Building Project-Based Learning Platform for the Capstone Project

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Abstract: The goal of capstone project is to train students to be able to apply the required knowledge and skill to collaboratively complete the assigned work. The project-based learning (PBL) is a popular strategy used by teachers to guide students to organize teams to solve problem collaboratively and to enhance students' creative and problem solving abilities in capstone project. However, the traditional PBL strategy cannot effectively enhance the students' abilities because the previous good cases cannot be easily shared and reused. Therefore, our idea is to develop a good platform to be able to share and reuse the cases together with portfolios to motivate student's imaginative power and creativity and the teachers can easily assess the students' learning achievements. Because Case-Based Reasoning (CBR) techniques consisting of cases retrieve, reuse, revise and retain can be used to model the computer reasoning, we develop a project-based learning platform using the CBR techniques to provide the case scaffoldings and reserve the learning portfolio. We further design an experiment based upon our learning platform to complete the e-book visual creative design. The experimental result shows that the given appropriate learning scaffoldings can guide students to improve the creative and problem solving abilities.

Keywords: problem solving learning, project-based learning, case-based reasoning, capstone project.

1. Introduction

The goal of capstone project is to train students to be able to apply the required knowledge and skill to collaboratively complete the assigned work (Gardner and Van der Veer, 1998; Brown, 2004; Todd et al., 1995). Through the capstone project, students should have the ability to solve complex problems with effective communication ability. As we know, project-based learning (PBL) is a popular strategy used by teachers to motivate students learning and to develop students' professional knowledge and problem solving abilities (Hung et al., 2014; Barrows, 1996). In general, the PBL strategy is often used to guide students to organize teams to solve problem collaboratively and to enhance students' creative and problem solving abilities in capstone project in the last year of the students' undergraduate study.

However, the traditional PBL strategy cannot effectively enhance the students' creative and problem solving ability (Barab & Luehmann, 2002; Barak & Dori, 2004; Barron et al., 1998; Edelson et al., 1999; Solomon, 2003) because the previous good cases cannot be easily shared and reused. Therefore, in this paper, our idea is to develop a good platform to be able to share and reuse the cases together with portfolios to motivate student's imaginative power and creativity to guide students learning, and therefore the teachers can easily assess the students' learning achievements.

In recent years, capstone project of learning design or e-book design has become a hot topic in many information management related departments. With our observations, students can hardly complete their project in e-book production, because they usually lack creative and problem solving abilities to present the ideas and effects of design. Therefore, having creativity to present idea and problem solving abilities to solve these problems is very important.

For creative and problem solving abilities learning, establishing a set of standards process should be able to improve the students' learning motivation and learning effectiveness. Although PBL is indeed a good learning strategy, applicable techniques are still needed to improve the learning effectiveness

(Hwang, Shi, & Chu, 2011; Mora Luis et al., 2014). Because case-based reasoning (CBR) techniques consisting of cases retrieve, reuse, revise and retain can be used to model the computer reasoning (Aamodt & Plaza, 1994), we develop a project-based learning platform using the CBR techniques to provide the case scaffoldings and reserve the creative and problem solving abilities learning portfolio in capstone project. Depending on the students' characteristics and learning portfolio to retrieve appropriate cases as creative learning framework and trigger students' creative thinking to assess the achievements of the capstone project.

In this paper, we focus on creative design of e-book in the capstone project consisting of story design phase, style design phase, and layout design phase. Each phase needs its appropriate creative and problem solving abilities to achieve a complete visual creative design of e-book. Since multi-phase design thinking needs to consider the design links and consistency between the design phases, the creative brainstorming activity is not easy for students. Hence, there often exist inconsistencies between idea and the final productive result.

Our project-based learning platform is a spiral model; each spiral corresponds to a design phase; each design phase consisting of four steps: similar case inquiry, brainstorming, collaborating and discussing. For assisting students' brainstorming activity, the processes of the cases and teams' learning portfolio are stored. For different design phase, according to the characteristics of case, we also define the similarity functions to retrieve appropriate cases. CBR case retrieve, reuse or revise, and retain techniques are used to assist students to solve the difficulties in case inquiry, brainstorming, and discussing, respectively.

We further design an experiment based upon our learning platform to complete the e-book visual creative design with capstone project. The students are divided into experimental group and control group. The experimental group used the project-based learning platform in each e-book production phase and the control group only used the traditional PBL learning strategy to develop their e-book. The experimental result shows that the given appropriate learning scaffoldings can guide students to improve the creative and problem solving abilities.

2. Related Works

PBL has been proved to be an effective learning strategy (Blumenfeld et al., 1991; Huang et al., 2002). In the capstone project, the students are grouped into several teams, each of which should complete a project and develop their core abilities through interaction and collaboration with other students (Edward, 1995; Jang, 2006a; Jang, 2006b; Johnson & Aragon, 2002; Prince & Felder, 2007; Chang & Lee, 2010). With the progress of new era, e-PBL (PBL joins the IT technology) is used as a powerful tool to simulate the dangerous or expensive projects and provide scaffolding assist students learning (Rienties et al., 2012; Chu & Hwang, 2010; Heo et al., 2010; Raud & Vodovozov, 2010; Rooij, 2009; Domínguez & Jaime, 2010; Keser & Karahoca, 2010). The e-PBL can improve the effectiveness of learning by the following steps (Barron, 1998; Edelson et al., 1999; Solomon, 2003; Chang & Lee, 2010):

1. Inquiring: Students inquire and collect of various materials
2. Reflection: Reflect and learn about the original subject
3. Selection: Select the appropriate solution
4. Presentation: Present the project result
5. Analysis: Analyze the capstone project process and final result
6. Conclusion: Discuss and share findings and conclusions

However, without good platform, the previous cases cannot be properly stored and reused, and the achievement cannot be easily assessed. Therefore, in the capstone project learning, PBL using CBR techniques can provide appropriate learning scaffolding to assist students and improve learning performance.

3. Capstone Project Learning Platform

Good strategies with the appropriate learning scaffolding can allow students to obtain the creative and problem solving abilities with the consideration of the viewpoints of person, the process, the product, and the environment (Torrance, 1993; Sternberg, 1999). Brainstorming is often used to shorten the design process (Yu et al., 2011). But, these previous good cases cannot be easily shared and reused without appropriate learning platform.

In this paper, we use CBR techniques consisting of cases retrieve, reuse, revise and retain to model the workflow of the traditional capstone project. Creative thinking, which is the first task in the capstone project, should be free and unrestricted in theory. In reality, the learning resources are limited in the school's learning environment. For improving students' creative and problem solving abilities, we apply case retrieval techniques to assist students to achieve learning objectives from previous good cases, and also design the appropriate learning scaffolding to assist students learning in capstone project. In the rest of this paper, we use the e-book creative design capstone project as an example to elaborate our method.

As shown in Figure1, the creative design of e-book can be divided into story design phase, style design phase, and layout design phase, each of which can be beneficial from project-based learning platform using CBR techniques. To facilitate the brainstorming and ensure the entire e-book visual creative design integrity, the platform provides the case scaffoldings and reserves the creative and problem solving abilities learning portfolio from capstone project repository. The capstone project repository consists of case file and learning portfolio file. The case file consists of the previous good cases and the learning portfolio file consists of the teams' learning portfolio. For the animated fairy tale e-book, the case and learning portfolio are defined as below.

Case = < c-id, story-kw, user, synopsis, style-kw, style, layout-kw, layout, member, role, task >
where c-id is used to denote the id of the case,
story-kw is used to denote the keywords about the story design phase of the case,
user is used to denote the users that the e-book is created for,
synopsis is used to denote the synopsis of the story,
style-kw is used to denote the keywords about the style design phase of the case,
style is used to denote the style of the case,
layout-kw is used to denote the keywords about the layout design phase of the case,
layout is used to denote the layout of the case,
member is used to denote the members of the students,
role is used to denote the role of the member in the team,
task is used to denote the members' task in the team.

Learning portfolio = < c-id, (P_1, S_1, M_1, T_1, O_1), (P_1, S_2, M_2, T_2, O_2), ⋯, (P_i, S_j, M_j, T_j, O_j), ⋯, (P_3, S_4, M_4, T_4, O_4) >
where c-id is used to denote the id of the case,
P_i is used to denote the i-th phase of the platform, for i=1, 2, 3,
S_j is used to denote the j-th step of the phase, for j=1, 2, 3, 4,
M_j is used to denote the members who participate in j-th step of the phase,
T_j is used to denote the members' task in j-th step of the phase,
O_j is used to denote the outcomes in j-th step of the phase.

For different design phase, according to the characteristics of case, we also define the similarity functions to retrieve appropriate cases. The values of the similarity function are between 0 and 1. The higher the value is, the greater the similarity.

Story similarity function = story-kw*0.5+user*0.2+ synopsis *0.3
Style similarity function = style-kw*0.7+style*0.3
Layout similarity function = layout-kw*0.7+layout*0.3

The project-based learning platform based on e-PBL consists of four steps: similar case inquiry, brainstorming, collaborating, and discussing, where the modified CBR including Case retrieve, reuse/ revise, produce collaboratively, and retain techniques is used to assist students to solve the difficulties in similar case inquiry, brainstorming, collaborating, and discussing, respectively. The relationship between platform and the modified CBR techniques is shown in Table1. Thus, the platform can provide creative thinking and make up the traditional PBL strategy.

Table1. The relationship between platform and the modified CBR techniques.

Steps	The problem-based learning platform	e-PBL steps	Modified CBR techniques
1	Similar Cases Inquiry	Inquiring	Case Retrieve
2	Brainstorming	Reflection, Selection	Case Reuse or Case Revise
3	Collaborating	Presentation	Produce collaboratively
4	Discussing	Analysis, Conclusion	Case Retain

Step1. **Similar case inquiry**: According to students' characteristics and learning portfolio, CBR case retrieve technique is used to inquire appropriate learning scaffolding in the learning process. This step corresponds to e-PBL inquiring step.

Step2. **Brainstorming**: According to the learning scaffolding, CBR case reuse or case revise technique is used to assist students to brainstorm and trigger creativity in the learning process. This step corresponds to e-PBL reflection and selection steps.

Step3. **Collaborating**: Students collaborate to stimulate their creativities in the learning process. This step corresponds to e-PBL presentation step.

Step4. **Discussing**: CBR case retain technique is used to clarify the capstone project and assist students to discuss and share their experiences in the creative process. This step corresponds to e-PBL analysis and conclusion steps.

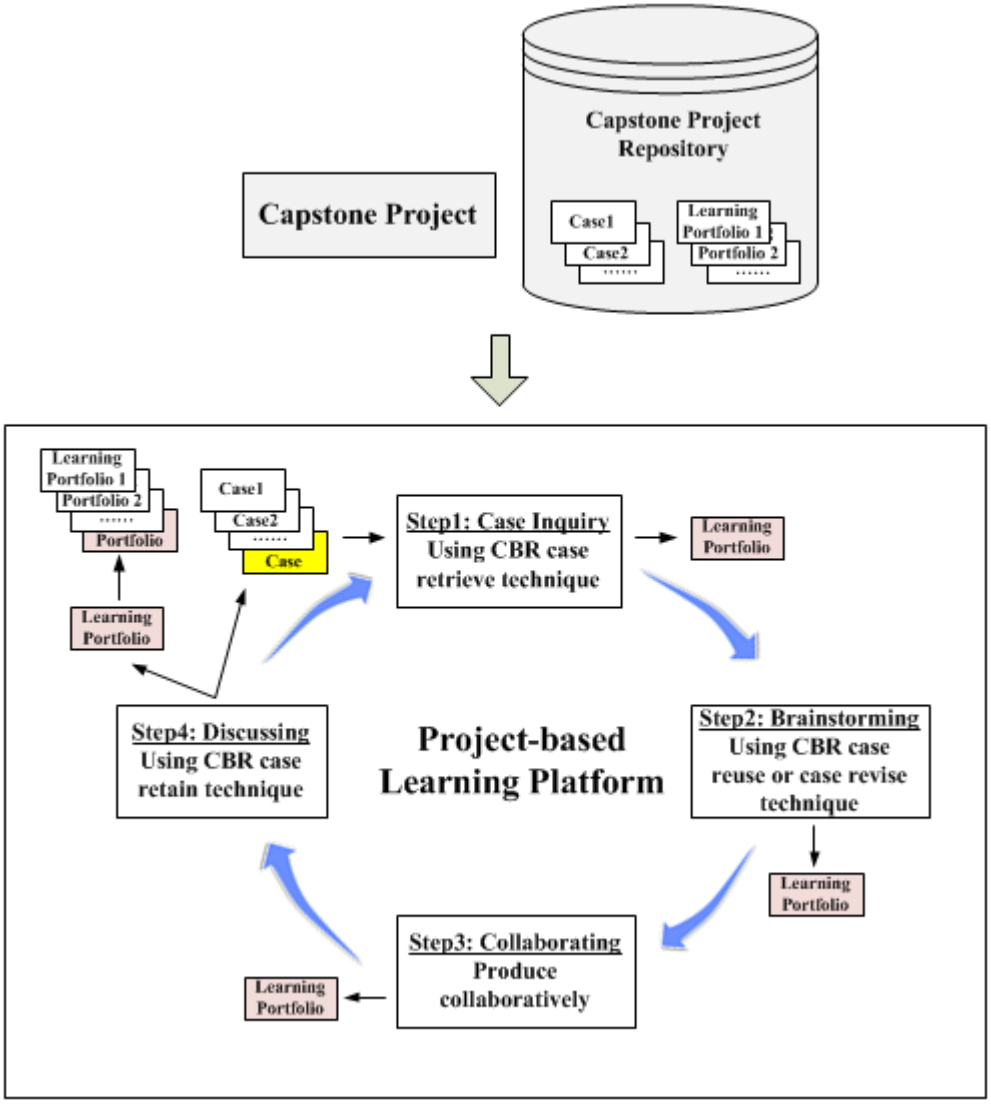

Figure 1. Project-based learning platform using CBR techniques

The project-based learning platform is a multi-step spiral learning model, as shown in Figure2. In the spiral creative learning model, the learning objectives can be gradually achieved from outside to inside, where each spiral consists of similar case inquiry, brainstorming, collaborating and discussing to be able to preserve the integrity of design and creativity in e-book production process.

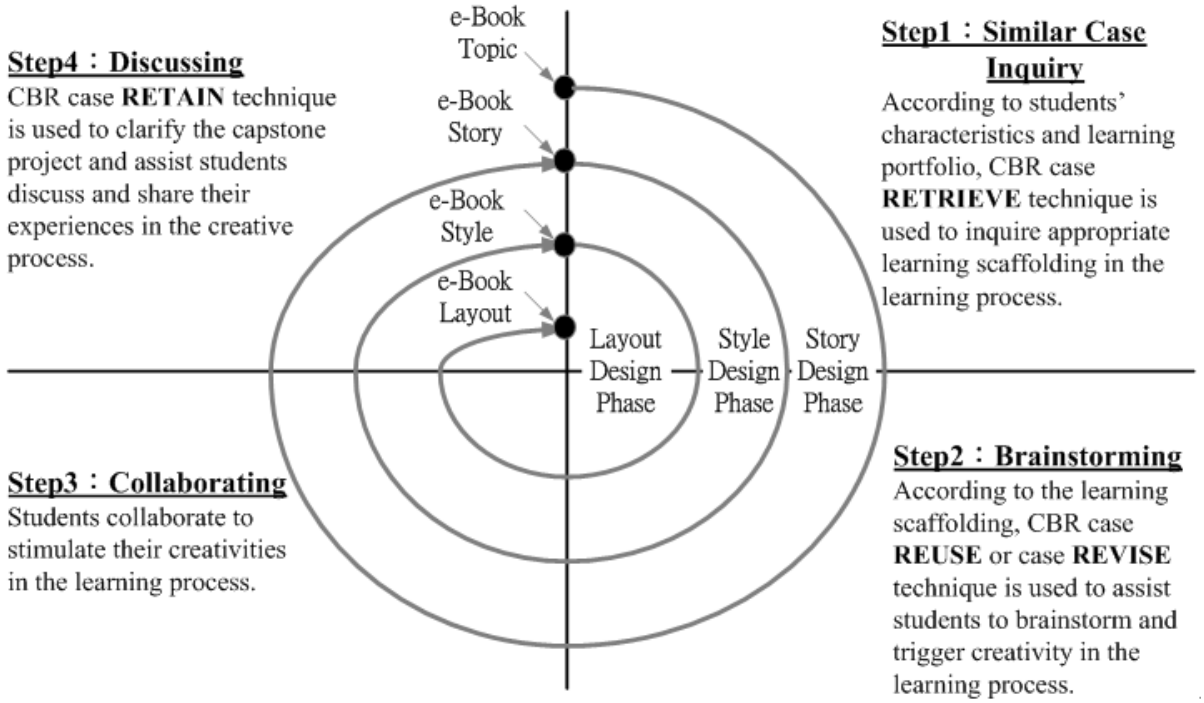

Figure 2. Multi-step spiral PBL learning model

In the animated fairy tale e-book project, the team has four members to produce the e-book in accordance with the story design, style design, and layout design in capstone project.

Story design phase

Step1. Similar Case Inquiry

This fairy tales of the e-book is created for children. In the beginning of the production, the team members discussed and decided the protagonist of the story is bear cub and the story type is "Explore"; the bear cubs are the main material of the e-book; the story keyword could be "Explore", "Fantasy" or "Journey". Then, appropriate cases with high story similarity will be retrieved as the scaffolding.

Step2. Brainstorming

Using the learning scaffoldings retrieved from step1, the team members can create a variety of story synopsises through reusing or revising the scaffoldings.

Step3. Collaborating

The team members collaborate to consolidate a variety of story to a final version.

Step4. Discussing

In this step, the team members discuss and clarify the learning process of the design phase and share their experiences with each other. The teacher observes and records learning performance as the reference of the next stage. After this step, the team will go back to step1 and start the next learning process.

Style design phase

Step1. Similar Case Inquiry

The team members discuss and decide the style of the story is "Interstellar". The story keyword could be "Star", "Astronomical" or "Universe". Then, appropriate cases with high style similarity will be retrieved as the scaffolding.

Step2. Brainstorming

Using the learning scaffoldings retrieved from step1, the team members brainstorm a variety of style through reusing or revising the scaffoldings.

Step3. Collaborating

The team members collaborate to consolidate a variety of style to a final version.

Step4. Discussing

In this step, the team members discuss and clarify the learning process of the design phase and share their experiences with each other. The teacher observes and records learning performance as the reference of the next stage. After this step, the team will go back to step1 and start the next learning process.

Layout design phase

Step1. Similar Case Inquiry

For the creation of animated style fairy tale story, "Kids' story house" is retrieved from the case repository to be the learning scaffolding in this phase. As shown in Figure3, this is the 1-1-2 frame. The page is divided into upper and lower parts. The upper part of the page is divided into left and right areas. The left area is the logotype area and the right area is the function area. The lower part of the page is content area displaying the contents of the page.

Figure 3. Inquiring the learning scaffolding by CBR case retrieval technique

Step2. Brainstorming

Using the learning scaffolding retrieved from step1, the team members create a variety of different schemes, as shown in Figure4. The more schemes, the higher the degree of the students' creativity is stimulated. We find that the schemes have the following common features: (1) bear cubs, (2) 1-1-2 frame. We believe that the learning scaffolding retrieved from step1 has a great impact on the students' production.

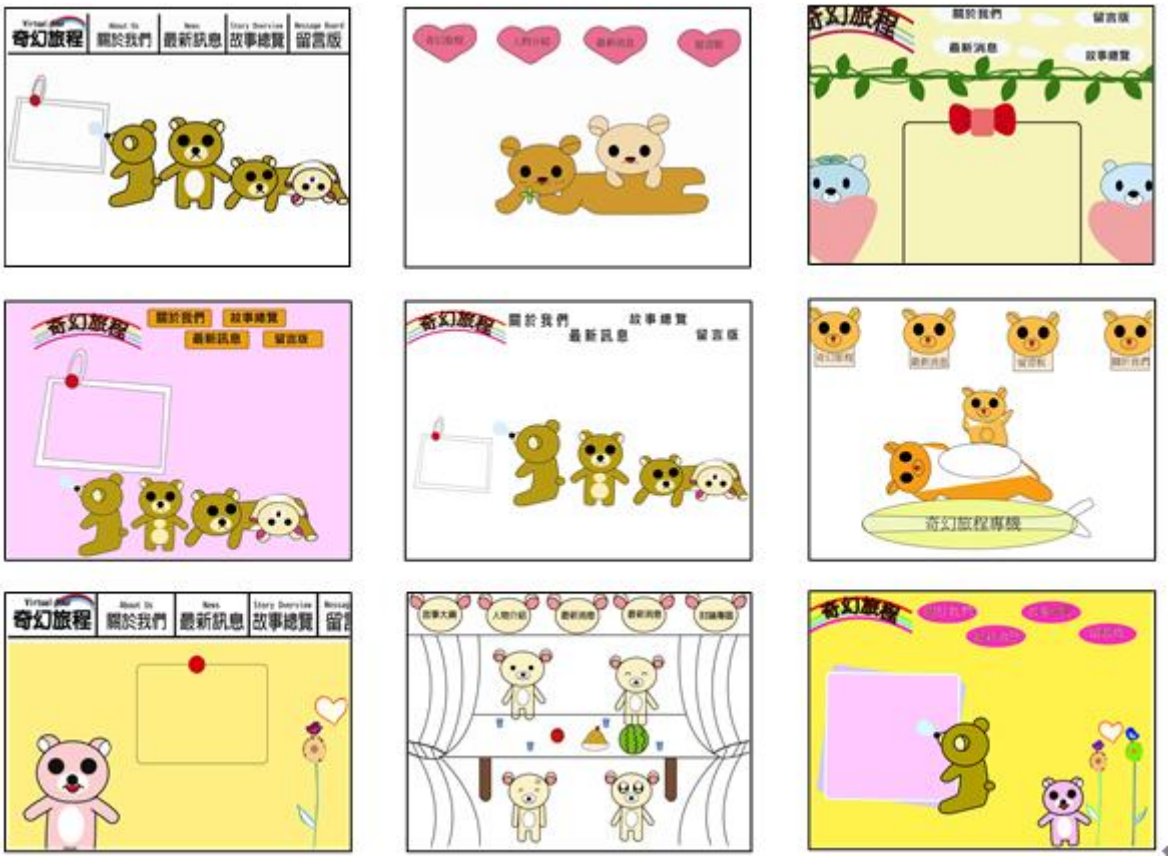

Figure 4. A number of schemes for the layout design of the animated fairy tale story

Step3. Collaborating

All of the members participate in this step. Team members state the creative ideas about the schemes generated in step2. Through voting or asking teacher for advice, consolidate these schemes into feasible solutions, as shown in Figure5.

Figure 5. Converging collaboratively a number of schemes into one scheme

Step4. Discussing

In this step, students discuss and clarify the learning process of the design phase and share their experiences with each other. The teacher observes and records students' status and learning performance as the future reference.

4. Experiment and Findings

4.1 Experiment

Eight students who study the capstone project course are divided into experimental group and control group to complete the e-book visual creative design in the experiment. In accordance with the story design phase, style design phase, and layout design phase to complete the e-book visual creativity, each phase lasts for a week for two groups of students, where the experimental group used the project-based learning platform in each e-book production phase and the control group only used the traditional PBL learning strategy to produce the e-book.

The experimental result shows that the number of creative ideas proposed in the experimental group is more than that in the control group in the design phases of visual creativity, as shown in Table2.

Table2. The comparison of the quantities of creative ideas between the experimental group and control group

	Story Design Phase	Style Design Phase	Layout Design Phase
Experimental Group	8	9	14
Control Group	2	4	3

For understanding the students' inner thoughts and feelings, we designed a questionnaire and performed an in-depth interview about the capstone project process. The questionnaires consisting of 6 items were revised from Wang and Hwang (2012) and Hwang et al. (2013) questionnaires. The questionnaire result shows that the experimental group thought that the learning scaffolding could benefit the brainstorming, and the final result of the design is consistent with the initial design idea. With the guidance of learning scaffolding, the pressure and discomfort of the students in the capstone project process can be reduced, and the experimental group felt more confident in the learning process. Such a feeling is very important for e-book production. In particular, the students believed that the relationship among the team members is better than before.

According to the in-depth interview results, the experimental group thought that in the story design phase, the creativity is not easy to present due to the difficulty of use of the unfamiliar software. The students are more proficient and more creative in the style design phase and layout design phase. We may conclude more learning scaffoldings are needed to inspire students thinking and to motivate the frequent interaction between the team members.

During the capstone project process, the experimental groups are apt to help each other to create a number of different schemes due to the understanding of each member's status. In many schemes, there are also some good creative ideas, and the team members can then collaboratively work out the final solution. During the discussions step, students express their views and ideas and record it as the reference in the next learning process.

On the contrary, the control group said they sometimes could not easily show up their ideas and could not design the outcome that they desired. Students sometimes asked the teacher to give advises, but most of the time they searched the relevant works to reference. The control group students could complete the tasks finally without collaboration in the capstone project process, so their design products are most likely worse than those of the experimental group's.

4.2 Findings

We have two findings:

1. The students sometimes have insufficient creativity in the capstone project, and they need good learning scaffolding as a seed to inspire. Thus, exploring an appropriate case as learning scaffolding can inspire students' creativity and problem solving brainstorming.
2. Learning the conducting of a capstone project can be divided into many phases, each of which has its creative target. The students' learning performance can be improved in our proposed multi-phase learning process.

5. Conclusion

For creative and problem solving abilities learning, we have developed a project-based learning platform which is a spiral model using the CBR case retrieve, reuse, revise, and retain techniques to assist students to solve the difficulties in case inquiry, brainstorming, and discussing, respectively. Therefore, it can provide the case scaffoldings and reserve the creative and problem solving abilities learning portfolio in capstone project. According to the students' characteristics and learning portfolio, the platform can be used to trigger students' creative thinking and assist teacher to easily assess the students' achievements of the capstone project. The experimental result shows that the given appropriate learning scaffoldings can guide students to improve the creative and problem solving abilities. In the near future, we will focus on the acquisition and analysis of the learning portfolio.

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References

Aamodt, A. and Plaza, E. (1994). Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches, *Artificial Intelligence Communications*,7(1), 39-59.

Anderson, R. E. (1992). Social impacts of computing: Codes of professional ethics. *Social Science Computing Review*, *10*(2), 453-469.

Barab, S.A., and Luehmann, A.L. (2002). Building sustainable science curriculum: acknowledging and accommodating local adaptation, *Science Education*, 87(4), 454-467.

Barak, M. and Dori, Y.J. (2004). Enhancing undergraduate student's chemistry understanding through project based learning in an IT environment, *Science Education*, 89(1), 117-149.

Barron, B.J.S., Schwartz, D.L., Vye, N.J., Moore, A., Petrosino, A., and Zech, L. (1998). Doing with understanding: lessons from research on problem- and project-based learning, *The Journal of the Learning Sciences*, 7(3-4), 271–311.

Barrows, H.S. (1996). Problem-based learning in medicine and beyond: A brief overview, *New Directions for Teaching and Learning*, 68, 3-12.

Blumenfeld, P.C., Soloway, E., Marx, R.W., Krajcik, J.S., Guzdial, M., and Palincsar, A. (1991). Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning, *Educational Psychologist*, 26(3-4), 369-398.

Brown S.C. (2004). Learning Across the Campus: How College Facilitates the Development of Wisdom, *Journal of College Student Development*, 45(2), 134-148.

Carson, D.K., and Becker, K.W. (2003). Creativity in psychotherapy: Reaching new heights with individuals, couples, and families, *New York: Haworth Press*.

Chan, T.W., Roschelle, J., Hsi, S., Kinshuk, Sharples, M., Brown, T., et al. (2006). One-to-one technology-enhanced learning: An opportunity for global research collaboration. *Research and Practice in Technology-Enhanced Learning*, 1(1), 3-29.

Chang, L.C., and Lee, G.C. (2010). A team-teaching model for practicing project-based learning in high school: Collaboration between computer and subject teachers, *Computer & Education*, 55, 961-969.

Chu, H.C., and Hwang, G.J. (2010). Development of a project-based cooperative learning environment for computer programming courses, *International Journal of Innovation and Learning*, 8(3), 256-266.

Conger, S., & Loch, K. D. (1995). Ethics and computer use. *Communications of the ACM*, *38*(12), 30-32.

Domínguez, C., and Jaime, A. (2010). Database design learning: A project-based approach organized through a course management system, *Computers & Education*, 55, 1312-1320.

Edelson, D.C., Gordin, D.N., and Pea, R.D. (1999). Addressing the challenges of inquiry based learning through technology and curriculum design, *Journal of the Learning Sciences*, 8(3-4), 391-450.

Edward, L.D. (1995). The design and analysis of a mathematical micro-world, *Journal of Educational Computing Research*, 12, 77-94.

Gardner, J. N., and Van der Veer, G. (1998). The emerging movement to strengthen the senior experience. *In J. N. Gardner & G. Van der Veer & Associates* (Eds.), The senior year experience: Facilitating integration, reflection, closure and transition (pp. 3-20). San Francisco CA: Jossey-Bass.

Heo, H., Lim, K.Y., and Kim, Y. (2010). Exploratory study on the patterns of online interaction and knowledge co-construction in project-based learning, *Computers & Education*, 55, 1383-1392.

Huang, G.Q., Shen, B., and Mak, K.L. (2002). Participatory and collaborative learning with TELD courseware engine, *Journal of Professional Issues in Engineering Education and Practice*, 128(1), 36-43.
Hung, P.-H., Hwang, G.-J., Lee, Y.-H., Wu, T.-H., Vogel, B., Milrad, M., & Johansson, E. (2014). A Problem-based Ubiquitous Learning Approach to Improving the Questioning Abilities of Elementary School Students. *Educational Technology & Society*, 17(4), 316–334.
Hwang, G. J., Shih, Y. R., & Chu, H. C. (2011). A concept map approach to developing collaborative Mind-tools for context-aware ubiquitous learning. *British Journal of Educational Technology*, 42(5), 778-789.
Hwang, G. J., Yang, L. H., & Wang, S. Y. (2013). A concept map-embedded educational computer game for improving students' learning performance in natural science courses. *Computers & Education*, 69, 121-130.
Jang, S.J. (2006a). The effects of incorporating web assisted learning with team teaching in seventh-grade science classes, *International Journal of Science Education*, 28(6), 615-632.
Jang, S.J. (2006b). Research on the effects of team teaching upon two secondary school teachers, *Educational Research*, 48(2), 177-194.
Johnson, S.D., and Aragon, S.R. (2002). An instructional strategy framework for online learning environments, In M. Driscoll & T. Reeves (Eds.), Proceedings of E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education, 529-536.
Jonassen, D. H., Peck, K. L., & Wilson, B. G. (1999). Learning to Solve Problems with Technology: A Constructivist Perspective (2nd Edition). *Columbus, OH: Prentice Hall*.
Keser, H., and Karahoca, D. (2010). Designing a project management e-course by using project based learning, *Procedia Social and Behavioral Sciences*, 2(2), 5744-5754.
Mackay, W. E. (1995). Ethics, lies and videotape. In I. R. Katz, R. Mark, L. Marks, M. B. Rosson, & J. Nielsen (Eds), *Proceedings of CHI'95* (pp. 138-145). Denver, Colorado: ACM Press.
Mora Luis, C.E., Gutierrez, J.M., and González Marrero, A.M. (2014). Using mobile devices and internet technologies in problem-basedlearning: Design of a suitable active and collaborative learning environment in engineering education, *Frontiers in Education Conference (FIE), 2014 IEEE*.
Petty, G. (1997). How to be better at creativity, *London: Kogan Page Limited*.
Prince, M., and Felder, R. (2007). The many faces of inductive teaching and learning, J*ournal of College Science Teaching*, 36(5), 14–20.
Raud, Z., and Vodovozov, V. (2010). Project-based collaborative learning of electrical engineering master students, *IEEE Education Engineering (EDUCON)*, 1611-1617.
Rienties, B., Giesbers, B., Tempelaar, D., Lygo-Baker, S., Segers, M., & Gijselaers, W. (2012). The role of scaffolding and motivation in CSCL. *Computers & Education*, 59(3). 893-906.
Rooij, S.W.v. (2009). Scaffolding project-based learning with the project management body of knowledge (PMBOK®), *Computers & Education*, 52, 210-219.
Schwartz, M., & Task Force on Bias-Free Language of the Association of American University Press (1995). *Guidelines of Bias-Free Writing*. Bloomington, IN: Indiana University Press.
Solomon, G. (2003). Project-based learning: a primer, Technology & Learning, 23(6), 20.
Sternberg, R.J. (1999). Handbook of creativity. *Cambridge, UK: Cambridge University Press*.
Tan, A.G., and Law, L.C. (2004). Creativity for teachers. *Singapore: Marshall Cavendish International*.
Todd, R. H., Magleby, S. P., Sorensen, C. D., Swan, B. R., & Anthony, D. K. (1995). A survey of capstone engineering courses in North America. Journal of Engineering Education, 84(2), 165-174.
Torrance, E.P. (1993). Understanding creativity: where to start? *Psychological Inquiry*, 4(3), 232-234.
Wang, S. L., & Hwang, G. J. (2012). The role of collective efficacy, cognitive quality, and task cohesion in computer-supported collaborative learning. *Computers & Education*, 58(2), 679-687.
Yu, Y., Choi, T.M., Hui, C.L., and Ho T.K. (2011). A new and efficient intelligent collaboration scheme for fashion design, *IEEE Transactions on Systems*, Man, and Cybernetics : Part A : Systems and Humans, 41(3), 463-475.