively and creatively. However, regardless of proportions of time spent online versus in-class, the vast majority of the students benefitted from mixed environment.

The success of hybrid courses depends on the perception of students and the faculty towards this design. There is no doubt that in the educational process student results should be the top priority (presumably followed by cost savings on the part of the educational institution). The degree of student learning satisfaction

plays an important role in evaluating the effectiveness of the hybrid learning environment. This also implies that the hybrid course was worth the time and effort of the teacher. Next year, more effort will be taken to activate the user forum on the platform to provide additional educational space.

In the author's opinion, teaching and learning in a traditional formula, blending options, or fully online courses should be "equivalent" experiences to be selected basing on learner preferences. Graham believes that "it may even become so ubiquitous we will eventually drop the word 'blended' and just call it learning" (Graham, 2006, p. 7).

References

Bonk, C. J. & Graham, C. R. (Eds.). (2006). *Handbook of blended learning: Global perspectives, local designs*. San Francisco, CA: Pfeiffer Publishing.

Graham, C. R. (2006). Blended learning systems: Definition, current trends, and future directions. In C. J. Bonk & C. R. Graham (Eds.), *Handbook of blended learning: Global perspectives, local designs* (pp. 3–21). San Francisco, CA: Pfeiffer Publishing.

Hibbert, M. (2014). What makes an online instructional video compelling? *Educause Review*. Accessed 1 June 2017. Retrieved from http://er.educause.edu/articles/2014/4/what-makes-an-online-instructional-video-compelling.

Hugo, R. J. & Brennan, R. W. (2016). Student study habits as inferred from on-line watch data. In *Proceedings of the 12th International CDIO Conference, Turku University of Applied Sciences, Turku, Finland, June 12–16, 2016*. Accessed 1 June 2017. Retrieved from http://www.cdio.org/files/document/cdio2016/197/197_Paper_PDF.pdf.

Karabulut-Ilgu, A. & Jahren, C. (2016). Evaluation of hybrid learning in a construction engineering context: A mixed-method approach. *Advances in Engineering Education*, *5*(3), 1–26.

Lamport, M. A. & Hill, R. J. (2012). Impact of hybrid instruction on student achievement in post-secondary institutions*:* A synthetic review of the literature. *Journal of Instructional Research*, *1*. Accessed 1 June 2017. Retrieved from http://files.eric.ed.gov/fulltext/EJ1127597.pdf.

Marius-Costel, E. (2010). The didactic principles and their applications in the didactic activity. *Sino-US English Teaching*, *7*(9) (Serial No. 81), 24–34.

Opoka, J. (2008). Multimedia w edukacji. *Studia i materiały Centrum Edukacji Przyrodniczo-Leśnej*, R. 10, *1*(17), 120–129.

Peercy, P. S. & Cramer, S. M. (2011). Redefining quality in engineering education through hybrid instruction*. Journal of Engineering Education*, *100*(4), 625–629.

Appendix 1. Teaching content

Computer techniques I (30 lab hours)

1. Introduction to 3D modelling in SketchUp – 2 h
2. Building models of architectural objects – 2 h
3. Introduction to architectural visualisation – 2 h
4. Curvilinear surface modelling – 2 h
5. Modelling skill test I – 2 h
6. Introduction to AutoCAD – 2 h
7. Advanced drawing tools and drawing aids cont. – 2 h
8. Rules for digital engineering documentation drawing – 2 h
9. Drawing conceptual floor plan in AutoCAD – 2 h
10. Drawing skill test II – 2 h
11. Introduction to post-processing in Corel Draw Photo-Paint – 2 h
12. Post-processing special effects cont. – 2 h
13. Digital collage (abstract self-portrait) – 2 h
14. Vector drawing and text editing in Corel Draw – 2 h
15. 2D graphics skill test III – 2 h

Computer techniques II (15 lab hours)

1. Introduction to 3D modelling in AutoCAD – 2 h
2. Solids and surfaces modelling in AutoCAD – 2 h
3. NURBS modelling in AutoCAD – 2 h
4. Cottage model based on elevations and floor plans – 2 h
5. Introduction to rendering in AutoCAD – 2 h
6. Creating a visualisation of an architectural object in AutoCAD – 2 h
7. Modelling and visualisation skill test – 2 h
8. Introduction to BIM concept (Revit) – 1 h + non-obligatory 1 h

Appendix 2. Number of views for five top videos used for computer techniques I and computer techniques II

Computer techniques I – 107 students enrolled on the hybrid course; the analysed period: 1 September 2016–27 January 2017

No.	Video title/content	Views
1	Building a cottage model in SketchUp	367
2	Modelling a house from floor plans in SketchUp	221
3	Creating materials in SketchUp	209
4	Adjusting scene content in SketchUp	240
5	Usage of 2D window blocks in AutoCAD	174

Computer techniques II – 110 students enrolled on the hybrid course; the analysed period 23 February 2017–20 June 2017

No.	Video title/content	Views
1	Nurbs modelling – a chapel model in AutoCAD, part 1	288
2	Solid modelling in AutoCAD – a chess figure	243
3	Mesh modelling in AutoCAD – a chess figure	241
4	Nurbs modelling – a chapel model in AutoCAD, part 2	212
5	Matching raster image size to programme units	214

Maria Helenowska-Peschke

Model *blended learning* dla przedmiotu techniki komputerowe dla studentów architektury

S t r e s z c z e n i e

Niniejszy artykuł podsumowuje dwuletnie doświadczenie wynikające z wprowadzenia formuły hybrydowej dla nauczania przedmiotu techniki komputerowe na Wydziale Architektury Politechniki Gdańskiej. Autorskie materiały edukacyjne składające się z wideoklipów, instrukcji tekstowych i graficznych oraz linków do zasobów online zostały umieszczone na uczelnianej platformie e-learningowej. W artykule zostały omówione ograniczenia technologiczne związane z tworzeniem e-materiałów i udostępnieniem ich na platformie Moodle, a także wyzwania dydaktyczne, takie jak ocena umiejętności studentów i komunikacja w czasie rzeczywistym.

S ł o w a k l u c z o w e: *blended learning*, instrukcje multimedialne, programy graficzne

Maria Helenowska-Peschke

Смешанная модель обучения компьютерным техникам для студентов- архитектуров

А н н о т а ц и я

В статье кратко излагается двухлетний опыт внедрения гибридной формы для обучения компьютерным техникам на архитектурном факультете Гданьского технологического университета. Оригинальные образовательные электронные материалы, состоящие из видеороликов, текстовых и графических инструкций, а также ссылки на онлайн-ресурсы, встроены в образовательную платформу электронного обучения в университете. Автор обсуждает технические ограничения, связанные с созданием электронных материалов и их размещением на платформе Moodle, а также связанные с ними дидактические задачи, т.е. оценка навыков учащихся и общение в режиме реального времени.

Ключевые слова: смешанное обучение, мультимедийные инструкции, программное обеспечение для компьютерной графики

Maria Helenowska-Peschke

Modelo de aprendizaje mixto para técnicas informáticas para estudiantes de arquitectura

Resumen

El artículo resume la experiencia de dos años de implementación de la fórmula híbrida para la enseñanza de Técnicas de Computación en la Facultad de Arquitectura de la Universidad de Tecnología de Gdansk. Los materiales educativos originales consisten en videoclips, instrucciones de texto y de gráficos, así como enlaces a recursos en línea los cuales están integrados en la plataforma educativa universitaria de e-learning. El autor debate acerca de las limitaciones técnicas asociadas con la creación de materiales digitales y su subida a la plataforma Moodle, así como los desafíos didácticos asociados a la evaluación de las habilidades de los estudiantes y la comunicación en tiempo real.

Palabras clave: blended learning, instrucciones multimedia, software de gráficos de ordenador