

A Case Study on the SCORM-Based E-learning in Computer-Aided Drafting Course with Users' Satisfaction Survey

CHE-CHERN LIN*, JIA-HSENG PAN**

*: National Kaohsiung Normal University

** : National Yu-Lin Agriculture and Industrial Vocational High School

TAIWAN

cclin@nknuc.nknu.edu.tw*; span@ylvs.chc.edu.tw**

Abstract: -. In this paper, we propose a case study to compare the learning difference on a Computer added Drafting (CAD) course between traditional learning and e-learning. The learning materials for the e-learning were designed in Shareable Contents Object Reference Model (SCORM) standard. Seventy-four students from a vocational high school in Taiwan attended the experiment. These students were divided into two groups: the control group and the treatment group. The control group was provided with traditional learning in a regular classroom. The treatment group utilized an e-learning platform to conduct learning activities. The experimental results show that the learning performance between the traditional learning and the e-learning on CAD course is not different. Finally, a survey was also conducted to realize the users' satisfaction of using the e-learning course.

Key-words: - CAD, e-learning, SCORM, Engineering Education, Moodle, User satisfaction.

1. Introduction

Due to the development of software technologies and the promotion of network infrastructure, internet usages are rapid growing up recently. More and more daily activities are engaged via internet nowadays. One of the frequent internet activities is e-learning. People use internet to learn anywhere and anytime without the limitations of time and geometrical space. With the well-developed network infrastructure, e-learning is widely utilized in schools, companies and learning institutes. In stead of traditional learning with face-to-face contacts between teachers and learners, e-learning employs digitalized learning platform to engage learning activities. In addition, with the popularity of web-based applications, most of e-learning activities are conducted with browsers. Many web-based learning platforms are often used to provide unlimited learning environments for learners. Module Object-Oriented Dynamic Learning Environment (Moodle) is one of the most popular web-based e-learning platforms [1]. It is a free computer package designed with PHP internet programming language. Moodle also provides on-line management mechanism for course administrators to manage the learning activities and learners' profiles.

To conduct e-learning activities, we first need to design learning materials and then deploy them on the e-learning platforms. To improve the reusability, the learning materials are usually

divided and organized in modules. Many e-learning standards have been developed with successful applications. Shareable Contents Object Reference Model (SCORM) is one of the most popular standards for designing web-based learning materials [2,3]. The latest version of SCORM is SCORM 2004 which contains three parts: Content Aggregation Model (CAM), Run Time Environment (RTE), and Sequencing and Navigating (SN) [2-6]. One of important goals for SCORM is to achieve the high reusability of learning materials by sharing the materials to other people who are interested in designing the similar learning materials. SCORM uses content packages to hierarchically divide learning materials into different levels of learning modules. CAM is the mechanism to define the module-based architecture for the learning materials. Two types of learning resources are used in CAM: asset and Sharable Content Object (SCO). Assets are the basic unit for learning materials. They are electronic media displayable by browsers. Types of assets include html pages, image files, video files, and audio files. Assets lack the communication ability to a learning management system so that they cannot be played alone in RTE. SCOs, however, can communicate with the learning management system and can be displayed independently in RTE. Assets and SCOs can be recursively organized with nested structures. Figure 1 demonstrates the conceptual structure of a content package of CAM [3]. The structure starts with a manifest and is recursively expended to sub-manifests. The

organizations in the structure define the logical architecture of content packages. The resources in the structure describe the type and properties of the learning materials. The tags of eXtensible Markup Language (XML) are employed to define metadata for learning resources. RTE is the platform for the e-learning activities where a Learning Management System (LMS) is used to administrate the courses and learning activities for course managers and learners. In addition, RTE provides programmable modules with Application Programmer Interfaces (APIs) for e-learning developers to customize the learning systems according to their special needs. Figure 2 shows a SCORM based learning management system [3]. SN serves to navigate learners by a sequence of learning activities. Detailed descriptions about SCORM 2004 can be found in [2-6].

This study used a Computer Aided Drafting (CAD) course as an e-learning example. In addition to the CAD course, e-learning has been utilized in many courses with successfully applications [7-9]. The CAD is a fundamental course for mechanical engineering students. Unlike the traditional Drafting course using drafting tools (e.g., rules, setsquares, and compasses) to draw engineering diagrams, the CAD course employs computer packages to draw diagrams. It has been known that using CAD to draw diagrams has the following advantages:

- Easy to use: CAD uses visualized components to draw pictures with friendly user interfaces. Users can easily draw pictures by simple actions such as clicking buttons, moving mouse, and typing parameters for generating geometrical elements (circles, ellipses, rectangles, curves, etc).
- Easy to modify: CAD basically uses computer graphics techniques to draft pictures. It is therefore easy to make the modifications for the pictures. For example, if one needs to enlarge a circle, he can simply enter the ratio of amplification or the radius to get the desired circle size.
- Easy to store: The pictures drawn by CAD are stored in electronic media and therefore easy to store and to make reproductions.

In addition, the files generated by CAD can be utilized for Computer Aided Manufacture (CAM) to create machine codes for CAM processes.

AutoCAD is one of the most popular CAD packages used for engineering drafting [10]. It provides necessary tools for a wide scope of engineering design, from conceptual designs to drafting delivery details [10]. In addition, for those users who want to generate their customized

applications, CAD also offers instruction libraries to meet their special needs.

In this study, we propose a case study to discuss the learning performance on CAD course between traditional learning and e-learning. Seventy-four students of grade 11 from the Department of Mechanical Engineering at National Yu-Lin Agriculture and Industrial Vocational High School were selected as samples. This school is a three-year vocational high school (grades 10 to 12) in central Taiwan. The 74 students were divided into two groups: a treatment group and a control group. The students in the control group were conducted with the traditional teaching activities in a regular classroom. The students in the treatment group were conducted with SCORM-based e-learning materials. We designed an experiment to compare the learning performance between the control group and treatment group. A survey was also conducted to realize the users' satisfaction of using the e-learning course. Figure 3 shows the conceptual diagram of the research design of this study [11].

2. Research design

2.1 Creating learning materials

To conduct the experiment, three computer package were utilized: Camtasia [12], Reload [13], and Moodle [1]. Camtasia is a video/audio capturing software serving to record the computer screens when creating learning materials [12]. Reload is an authoring platform for generating SCORM compliant learning materials [13]. Moodle is an e-learning platform to conduct e-learning activities and to manage the course [1]. Figure 4 shows a snapshot of playing the e-learning materials of the CAD course [11].

2.2 Procedure

The CAD course is a three-credit core course for mechanical engineering students. It is taught in grade 11 (the second year of a three-year study period in the school) with a length of 18 weeks (three teaching hours per week). Of the 18 weeks, we took 5 weeks for the experiment. 74 students from two classes at the same department attended the experiment. The first class was the control group containing 36 students and the second class is the treatment group containing 38 students. During the experiment, the students in the control group took the traditional course taught by a teacher in a classroom while those in the treatment group were conducted by the SCORM-based learning materials via browser.

During the experiment, four topics were taught

for the students including

Topic 1: The environment of the AutoCAD.

Topic 2: Familiarity with the function keys of AutoCAD.

Topic 3: Fundamental skills of drawing lines, multi-lines, curves, circles, ellipses, rectangles, and polygons.

Topic 4: Skills of drafting duplicated figures.

In addition, some examples combining the above four topics were given to help the students build comprehensive understanding about the topics. Figure 5 shows some selected CAD design samples used in this study.

3. Analyses on learning performance

3.1 Data processing

To further discuss the learning performance among different academic achievements in the experiment. We then divided the students in the control group into three sub-groups: high achievement, medium achievement, and low achievement. Similarly, we also divided the students in the treatment group into the same sub-groups in the control groups. The dividing is based on the following criteria:

- High achievement: the students whose academic scores in mechanical drafting lab are within top 27% (in a descending order).
- Middle achievement: the students whose academic scores in mechanical drafting lab are between 27% and 63% (in a descending order).
- Low achievement: the students whose academic scores in mechanical drafting lab are within bottom 27% (in a descending order).

Table 1 shows the dividing results of the sub-groups.

3.2 Pre-tests

To conduct an Analysis of Covariance (ANCOVAR), we need to perform pre-tests. In this study we used the scores of mechanical drafting as covariance measurements. It is necessary to verify the correlation between the scores of the pre-test course (mechanical drafting course) and the experimental course (CAD course). We used historical data as examples and designed an experiment to examine the correlation. In this experiment, we used Pearson product-moment correlation method to test the correlation between the mechanical drafting course and the CAD course. We used the scores of the two courses of two previous classes at the department to validate the correlation. Tables 2 and 3 demonstrate the cross-tables for test results.

From Tables 2 and 3, we conclude that there

exists a significant positive correlation between the mechanical drafting course and the CAD course. Based on the statistical results, we used the scores of mechanical drafting as covariance measurement for further analyses.

The students in the control and treatment groups were from two classes. We then used the scores of the mechanical drafting as data and conducted a t-test to examine if the score means of the mechanical drafting course between the control group and the treatment group are equal. Table 4 displays the results of the t-test.

From Table 4, we conclude that the students in the control group and the treatment group are from the same population.

3.3 Learning performance of the control and treatment groups

During the experiment, all students were required to submit an assignment after completing each of the four topics. In addition, they were also given a quiz after completing each of the four topics. Meanwhile, after finishing the five-week course, the students took an overall examination to evaluate their learning performance. Figure 6 shows some selected CAD design questions of the overall examination.

The learning materials in the experiments include four topics, as mentioned in Section 2.2. The students in the control group were given by a 3-hour regular lecture per week while those in the treatment group by 3-hour e-learning per week.

We performed t-tests to examine the learning performance between the students in the control group and the treatment group, using the scores of the four assignments. Similarly, we used the same procedure to examine the learning performance between the two groups using the scores of the four quizzes. Tables 5 and 6 demonstrate the results of the t-tests.

From tables 5, we conclude that the scores of assignments for the four topics between the control group and treatment group are not different. Similarly, from Table 6, we also conclude that the scores of quizzes for the four topics between the control group and treatment group are not different.

3.4 Learning performance of the three achievement sub-groups in the control and treatment groups

The students in the control and treatment groups were divided into three sub-groups, as mentioned early. We then employed ANCOVAR to test if the learning performance between the control group and

treatment group for the three sub-groups are the same. The scores of the overall examination (after a five-week experiment) were used in the ANCOVAR procedure. Before applying the procedure, we utilized homogenous tests to make sure the homogenous properties of regression coefficients. Table 7 shows the results of the homogenous tests. From Table 7, we conclude that all of students in the three sub-groups of the control and treatment groups are from the same population.

After passing the homogenous tests, we took the score of mechanical drafting course as the covariance since the scores between mechanical drafting and CAD are highly correlated. Table 8 shows the results of ANCOVAR. From Table 8, we conclude that the learning performances of the three achievement sub-groups in the control group and the treatment group are not different.

4. Survey of using the e-learning

4.1 Questionnaire design

After completing the e-learning activities in Section 3, we performed a survey of using e-learning of the CAD course. A questionnaire was designed for this survey. There were two parts in the questionnaire: the usages of internet and the satisfactions of using the e-learning course.

In the first part (Part A) of the questionnaire, four questions were answered by the students who took the e-learning course. The four questions are:

QA-1 Gender: Categorical variable with two values: Male and Female.

QA-2 E-learning experience: Categorical variable with two values: 1 (Yes) and 0 (No).

QA-3 Total hours of using internet per week: Categorical variable with five values: (1) none, (2) $h \leq 7$, (3) $7 < h \leq 14$, (4) $14 < h \leq 21$, (5) $21 < h$ (h = total hours).

QA-4 Commonly used internet activities: Categorical variable with more than one answers (multiple answers). The answers include

- obtaining software
- searching information
- using email
- playing on-line game
- chatting and making friend
- browsing leisure information
- reading news and magazine
- shopping

The second part (Part B) of the questionnaire is related to the satisfaction of the e-learning course. There were 20 (QB-1 to QB-20) questions in this part. The 20 questions were then divided into four

dimensions: contents and presentation of the e-learning (QB1 to QB-5), curriculum design (QB6 to QB-10), learning environments (QB11 to QB-15), and learning mode (QB16 to QB-20). The 20 questions were answered by a five-point scale (1 to 5) with the following representations:

- 5: Absolutely agree
- 4: Agree
- 3: Average (50% of agreement and 50% of disagreement)
- 2: Disagree
- 1: Absolutely disagree

The 20 questions are listed in Table 9.

There were 38 questionnaires sent to the 38 students who took the e-learning course and all of them were returned. The Cronbach α 's of the overall questionnaire and the four dimensions are shown in Table 10. From the table, the questionnaire was designed with high reliability. Table 11 demonstrates the descriptive statistics in Part A.

4.2 Statistical analyses

We used statistical methods to test the relationships between the students' internet activities (Part A) and the satisfaction of the e-learning course (Part B). Two hypotheses were tested to examine the relationships between the questions in Part A and Part B. In Hypothesis 1, we used one-way ANOVA to test the relationships between the questions in Part B and the total hours of using internet. In Hypothesis 2, we use one-way ANOVA to test the relationships between the questions in Part B and the numbers of commonly used internet activities (if the number is more than 4, we treated the number as 4). In Hypothesis 2, we also utilized the Scheffe's method to make all possible pair-wise comparisons. The statistical hypotheses are

H1: The satisfactions of the e-learning course are not different among the total hours of using internet.

H2: The satisfactions of the e-learning course are not different among the number of commonly used internet activities.

Table 12 displays the statistical results.

5. Conclusions

We proposed a case study to compare the learning performance between the traditional learning and the e-learning on the CAD course. The learning materials for the e-learning were designed based on the SCORM standard. We explained the three major parts in the SCORM 2004 including CAM, RTE,

and SN.

Seventy-four students of grade 11 from a mechanical engineering department at a vocational high school in Taiwan attended the experiments. These students were divided into two groups: the control group and the treatment group. The experimental results showed that the learning performance between the traditional learning and the e-learning on the CAD course is not different.

As for the future studies, we suggest that the size of the examples can be reasonably enlarged. In addition, the experiment duration could be extended to 12 weeks or even the entire semester (18 weeks). Besides, more experiments could be designed to explore the differences between the traditional learning and the e-learning on other courses in vocational education.

References:

- [1] <http://moodle.org/>
- [2] <http://www.adlnet.org/>
- [3] SCORM 2004 overview, 2th edition, Advance Distributed Learning, July 22, 2004.
- [4] SCORM Content Aggregation Model, Version 1.3.1, Advance Distributed Learning, July 22, 2004.
- [5] SCORM Run-Time Environment, Version 1.3.1, Advance Distributed Learning, July 22, 2004.
- [6] SCORM Sequencing and Navigation, Version 1.3.1, Advance Distributed Learning, July 22, 2004.
- [7] W. Tsai, H. Chang, An application of e-learning information system in sports-tennis course, *The WSEAS Transactions on Information Science and Applications*, Issues 3, Volume 4, 2007, pp. 560-567.
- [8] H. Chang, A noble multimedia digital learning platform for the autism students, *The WSEAS Transactions on Information Science and Applications*, Issues 12, Volume 3, 2006, pp. 2563- 2570.
- [9] G. Rigopoulos, V.V. Karadimas, Increasing ethical awareness of IT students through online learning, *The WSEAS Transactions on Computers*, Issues 12, Volume 5, 2006, pp. 3160-3164.
- [10] <http://usa.autodesk.com/>
- [11] J. Pan, A study on teaching performance and user satisfaction- a case study on a computer aided drafting course at the department of machine in a vocational high school, Mater Thesis, National Kaohsiung Normal University, Kaohsiung, Taiwan, 2005.
- [12] <http://www.techsmith.com/>
- [13] <http://www.reload.ac.uk/>
- [14] C.E. Jacobson, Using AutoCAD for descriptive geometry exercises: in undergraduate structural geology, *Computers & Geosciences*, Volume 22, Issue 4, May, 1996, pp. 379-386.
- [15] R. Marschallinger, A Voxel Visualization and Analysis System Based on Autocad, *Computers & Geoscience*, Volume 22, Issue 4, May, 1996, pp. 379-386.
- [16] R. Feyen, Y. Liu, D. Chaffin, G. Jimmerson, B. Joseph, Computer-aided ergonomics: a case study of incorporating ergonomics analyses into workplace design," *Applied Ergonomics*, Volume 31, Issue 3, June 1, 2000, pp. 291-300.
- [17] J. Park, and R.L. Storch, Pipe-routing algorithm development: case study of a ship engine room design, *Expert Systems with Applications*, Volume 23, Issue 3, October 1, 2002, pp. 299-309.
- [18] J. Oliveira, CAD tool extension for formal building description language, *Advances in Engineering Software*, Volume 29, Issue 7-9, August 11, 1998, pp. 571-586.
- [19] C Chi; K Chung, Task analysis for Computer-Aided Design (CAD) at a keystroke level," *Applied Ergonomics*, Volume 27, Issue 4, August, 1996, pp. 255-265.
- [20] J. Hall, W.E. Biles, J. Leach, An AutoCAD-12 based maintenance management system for manufacturing, *Computers and Industrial Engineering*, Volume 29, Issue 1-4, September, 1995, pp. 285-289.
- [21] C.Y. Teo, Computer-aided design and simulation of low-voltage electrical distribution systems, *Computers in Industry*, Volume 34, Issue 1, October, 1997, pp. 87-94.

Table 1 The dividing result of subgroups.

Subgroup	Treatment group	Control group
High Achi.	10	10
Middle Achi.	16	18
Low Achi.	10	10

Table 2: The results of Pearson correlation for class 1.

		CAD	Mechanical Drafting
CAD	Pearson correlation	1	0.627**
	Significant		0.000
	Sample size	35	35
Mechanical Drafting	Pearson correlation	0.627**	1
	Significant	0.000	
	Sample size	35	35

Table 3: The results of Pearson correlation for class 2.

		CAD	Mechanical Drafting
CAD	Pearson correlation	1	0.740**
	Significant		0.000
	Sample size	33	33
Mechanical Drafting	Pearson correlation	0.740**	1
	Significant	0.000	
	Sample size	33	33

Table 4: The results of the t-test for equal mean.

	Equal Variance Levene test		Equal mean		
	F	Sig.	t	DF	Sig.
Mechanical drafting	0.035	0.852	0.153	72	0.879

Table 5: The results of the t-test on the scores of the assignments for the control and treatment groups.

	Equal Variance Levene test		Equal mean		
	F	Sig.	t	DF	Sig.
Topic 1	1.994	0.162	-0.854	72	0.396
Topic 2	9.401	0.003	-1.674	72	0.099
Topic 3	0.089	0.766	0.977	72	0.332
Topic 4	0.070	0.792	0.559	72	0.578

Table 6: The results of the t-test on the scores of the quizzes for the control and treatment groups.

	Equal Variance Levene test		Equal mean		
	F	Sig.	t	DF	Sig.
Topic 1	0.241	0.625	-1.831	72	0.071
Topic 2	3.016	0.087	-0.271	72	0.787
Topic 3	0.110	0.741	1.193	72	0.237
Topic 4	0.070	0.792	0.559	72	0.578

Table 7: results of homogenous tests.

Source of variance		Sum of square of type III	DF	F	Sig.
High Achi.	Pre-test	25.544	1	3.25	0.090
	Error	125.502	16	—	—
Middle Achi.	Pre-test	9.759	1	0.446	0.510
	Error	656.992	30	—	—
Low Achi.	Pre-test	10.031	1	0.698	0.416
	Error	229.862	16	—	—

Table 8: results of ANCOVAR.

Source of variance		Sum of square	DF	F	Sig.
High Achi.	Contrast	3.515	1	0.396	0.538
	Error	151.046	17	—	—
Middle Achi.	Contrast	18.770	1	0.873	0.357
	Error	666.731	31	—	—
Low Achi.	Contrast	1.963	1	0.139	0.714
	Error	239.893	17	—	—

Table 9: The questions of the questionnaire of the satisfaction survey.

No.	Question
QB-1	I am satisfied with the displaying of the e-learning materials.
QB-2	The displaying of the e-learning materials is more vivid, interesting, and variegated.
QB-3	The displaying of the e-learning materials helps me to learn more about the course.
QB-4	I am satisfied with the abundance of the learning materials in the e-learning course.
QB-5	I pay more attention on the e-learning course than traditional courses.
QB-6	The repeating of using e-learning materials helps me to enhance my learning performance.
QB-7	The e-learning can help me to conduct the real-time learning activities on the part which I don't understand.
QB-8	In e-learning, I can arrange my learning progress based on my own needs.
QB-9	I can learn some learning topics which I don't understand by myself without the fear of asking questions in front of the public (classmates).
QB-10	The e-learning has more learning space than traditional learning.
QB-11	The interactions with the teachers and classmates through the discussion board in the e-learning platform assist me to learning more about this course.
QB-12	The operation menu of the e-learning platform is easy to understand.
QB-13	The manipulation of the e-learning platform is easy to use.
QB-14	The functions provided by the e-learning platform are enough.
QB-15	Using the e-learning platform helps me to learn more about the functions of computes.
QB-16	The materials of the e-learning are much easier to absorb and understand than those of traditional learning.
QB-17	If a course provides two learning types: e-learning and traditional learning, I will choose the e-learning method rather than the traditional one.
QB-18	In general, the e-learning of the CAD course help me a lot in conducting my learning activities.
QB-19	In the CAD course, the e-learning is more acceptable for me than a traditional learning.
QB-20	I hope other courses can be taught through e-learning.

Table 10: The Cronbach α s of the questionnaire.

Dimension	Question No.	Cronbach α
Overall	QB1 to QB-20	0.907
Contents and presentation	QB1 to QB-5	0.698
Curriculum design	(QB6 to QB-10)	0.772
Learning environments	QB11 to QB-15	0.789
Learning mode	QB16 to QB-20	0.776

Table 11: The descriptive statistics in Part A.

Item	Value	N	%
Gender	Male	38	100
	Female	0	0
E-learning experience	Yes	2	5
	No	36	95
Total hours of using internet per week	$h^* \leq 7$	25	65
	$7 < h \leq 14$	5	13
	$14 < h \leq 21$	1	2
	$21 < h$	7	20
Commonly used internet activities	Obtaining software	9	24
	Searching information	6	16
	Using email	14	37
	Playing on-line game	30	79
	Chatting and making friend	22	58
	Browsing leisure information	7	18
	Reading news and magazine	6	16
Shopping	3	8	

*: h = total hours per week

Table 12: The statistical results of the satisfaction if the e-learning course.

Dimension	Question No.	Mean	Hypothesis 1		Hypothesis 2		Scheffe's comparison
			F test	Sig.	F test	Sig.	
Contents and presentation	QB-1	3.68	0.644	0.592	1.781	0.169	
	QB-2	3.50	0.842	0.480	2.607	0.068	
	QB-3	3.63	0.256	0.857	2.273	0.098	
	QB-4	3.39	1.114	0.357	1.087	0.368	
	QB-5	3.32	1.013	0.399	0.710	0.553	
Curriculum design	QB-6	3.71	0.370	0.775	1.189	0.328	
	QB-7	3.74	0.823	0.490	2.403	0.085	
	QB-8	3.58	2.089	0.120	0.372	0.774	
	QB-9	3.71	1.544	0.221	3.344	0.030*	4 > 3
	QB-10	3.53	1.643	0.198	0.168	0.917	
Learning environments	QB-11	3.66	1.064	0.377	4.243	0.012	4 > 3; 4 > 1
	QB-12	3.53	0.300	0.825	0.816	0.494	
	QB-13	3.63	0.631	0.600	1.100	0.362	
	QB-14	3.50	0.407	0.749	2.413	0.084	
	QB-15	3.61	1.169	0.336	2.243	0.101	
Learning mode	QB-16	3.55	1.417	0.255	1.018	0.397	
	QB-17	3.68	0.829	0.487	1.771	0.171	
	QB-18	3.66	1.023	0.395	6.760	0.001**	4 > 3; 1 > 3
	QB-19	3.55	0.613	0.611	2.091	0.120	
	QB-20	3.58	01.647	0.197	0.591	0.625	

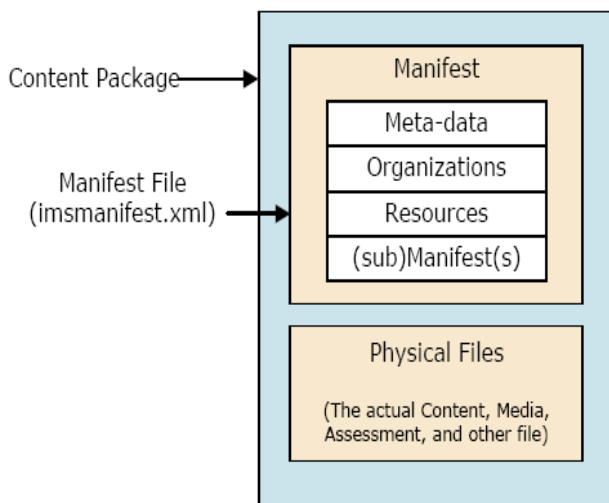


Figure 1: The conceptual diagram of a content package (taken from [3]).

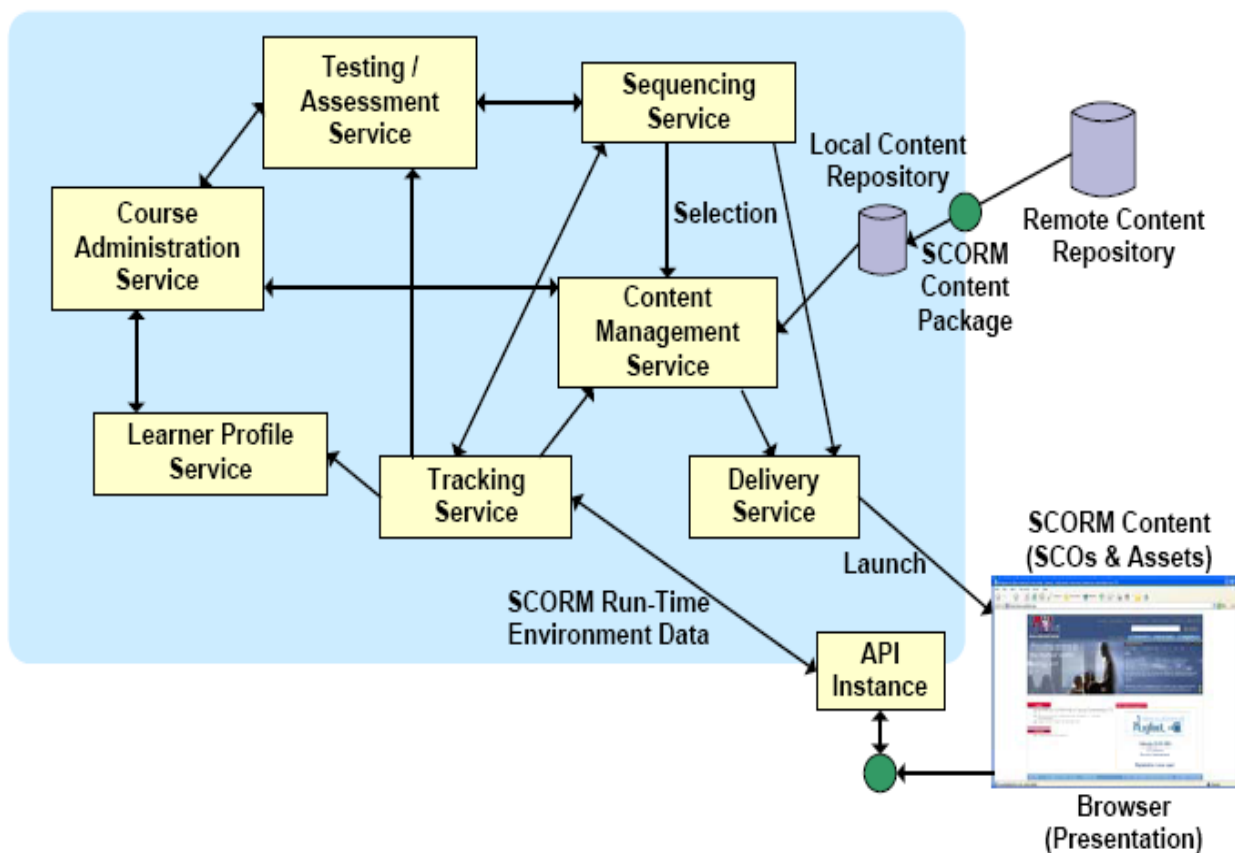


Figure 2: The schema of a SCORM-based learning management system (taken from [3]).

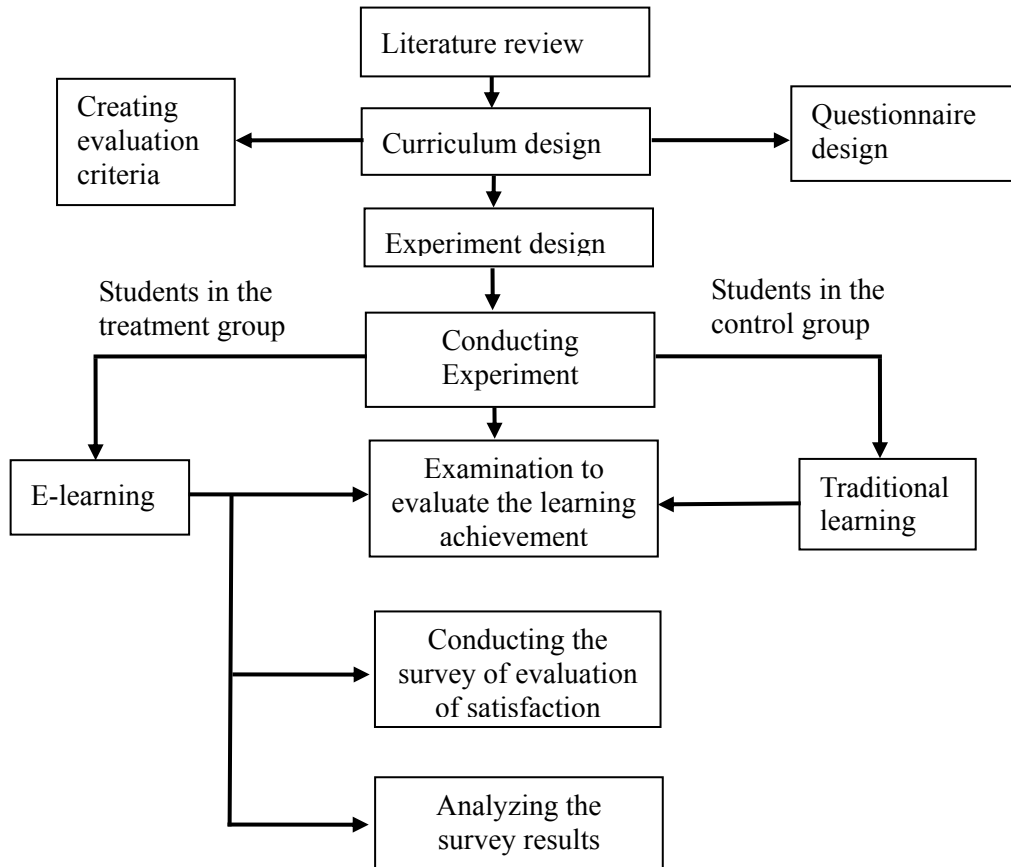


Figure 3: The conceptual diagram of the research design [11].

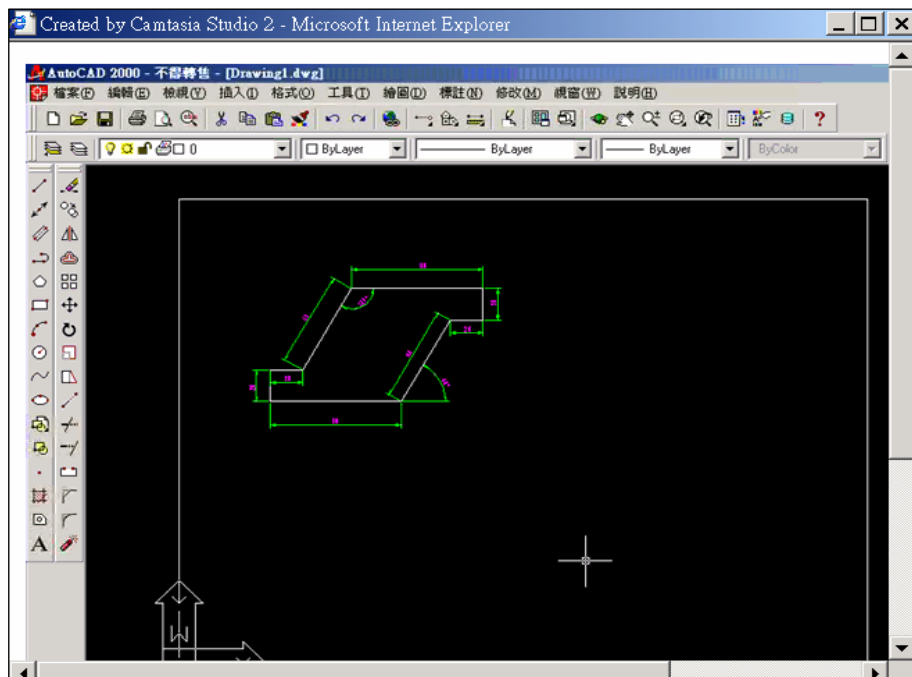


Figure 4: A snapshot of playing the e-learning materials of the CAD course [11].

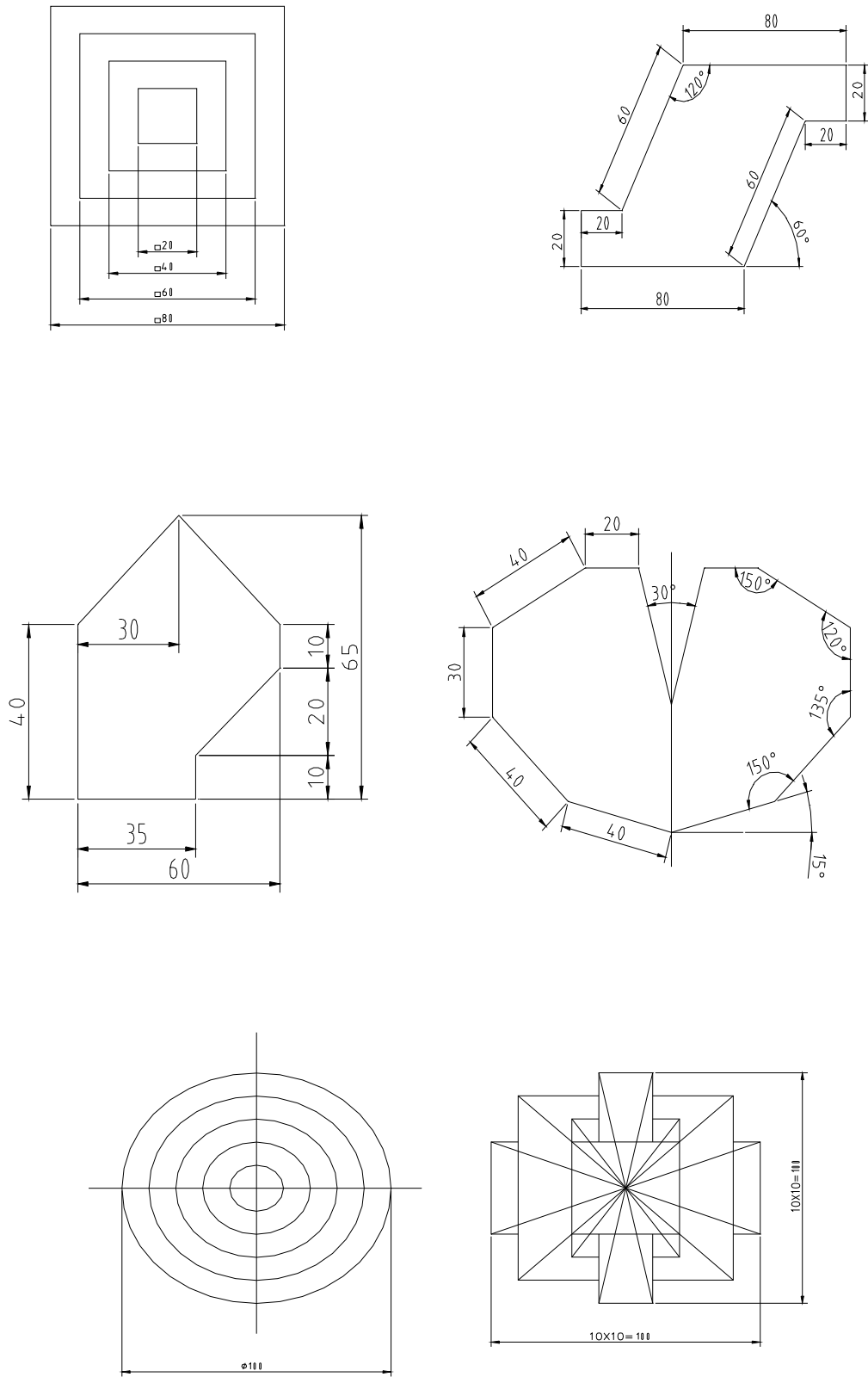


Figure 5: Selected CAD design samples.

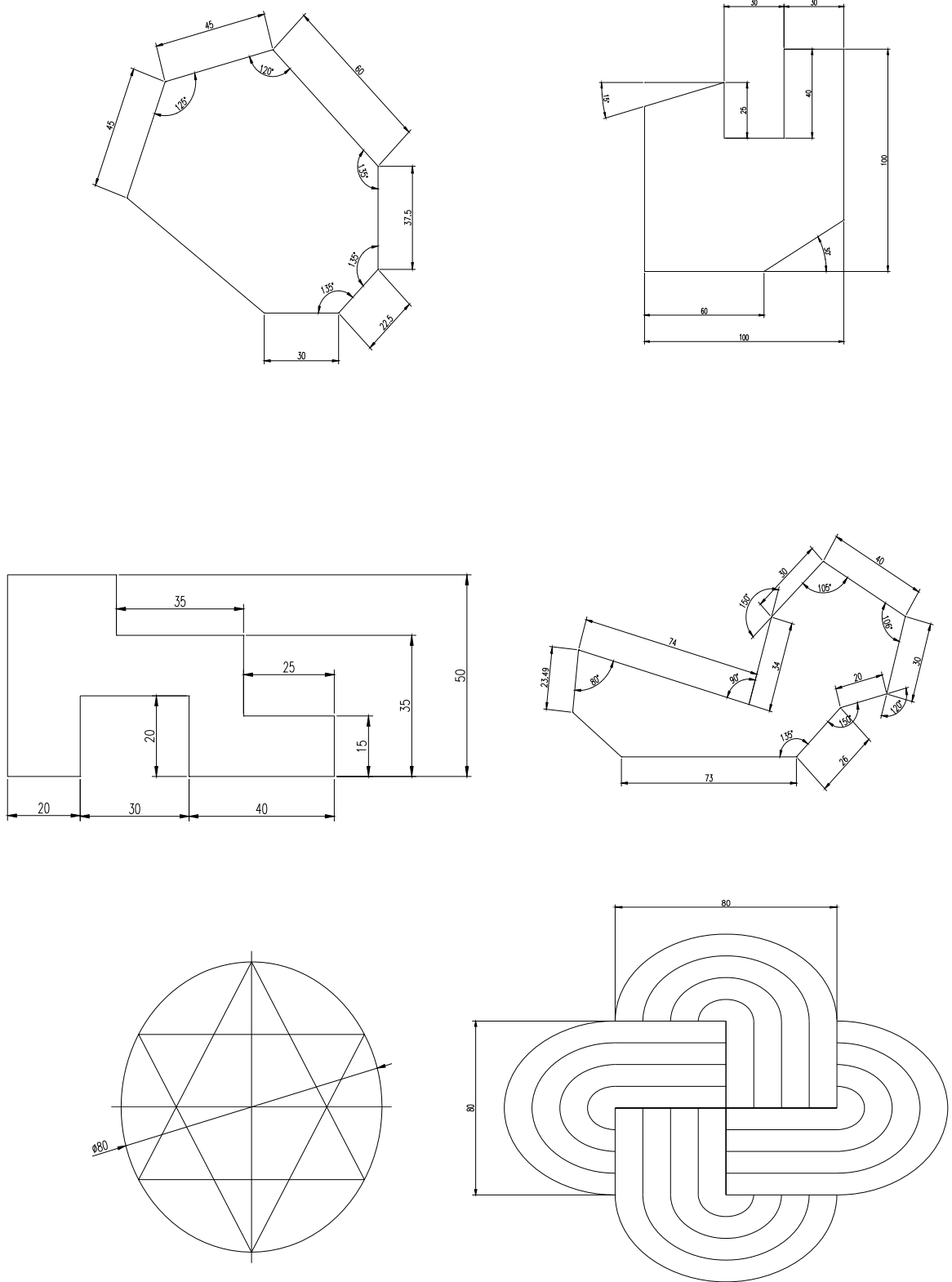


Figure 6: Selected CAD design questions of the overall examination.