A Study of Learning Effectiveness for PBL-flipped and PBL-online in a Digital Information Literacy Curriculum

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Abstract - This study integrates PBL and innovative teaching, flipped classroom and blended e-learning environments using the digital materials, “Information Literacy and Ethics”, to explore motivation for learning and learning outcomes. The study uses the ARCS motivation model as the quantitative indicator in an online questionnaire and in-depth interviews for qualitative analysis. The results show that the ARCS model is valid for both methods and that each method has its own advantages and disadvantages, in terms of learning outcomes. Based on the results, this study proposes four key elements for the promotion of PBL teaching and initiates a new and innovative teaching model - blended flipped online instruction - which produces the best learning outcomes.

Keywords: Problem-based learning, Innovative teaching, Flipped classroom, Blended learning, Information literacy.

1 Introduction

As information technology grows rapidly, educational technology has a crucial role in reforming teaching and learning models. Educational technology is widely used to facilitate learning and improve performance by creating, using and managing appropriate technological processes and resources [1]. The NMC Horizon Report noted that education paradigms were shifting to the integration of online learning, blended learning and cooperative learning and that this would be the fastest area of growth in educational technology for Higher Education [2]. Flipped learning is often referred to as an “inverted classroom”, where students watch recorded video lectures at home and do their homework exercises in school. Studies have shown that there is a lack of sufficient discussion digital learning platforms [3]. Datig and Ruswick found that an information literacy (IL) course that used the flipped classroom model allowed a more efficient and beneficial use of class time [4]. Mutula et al. found that IL was delivered online more frequently in higher education and that students preferred the medium of technology for library instruction to face-to-face instruction [5].

Problem based learning (PBL) is strengthened by the Constructivist approach. It is an instructional strategy that is organized around the study and resolution of problems [6]. PBL was introduced at McMaster University (Canada) in the 1960s. Originally, it was used particularly for traditional medical education [7]. However, the importance and the effect on students’ learning performance using PBL and learning via problem solving in technology-mediated PBL or using PBL in online environments have been the subject of many higher education studies worldwide in recent years [8]. PBL encourages collaboration and reinforces real world skills and it is believed that PBL enhances learning motivation and promotes the achievement of satisfactory learning performance. Students are confronted with a real or simulated problem that is a catalyst for the learning process. Students are transformed into active role players with responsibilities to develop skills in problem solving, so learning becomes reflective and involves a deep understanding of the materials. The challenges that are associated with integrating PBL and innovative teaching are manifold and are poorly documented. This study validates the ARCS model for motivation in the flipped classroom and online learning environment, analyses the learning outcomes for the two innovative teaching methods, proposes the key factors for a good PBL in an innovative teaching environment and proposes a new PBL model that produces the best learning outcomes.

2 The Five-step PBL model

The IL course for this study consisted of 3 PBL coursework in the Decision-making of Information Ethics, the Evaluation and Verification of Network Information and Internet Addiction. The coursework followed the 5-step PBL model. Within the PBL environment, the problem is a catalyst that initiates the learning process: 1. Students are introduced to an ill-structured problem that is related to their lives to increase interest and motivation; 2. Students analyze the problem to determine what they know about the problem and conduct independent investigation of the information needed to address the problem; 3. Students analyze the problem and identify action steps through collaboration; 4. Students generate possible solutions to the problem; 5. Students consider the consequences of each solution and select the most viable solution through metacognition.

The PBL process is supported by continuous reflection on the content and the process. This is improved on an ongoing basis by inputs from multiple sources and perspectives of assessment. The instructor acts as a facilitator and introduces the problem that is related to students’ lives, in order to increase interest and motivation. The instructor groups students and provides resources to promote teamwork. The instructor observes the PBL process and supports the group leaders to strengthen their leadership and stimulate effective
collaborative learning. The instructor also promotes self-regulated learning, in order to stimulate critical reasoning and elaboration on the topics. The instructor assesses the progress and designs the multiple evaluation scheme.

3 The ARCS model for motivation

The ARCS (Attention, Reference, Confidence, Satisfaction) model is created by generating a large list of motivational strategy statements, which are derived from research findings and real-world practices [9]. The strategy statements are then sorted into four requisite categories. Each category has three subcomponents. Attention is a prerequisite for learning. Attention refers to gaining and sustaining attention to the instruction by stimulating curiosity and interest. Relevance represents the importance and the value of learning. Confidence refers to building learners’ confidence in their ability to succeed in the learning task. Satisfaction refers to the potential for learning satisfaction. The ARCS model has been widely validated as a method for the systematic improvement of learner motivation and performance in e-learning settings [10]. The IL course for this study used an ARCS-based motivational course design for teaching and learning.

4 Research design

A total of 95 students (49 flipped and 46 online) were evaluated in the general education Information Literacy and Ethics digital materials for higher education module that is a product of the Ministry of Education in Taiwan. An ARCS-based online questionnaire used the first author’s previous research to measure students’ perception of their motivation [11]. In-depth interviews with group leaders and group members were used to gather qualitative evidence, in order to evaluate the PBL learning process. The questionnaire consisted of 20 items, which were derived from the four constructs of the ARCS model. Each construct is operationalized with five items, based on the subcomponents of ARCS model. The questionnaire items are measured using a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). A total of eight items (two in each construct) were removed because they exhibited cross-loading for different factors. Based on the first author’s previous research, the following hypotheses are proposed:

H1: Attention has a positive direct effect on relevance.
H2: Attention has a positive direct effect on confidence.
H3: Attention has a positive direct effect on satisfaction.
H4: Relevance has a positive direct effect on confidence.
H5: Relevance has a positive direct effect on satisfaction.
H6: Confidence has a positive direct effect on satisfaction.

5 Results and discussion

5.1 Validating the ARCS model

Regression analyses were performed to test the hypothesized relationships. As shown in Table 1, the factor loading for items meets the recommended threshold values of 0.60 (0.60–0.83). A reliability coefficient was computed for each factor, in order to estimate the reliability for each scale. All factors with a reliability coefficient of more than 0.8 (0.83–0.91) were considered to be acceptable in this study.

Table 1. Item factor analysis and reliability.

<table>
<thead>
<tr>
<th>Construct and item</th>
<th>Loading</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attention</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1 The content captured my interest and stimulated my curiosity.</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>A2 The multimedia motivated me and aroused my attention.</td>
<td>0.83</td>
<td>0.91</td>
</tr>
<tr>
<td>A3 The variability of instructional strategies helped keep my attention.</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td><strong>Relevance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R1 The content meets my personal needs and goals.</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>R2 The content uses concrete examples to illustrate the use of IL knowledge.</td>
<td>0.60</td>
<td>0.85</td>
</tr>
<tr>
<td>R3 It is clear to me how the content is related to things that I already know.</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td><strong>Confidence</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1 I could control the success of learning outcomes.</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>C2 The good organization of the content gave me confidence that I would master this material.</td>
<td>0.68</td>
<td>0.85</td>
</tr>
<tr>
<td>C3 I can establish the direction of self-learning after learning.</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td><strong>Satisfaction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1 Completing the course gave me a satisfying feeling of accomplishment.</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>S2 I believe that the course is worthwhile, in terms of study and daily life.</td>
<td>0.63</td>
<td>0.83</td>
</tr>
<tr>
<td>S3 I had a useful learning experience from the course tasks.</td>
<td>0.67</td>
<td></td>
</tr>
</tbody>
</table>

The R2 value shown in Figure 1 indicates that the coefficients in the ARCS model are generally statistically significant. The model explains a substantial proportion (flipped: 61% and online: 55%) of the variance in relevance. The respective variances for confidence and satisfaction are: flipped: 64%, online: 69% and flipped: 76%, online: 80%. The paths in the ARCS model, that is, Attention—>Relevance—>Confident—>Satisfaction, are all statistically significant (p-values between 0.001 and 0.01).
Figure 1. A summary of the path modeling and the statistical results

(Statistical significance is indicated by asterisks: ns: not significant; t>1.96 (p <0.05); t>2.58 (p <0.01); t>3.96 (p <0.001)

Figure 1 also demonstrates that for the flipped model, while attention is significantly related to relevance (H1), it also has a significant influence on confidence (H2), and while satisfaction is influenced by confidence (H6) in the model, there is a significant relationship between relevance and satisfaction (H5). Students may believe that they achieve a desirable level of success when they value the digital materials in a personally meaningful way and when those materials are relevant to their needs and goals. This increases confidence and sustains attention for learning. When students believe that the courses meet their expectations, positive quality perceptions are also generated and satisfaction is boosted.

Figure 1 also shows that for the online model, while satisfaction is significantly related to confidence (H6), it also is influenced by attention (H3). Students may achieve feelings of satisfaction as a result of interactive digital materials that attract their attention.

5.2 Learning outcomes

5.2.1 Class participation

The results show that the online group exhibits better engagement in the class and better performance than the flipped group, in terms of entering digital classroom times (flipped 426; online 815), reading hours (flipped 74:22:19; online 180:37:40), reading pages (flipped 974; online 1811) and average scores in the online exam (flipped 83.1; online 90.1). However, the flipped group exhibits higher average scores for the term than the online group (flipped 81.7; online 78.5). The online group also performs better than the flipped group in terms of self-regulated learning and collaborative learning that is required for PBL.

5.2.2 The PBL learning process

Parts of the in-depth interviews with group leaders and group members and feedback from the questionnaire are detailed herewith.

“We were all senior students and were busy planning our future careers. We created a FB club to make use of PBL, but the level of group engagement was low.” (flipped_groupLeader1)

“We were from different departments and were unfamiliar with each other. I asked group members to watch video lectures before PBL. I was satisfied with the PBL quality.” (flipped_groupLeader2)

“We were all from business school. We used PBL in class and on the Line social platform outside class. We had insufficient PBL engagement.” (flipped_groupLeader3)

“Based on my previous online learning experience, I thought that online PBL was more efficient than flipped PBL because students could do coursework at their own learning pace.” (flipped_groupLeader6)

“Based on my previous online learning experience, I suggested mixing the two models, because each model had its advantages and disadvantages.” (flipped_groupLeader7)

“We were all from design school. We used PBL entirely on the FB platform. I was happy that group members participated fully.” (online_groupLeader2)

“I hated PBL because our leader exhibited poor personal time management and often forgot the due date. I always had to complete the coursework at the last minute. I think that it was unfair that group members contributed little but still got marks!” (online_groupMember1)

“I made a concerted effort using PBL and the group members all worked hard to achieve our common goal, which was to achieve excellent grades.” (online_groupMember8)

The study shows that the online group gained more benefit than the flipped group and found that challenges were easier to overcome than did the flipped group. The two groups all gave negative feedback in the questionnaire on the theme of the ill-coordination of collaborative learning, using terms such as free-rider or irresponsible group leader. Overall, the study demonstrates that both models are viable for PBL IL courses.

6 Discussion and Conclusions

The IL courses in this study provide a student-centered, inquiry-learning environment, which promotes a more general and pervasive extrinsic orientation by allowing opportunities for self-direction and the acknowledgement of feelings about learning. This contrasts with the traditional, instructor-centered learning environment. Students who exhibit goal-oriented extrinsic motivation have a good chance of success if
they have a strong belief in their capabilities and make an effort, which in turn increases the intrinsic motivation that is derived from motivational instruction. Based on the results, four critical elements that increase the effectiveness of PBL are proposed:

1. Leadership: the study shows that good leadership allows a group to continuously produce excellent coursework. A good group leader creates a positive social climate and sense of community, encourages communication and leads the members to achieve common goals, participates in collaborative learning and increases confidence, which improves performance;

2. Self-regulated learning: this allows students to generate positive attitude towards responsible and active learning. This also depends on motivation and self-discipline, students who remain motivated and excited in the face of difficulties can persevere and experience increased feelings of self-efficacy when they use PBL;

3. In terms of the application of ARCS to teaching and learning, the IL digital materials are effective in capturing students’ interest and in stimulating a curiosity to learn and when the materials meet the students’ needs/goals, a positive attitude is generated. Instructors can increase students’ confidence by encouraging them to master the materials and control their individual success. The instructor reinforces accomplishment with internal/external rewards to increase the students’ satisfaction with the learning experience;

4. A proper learning environment: students in the general education curricula are from different grades and departments and not necessarily familiar with each other, so a well-planned learning environment that provides course assessment and a smooth network environment are all important factors that directly affect the efficiency of learning.

This study proposes that PBL should take account of institutional requirements, course objectives, learning context and the characteristics of learners. The study proposes a new innovative teaching mode by integrating both methods in a scheme that is termed, “blended flipped online instruction”. This provides a workable model that produces the best learning outcomes. The instructor starts with flipped PBL, in order to establish leadership in the group leaders and to encourage self-regulated learning by group members. The instructor also supports the PBL process by providing a proper learning environment that stimulates student engagement. The instructor monitors group communication and provides timely feedback whenever it is required. Students then continue to use PBL coursework with collaborative learning in an online community at an individual learning pace, which increases the effectiveness of learning. This innovative blended teaching mode retains the benefits of flipped PBL and online PBL and addresses the difficulties that each method presents.

7.Acknowledgement
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8. References