Designing and implementing constructionist learning in a blended advertising photography course

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Abstract: This study involved designing and implementing constructionist learning in an undergraduate advertising photography course. The design and implementation involved face-to-face learning blended with a course application that provided access to online tools such as a Facebook group, Google classroom and Moodle. The first objective involved the creation of a framework to guide the design of constructionist learning in the course. The second objective involved designing learning activities with technology and implementing the learning in the course over a five-week period. The third objective involved measuring students' achievement and satisfaction. Results related of the design highlighted the centrality of students' artefact creation and of collaborative learning by doing and making. Implications for practice relate to the value of use of new and emerging technologies to engage students not only in active forms of learning but also in the production of artefacts of their learning.

Keywords: constructionism; Moodle; Facebook; higher education; instructional design.

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1 Introduction

The exponential growth in information and communication technologies (ICTs) has provided an impetus to engage students in new forms of learning. These forms of learning rely on what is broadly referred to as constructivist versus instructivist approaches. The latter rely on an objectivist epistemology where "knowing and learning are processes for representing and mirroring reality", while the former conceptualise these processes in terms of "actively interpreting and constructing individual knowledge representations" (Jonassen, 1991, p.5). These forms of learning are made possible through students' use of ICTs that provide direct access to powerful tools for building and sharing knowledge collaboratively. More importantly, these powerful tools support not only construction of knowledge but also of student-created artefacts. According to this approach, students learn by doing, by making, by representing their knowledge and by creating. This form of learning has been termed constructionism (Papert, 1980, 1991). Rather than merely generating papers for submission or answering examination questions as the product of learning, a constructionist approach aims to engage learners in the creation of artefacts.

Constructionism grew out of Papert's (1980) research on and development of the programing language Logo in the 1960s at the Artificial Intelligence laboratory at MIT and the MIT Media Laboratory. Constructionism is 'a theory of learning and a strategy for education' (Kafai and Resnick, 1996). A constructionist approach to learning and knowledge arises through a process of active construction. Papert (1980) illustrated and tested this approach to learning in his seminal work 'Mind Storms', which described how children used a programing language to create, rather than merely play, a game. Constructionist learning experiences require learners to have existing knowledge in order to engage in the construction of complex artefacts (Dreher et al., 2009). The construction

of artefacts "promote[s] the internal activity of constructing knowledge through the external activity of constructing a representation or manipulation of that knowledge" (Clinton and Rieber, 2010, p.764). Papert (1990) contended that constructionism is more than 'learning by doing' and also encompasses 'learning by making'. Moreover, Papert explained that knowledge is best constructed in a social context where the participants make something shareable as the foundation for productive learning environments.

Papert (1990) outlined the main principles behind constructionism. The first principle is learning by doing, according to which students learn better when learning is part of doing something they find relevant and meaningful. The second principle is technology as building material. Students can create more interesting artefacts because of the availability of digital technology. Thus, constructionism typically relies on computational environments. The third principle is enjoyment and engagement. If students enjoy what they are doing, they will accept the challenges and enjoy working hard. The fourth principle is learning to learn and taking charge of one's own learning. The fifth principle is learning to manage time for learning. The sixth principle is the most important and emphasises learning from mistakes. The seventh is, as instructors, to do unto ourselves what we do unto students, because each one is different. The eighth idea is that digital technologies are as important as reading and writing.

Constructionism is grounded in constructivism. Constructivism sees learning as an active process of knowledge construction and not one of transmission of knowledge from teacher to student. Constructivism focuses on the learner, with a project or problem as the driving force of knowledge construction (Savery and Duffy, 1996). In constructivist learning, the pedagogy is more student-centred with teachers as facilitators and guides of learning (Norton and Wiburg, 2003). The instructor as facilitator does not mean that the learner does not receive instruction, but rather is guided with tools and environments that support active learning (Jonassen, 1991). Hay and Barab (2001) argued that "constructionist learning is vastly different both theoretically practically from apprenticeship learning" (p.282).

1.1 Constructionism and ICTs

From a constructionist perspective, the role of technology is to expand the scope of an activity, and computers 'provide an especially wide range of excellent contexts for constructionist learning' (Papert and Harel, 1991). Digital technologies support the creation of artefacts and are as important as reading and writing (Papert, 1990). Technology is a tool for intellectual expression and exploration (Hay and Barab, 2001) and creative production (Peppler and Kafai, 2007). Peppler and Kafai (2007) emphasise the role of technology in students' creative production of webpages and videos that moves students away from mere consumers of technology to producers, methodology and a tool for classroom inquiry. They argued that there has been little research on creative production using technology. Kafai (2006) uses the example of digital games to explain constructionism in relation to instructions. Kafai explained that the latter involves teachers' lessons embedded in the games themselves, and the former involves providing students with the opportunities to create their own digital games.

The use of social media for constructionist learning supports claims that social interactions combined with learner experiences help to construct new knowledge (Young, 2008). Institutions are increasingly encouraging faculty to adopt social media

applications in teaching (Wankel, 2010). Zakaria et al. (2010) argued that social media applications have already been accepted by younger generations as a platform to socialise, collaborate and learn in an informal and flexible manner, although their level of involvement and contribution varies significantly. Likewise, constructionism can be supported by use of mobile devices. Mobile learning environments offer relevant and interesting materials and activities for use in or outside the classroom (Tan and Liu, 2004). In general, as Kafai (2006) observed, in constructionist learning, learners and not just teachers make design decisions, and develop "technological fluency" that "involves not only knowing how to use new technological tools but also knowing how to make things of significance with those tools and most important, develop new ways of thinking based on use of those tools" (p.39).

1.2 Study purpose and objectives

An example of a constructionist approach to learning is the Scratch initiative (http://scratch.mit.edu/) at the Massachusetts Institute of Technology (Resnick, 2012). This initiative involved students' use of digital technologies to create games, stories, art and music. Such initiatives are, however, the exception rather than the norm because providing students with opportunities to learn by creating artefacts requires a complex blending of technology and pedagogy. The purpose of the study reported on in this paper was to design and implement constructionist learning for blended face-to-face (F2F) and ICT-supported learning. The specific context was an undergraduate advertising photography course at a university in Thailand. Thailand represents an appropriate and relevant context in which to study implementation of a constructionist approach since higher education in this country is typically characterised by traditional, teacher-centred, instructional approaches in spite of government's efforts aimed at educational reform (see Fry and Bi, 2013).The study's objectives were as follows:

1 Design a framework for constructionist learning;

2 Design and implement activities using a blend of F2F and ICT-supported learning;

3 Measure students' achievement and satisfaction.

The results will be relevant for instructors interested in implementing constructionist learning in their own classrooms. Results will also be of interest to researchers inquiring into how ICTs can support new forms of learning. Finally, the results will be relevant to policy makers aiming to support the redesign of learning in educational contexts.

2 Design for constructionist learning: review of the literature

This review of the literature focuses on studies that have investigated the design and implementation of constructionist learning into existing post-secondary courses. There are studies of the design of constructionist learning at the primary (e.g., Bers et al., 2002; Grenier, 2006) and elementary levels (e.g., Ioannidou et al., 2003). Bers et al. (2002) explained that integration of constructionism in early education is made easier by the fact that "the basic tenets of constructionism are already present" in this level of education (p.124). However, this review focuses on studies that are similar to the one presented in these papers that were conducted at the post-secondary level.

The selection of studies presented in this review is meant to be representative rather than exhaustive. The intent is to provide an overview of how instructors have designed or redesigned learning in post-secondary contexts in order to promote constructionist learning. We identified one study that implemented constructionist learning for the in-service professionals. Polly's (2011) study was premised on the argument that teachers could develop deeper understanding of both subject matter content as well as pedagogy by creating artefacts which, in this case, were a curriculum map and a wiki. As is evident in the review, studies have tended to report on the design of the environments for constructionist learning without reporting on the principles or frameworks of constructionism that informed the design as in the present study. In that regard, the constructionist framework created in this study is sufficiently broad that it can be used to inform the design of constructionist learning in many contexts.

Blikstein and Wilensky (2009) designed constructionist learning activities in an undergraduate-level computational materials science course with 21 students. The technology relied on programing simulations that engaged learners in scientific inquiry. The students used MaterialSim which is a micro-world that supports students in building agent-based models and investigating topics such as crystal growth. To create the micro-world, the authors first conducted classroom observations and subsequently completed "a literature review of engineering and materials science education, analysis of class materials and interviews with students" (p.83). Their initial observations led them to conclude that both the growth and "intricacy" of the content posed challenges for "traditional teaching approaches" (p.82). The agent-based modeling approach allowed students as modelers to create "simple individual-level rules to generate complex collective behaviors" (p.82). Blikstein and Wilensky do not report on the classroom implementation but on the prior interviews and laboratory studies.

Whereas in Blikstein and Wilensky's (2009) study participants constructed artefacts in the form of models, participants in Desselle's (2017) study did not construct models. Desselle (2017) used the micro-blogging tool Twitter in a pharmacy health systems course to "have students leveraging their skills and information provided in required course materials to gather and synthesize additional, relevant information to foster their engagement and learning" (p.187). A portion of the course grade was allotted for a reflection assignment in which students were expected "to provide insight on 3 tweets selected by the student" (p.187). The reflections were submitted using the Blackboard® course management system. Students could also opt to do a final summative 1500–1800 word paper using material from the tweets. Desselle then surveyed students to gather and evaluate the experience and to rate their likes and dislikes and provide suggestions for future use. Desselle concluded that "students performed well" and reported that students perceived the assignment as "useful" (p.193).

Clinton and Rieber's (2010) study also took place in the USA but with students enrolled in a Masters-level program in learning, design and technology. The design of the constructionist learning is similar in some respects to the design of this study except that it is part of three courses rather than one as in our study. Learning involves the "design and creation of personally meaningful artifacts that are shared with one's peers in a self-managed, self-reflective process" (p.765). The courses are project-based and collaborative and culminate with a presentation or "showcase" of students' creations. As in our study, students' projects are open to review and critique by others. Unlike in our study where students create their projects around predesigned course areas (e.g., food and

stills), students in Clinton and Rieber's study can select any topic. The authors collected data formally and informally using techniques such as student feedback on course evaluations and in "student debriefing sessions" (p.770). The authors noted that attempts to scale similar initiatives in other universities have met with "mixed success" (p.778).

3 Methods

3.1 Context

The study was conducted in an advertising photography course. This is a beginning course that provides students with knowledge and skills related to commercial photography and includes basic techniques of lighting, camera work and equipment. The course is offered face-to-face in a faculty of communication arts in a university in Bangkok, Thailand. The research complied with the ethics requirements of the university and was approved by an institutional review board. All participants gave their informed consent prior to participation. The advertising photography course took place over a 15-week period. For weeks 1–7 of the course, instruction was primarily teacher-led with lectures. During this time, students also had opportunities to visit a photography studio at the university where they could practice taking photos. Assessment involved a written test. During weeks 8–14, the instructor who also served as principal investigator (PI), implemented constructionist learning.

3.2 Steps

The design and implementation of constructionist learning was completed in multiple steps. These are outlined in Table 1.

Table 1 Outline of steps

Objective	*Steps*	*Methods*
1	1	Identify key components of constructionism and technology's role
	2	Create draft of framework
	3	Conduct focus groups and interviews with specialists regarding framework
	4	Create the final framework
2	5	Design the app and ICT tools (e.g., Moodle)
	6	Design the learning activities with the tools
	7	Implement the activities
3	8	Students complete pre-test
	9	Students complete post-test
	10	Students complete satisfaction survey

3.3 Objective 1: procedures

The first step in the design of the constructionist learning involved a review of both the theoretical and empirical literature on constructionist learning. This review resulted in the

creation of a preliminary framework for the design of learning. The second step involved providing 10 specialists with this preliminary framework and asking them for their guidance and feedback. The specialists provided this guidance and feedback in the context of interviews. The interviews were conducted individually. Each interview began with a brief introduction to the study and to the course. The semi-structured interviews were guided by a series of ten questions. Subsequently, the interview content was analysed and the PI created a revised framework.

The third step involved a focus group with ten other specialists. As with the interviews, the PI provided focus group participants with information about the study and the course. The PI presented them with the initial framework for constructionist learning created following the interviews. Participants were then asked to brainstorm about which elements should be included/not included in the design the constructionist learning. The focus group session was guided by the same questions as for the interviews.

3.4 Objective 1: participants

The ten participants for the interviews were lecturers from education faculties in Thai universities with interests in instructional design, curriculum design and educational foundations. The focus groups also involved ten participants. These participants were specialists in the areas of educational technology multimedia materials production and advertising photography. All held the position of associate professor with doctoral degrees.

For the design of the application, the PI collaborated with a computer programer specialising in application creation for mobile devices. AppBuilder software (http://www.apps-builder.com/) was used to design the application.

3.5 Objective 1: instruments

The following questions were used during the interviews and focus group. However, both the interviews and focus groups were semi-structured meaning that participants could add other questions or comments as the need arose.

1 What is constructionist learning?

2 What characteristics distinguish it from other forms of learning?

3 What should students be doing in constructionist learning?

4 What are the respective roles of students, peers and teachers in constructionist learning?

5 What is the role of knowledge and content in constructionist learning?

6 How can learners manage time and learning when they are actively, experiencing, doing and making artefacts?

7 What is the role of social interaction in this form of learning?

8 How can learners be assessed in this form of learning?

9 How can technology support constructionist learning?

10 Which technologies can best support constructionist learning? Why?

3.6 Objectives 2 and 3: participants

Participants were 30, third-year undergraduate students (15 females and 15 males) enrolled in an advertising photography course in a faculty of communication arts in a university in Thailand. The instructor for the course was also the PI. The instructor had previously taught the course four times. He held a bachelor's degree in audio-visual education, a masters in educational technology and was a PhD candidate at a learning and innovation program at a university of technology in Thailand.

3.7 Objectives 2 and 3: procedures

The framework was implemented in the advertising photography course for a period of seven weeks. Implementation began in week eight of the course.

3.8 Objectives 2 and 3: instruments

Achievement was measured using pre- and post-tests. Topics for the pre-test were the same as the post-test and related to the course such as: introduction to use of equipment, advertising photography, composition and lighting. The test relied on multiple choice questions for a total score of 30. The statistical test-retest reliability of the checklist of student was 0.88. The checklist was tested for internal consistency, test-retest and inter-rater reliability. The Quality Index had high internal consistency (the standard error of a Kuder-Richardson Formula 20 reliability coefficient is 0.88). All 30 questions were accompanied by four possible answers. An example follows:

1 What is the first thing that you notice about composition in advertising photography?

- Balancing the picture
- Point of interest
- Composition
- Lighting

To measure satisfaction we relied on a survey with a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. Seventeen items addressed satisfaction elements as presented in Table 4.

3.9 Data analysis

Results from the pre- and post-tests were analysed using *t*-tests. *P* values <0.05 were considered statistically significant. We show the results from the satisfaction survey were analysed using mean and standard deviation.

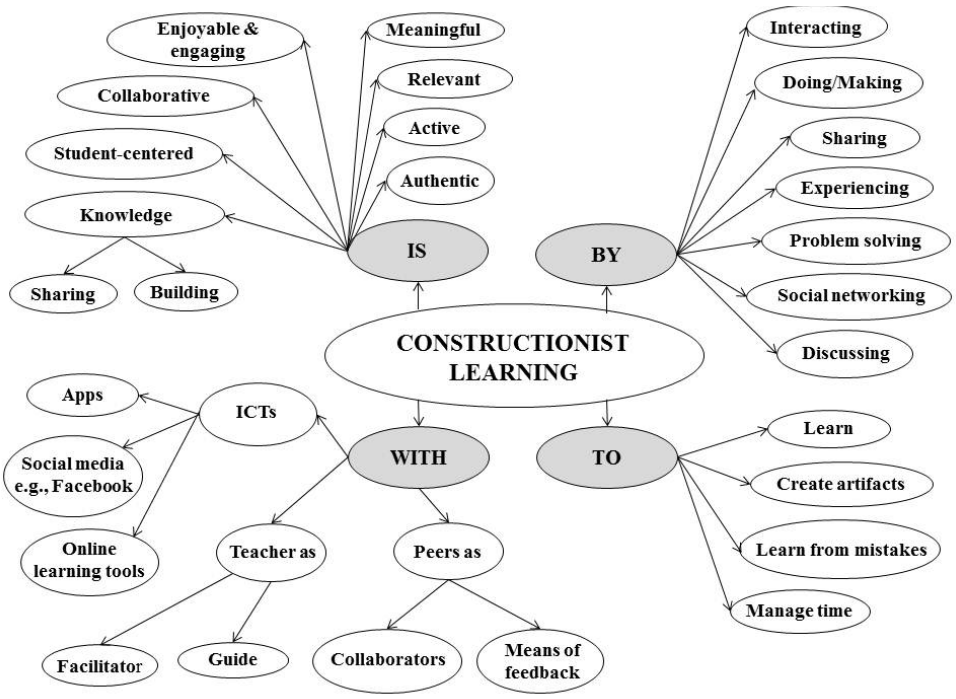
4 Results

4.1 Objective 1: design of a framework for constructionist learning

We conducted a review of the literature which we then used in the focus groups and interviews. The literature review included many different studies. The literature review

revealed the importance of concepts such as learners using existing knowledge to construct complex artefacts (Dreher et al., 2009); the art of learning; 'learning to learn', making things, conversation about artefacts, self-directed learning, construction of new knowledge (Ackermann, 2001, p.85); knowledge construction in a social context, participants making something shareable, productive learning environments, learning by doing, relevance and meaning, technology as building material, enjoyment and engagement, learning to learn, taking charge of one's own learning, learning to manage time for learning, learning from mistakes (Papert, 1990); learners develop reasoned interpretations of their interactions with the world, the creation of an external, shareable product (Hay and Barab, 2001, pp.282–283); constructing something that is public (Papert and Harel, 1991); learners in the role of designers, social participation with collaborative community input, participation and sharing (Peppler and Kafai, 2007).

Figure 1 Framework for constructionist learning



We used the literature review in the focus groups to drive the discussion. We present a summary of the main themes from the responses of the focus group participants and interviewees as follows: learners must know what to learn and how to learn from their own mistakes; the instructor should create activities that lead the learner to reflect on prior knowledge and experiences; the learning environment should be friendly and engaging; the technology should be familiar to students (e.g., Facebook); learners should have opportunities to actively share ideas and knowledge with each other and not just the instructor; learners must be capable of self-management of their time; learning should focus on creativity and problem-solving; learning must involve doing, creating and real-

world experience, aptitude and skill; learning should build on the different skills of students; learning must focus on real-life experiences and creation of real objects; the instructor's role is to help students find their own knowledge; technology should be easy to access from one site; learners should be enthusiastic about learning; learning should support self-directed learning; learning should stimulate learner's interests; learning should involve personal experiences that are meaningful to the learner; learners should communicate and interact with their peers and share their ideas, and reasoning and give each other feedback; the instructor should not direct learning but should be on the side.

Based on the results of the focus groups and interviews combined with a review of the literature, we identified the following framework for constructionism.

4.2 Objective 2:design and implement activities

The framework was used to design the learning activities and environment. Figure 2 shows how ICTs were integrated into learning. Table 2 shows how the course was organised around the technology and around projects and creation of artefacts. Figures 3 and 4 show additional tools such as a Facebook group to provide students with opportunities to comment on the artefacts created by other students. Figure 4 shows part of the content in the flip album that students could access online to support their independent learning.

Figure 2 ICTs to support constructionist learning

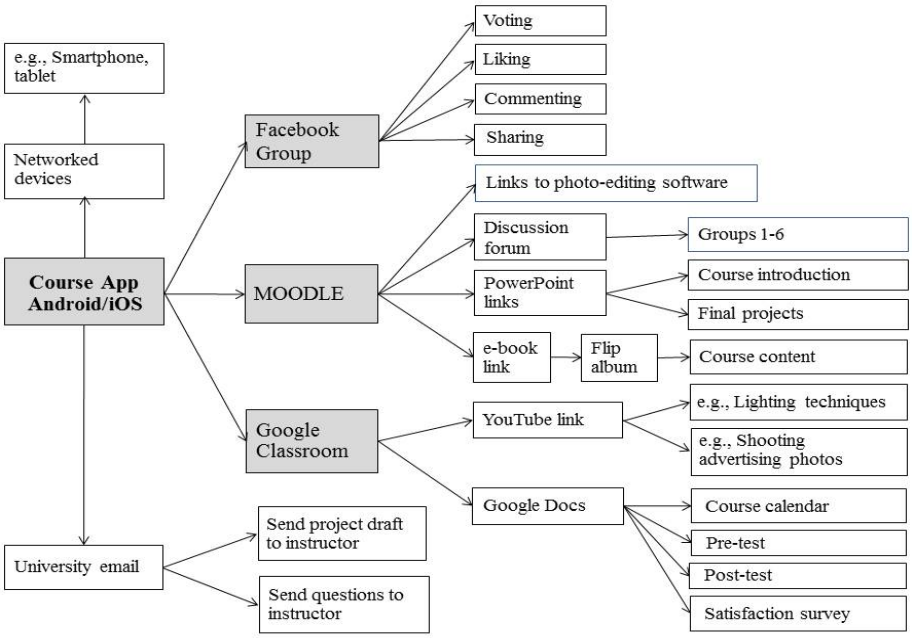


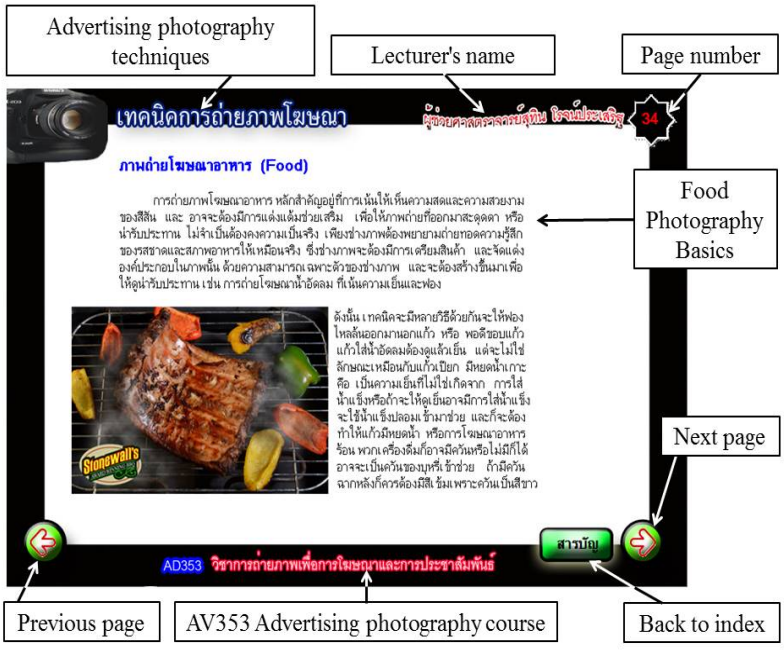
Table 2 Outline of implementation

Weeks		*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*
1	L				Classroom	Online
	T				PP	FB, MOO, GC
	A				Meet others; join groups; view PP about project	Register in MOO; join and post in FB group; see project calendar
2	L	Online	Online	Online	Campus photo studio	Online
	T	MOO; e-book	YT	FB; MOO; EM	Digital camera, PES; FB	MOO; FB
	A	Browse course content and read about how to take a still life product	View video about lighting techniques	In groups, interact, discuss, problem solve and share knowledge about how to take still life photo; create project plan; email plan to instructor	Collaborate in groups and create still photo; edit still photo; post still photo in FB group	View students' stills; discuss in MOO; share comments and vote in FB; discuss in MOO how to improve next photo
3–6		*(Calendar presents same format for weeks 3–6. Instead of still photo, students do (W3) food, (W4) beverage, (W5) fashion and (W6) use of products.)*				
7	L	Online			Classroom	
	T	PP; MOO			PP	
	A	Interact, discuss, share and finalise your project presentation. Decide how you will present and who will present.			In groups present your project	

Notes: L = location, T = tool, A = activity, MOO = Moodle, FB = Facebook, YT = YouTube, GC = Google classroom, E-book = e-book, PP = power point, email = EM, PES = photo-editing software, ND = networked device (e.g., Smartphone, tablet and laptop).

Figure 3 Screenshot of e-voting activity in Facebook mobile

Figure 4 Screenshot of Flip Album with course content



4.3 Objective 3: measure students' achievement and satisfaction

4.3.1 Achievement

Data from the pre-and post-test were quantitatively analysed using descriptive and inferential statistical procedures, and dependent samples *t*-test as shown in Table 3. Table 3 compares the pre- and post-test scores of the students. Mean scores (19.57 and 25.60, respectively) were obtained from a *t*-test analysis and show that the post-test mean scores were higher than the pre-test scores with a significance of $t = 13.56$, $p < 0.05$.

Table 3 Comparisons of pre- and post-test scores

	N	*Mean*	*SD*	*t*	*p*
Pre-test	30	19.57	3.06	13.56	0**
Post-test	30	25.60	2.73		

Notes: ** Level of significance $p = <0.05$.

4.3.2 Measure of satisfaction

Table 4 presents the results of the survey of students' satisfaction with constructionist learning. Data show that most respondents were highly satisfied (mean score of 4.10). No students strongly disagreed with any of the items. When strongly agree and agree are combined, the top ranked items (over 80%) were item 1 (81.11%), learning to learn; item 2 (73.33%), the teacher guided my work; item 3 (93.34%), time management; item 4 (93.34%), meaning fullness and relevance; item 5 (83.33%), clarity of directions; item 6 (76.66%), learner could learn with others; item 7 (66.67%), technology helps learning; item 8 (81.67%) usefulness of the course APP; item 9 (73.33%), technology was easy to use; item 10 (80%), learning was enjoyable and engaging; item 11 (90%), technology for collaboration; item 12 (83.34%), students' interest in a course engaged; item 13 (80.83%), learned by doing and making; item 14 (83.33%), build and shared students' knowledge; item 15 (80%), authentic learning is active learning; item 16 (86.67%), students discuss, share and interact with others; and item 17 (73.33%), learner happy with the product created.

Table 4 Results of survey of students' overall satisfaction ($n = 30$)

Survey items	*SA*	*A*	*N/U*	*SD*	*D*	*Rank SA+A*	*SD*
	%	*%*	*%*	*%*	*%*		
1. I learned how to learn.	50	31.11	16.67	2.22	0	9	0.74
2. The teacher guided my work.	30	43.33	26.67	0	0	15	0.76
3. I could manage my time.	36.67	56.67	3.33	3.33	0	1	0.69
4. The content was meaningful and relevant.	36.67	56.67	3.33	3.33	0	2	0.69
5. The directions were clear.	23.33	60	16.67	0	0	6	0.64
6. I could learn with others.	33.33	43.33	16.67	6.67	0	13	0.89
7. The technology helped me learn.	26.67	40	33.33	0	0	17	0.78
8. The course APP was useful.	51.67	30	17.5	0.83	0	8	0.66

Table 4 Results of survey of students' overall satisfaction (n = 30) (continued)

Survey items	*SA*	*A*	*N/U*	*SD*	*D*	*Rank SA+A*	*SD*
	%	*%*	*%*	*%*	*%*		
9. The technology was easy to use.	23.33	50	26.67	0	0	16	0.72
10. Learning was enjoyable and engaging.	26.67	53.33	20	0	0	12	0.69
11. The technology helped us collaborate.	63.33	26.67	10	0	0	3	0.68
12. The course engaged my interest.	6.67	76.67	13.33	3.33	0	5	0.57
13. I learned by doing and making	49.17	31.66	17.5	1.67	0	10	0.74
14. I built and shared knowledge	23.33	60	13.33	3.33	0	7	0.72
15. My learning was active and authentic (real).	30	50	16.67	3.33	0	11	0.78
16. I discussed, shared and interacted with others.	40	46.67	13.33	0	0	4	0.69
17. I am happy with the product I created.	33.33	40	26.67	0	0	14	0.78
Total (%)	34.36	46.83	17.16	1.65	0		0.72

Notes: SA = strongly agree; A = agree; N/U = neutral/uncertain; SD = somewhat disagree; D = strongly disagree.

5 Discussion and conclusions

As Laurillard et al. (2011) explained that the value of tools used by practitioners derives in large part from their capacity "to support and facilitate the ways in which they set about their normal practice, even though the aim is to enhance it" (p.3). In the context of this study the tools used are easily scalable for use in other contexts. The FB group is easily created even by instructors who may not have high confidence or high skill levels with technology. It is familiar to students and user-friendly as well as accessible on mobile devices. It therefore serves as an appropriate though 'slim' application to support social sharing and peer feedback which are important elements of constructionism. The FB group can serve as it did in this context as an easy means of promoting the constructionist principle of social interaction, communication and sharing. The value of sharing, voting and commenting in the FB group is that it serves as a form of prototyping. As Przybylla and Romeike (2014) explained prototyping is "particularly well suited for constructionist learning environments, as quickly interactive artifacts are created, which learners can investigate, show around, discuss and admire" (p.246). In the context of the advertising photography course, students could vote on and provide comments which served as a type of formative assessment for students providing them with peer feedback on their creations.

The choice of technologies needs to be carefully made to ensure that "they add value, being deployed alongside conventional methods of teaching in a mix that optimizes the learners' experience and enables them to achieve the agreed learning outcomes" (Laurillard et al., 2011, p.21). Girvan et al. (2013) refer to concepts related to the design of constructionist tools for learning as "low-floor (easy to use), high-ceiling (powerfully expressive) and wide-walls (support the creation of a variety of artefacts)" (p.115). Likewise, high-floor programs can limit the users' ability to engage in constructionist learning. In this study, participants were in an advertising photography course. If the participants had been enrolled in, for example, a computer-science course or program they may have been able to use more complex technologies that, for example, required programing. Results of the satisfaction survey revealed students' satisfaction with the technology tools. However, the survey did not provide the opportunity to question participants about the individual technologies, for example, Facebook versus Moodle.

The implementation based on the framework shows how constructionism can be used to guide the design of learning. Although constructionism has generally been applied in computer environments for programing, the use of constructionism in this advertising photography course provides an illustration of how versatile the framework is. This means that instructors can apply the framework for use in many different subject areas. The key element is that learning should be organised around opportunities for students to represent their learning in the form of meaningful and artefacts. Learning in general has typically been centred around creation of products of learning such as assignments, tests and examinations. These can be considered artefacts that represent students' learning but they represent typically knowledge that is given to the student as opposed to knowledge that is constructed by the student. In terms of implications for future research, this study was limited to an implementation in one context and one course. The framework might be tested in other contexts to determine its feasibility and scalability.

6 Limitations and implications

This study was conducted in only one country, Thailand. While this country represents an interesting and relevant context in which to investigate constructionist learning, it may not be representative of what might occur in other countries. Similarly, the study was conducted in one course only. The choice of advertising photography was a relevant choice because implementation of constructionist learning has often been investigated in contexts of programing and or computer science. Results of implementation in these contexts may not necessarily be replicable in or scalable to other types of courses especially those in the Arts. However, what made implementation easier in this context was that photography itself naturally implies creation of artefacts. Therefore, this simplified implementation. Implementation may not be as easily achieved in other contexts where the production of artefacts is less common or feasible.

One important challenge therefore for instructors interested in implementing constructionist learning is to identify exactly what types of artefacts students might create. Equally important is the need for instructors to identify the types of tools that can best support this creation. Furthermore, instructors should keep in mind that constructionism is more than merely creating artefacts rather it involves many other strategies and approaches as we outlined in the framework. These include but are not

limited to providing students with opportunities to interact, reflect, collaborate and problem solve. The implementation also means a change of roles for instructors and students whereby the former are merely guides and facilitators. In terms of opportunities for future research, the design and implementation of constructionist learning represent relevant avenues for understanding how technology can contribute to educational reform and how it can shift learning to more student-centered forms.

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