Using Kinect to Track Learning Behavior of Students in the Classroom as Video Portfolio to Enhance Reflection Learning

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Abstract: We propose a novel approach to produce video portfolios in the classroom, allowing student's whole body, which was captured by a Microsoft Kinect appear in a rich and context-sensitive background. The purpose of the study was to investigate this proposed system could impact on various learning style students' cognition and metacognition. The system makes the student have chance to examine and evaluate on one's own and then promotes metacognition. Experimental results indicated a variety of learning styles do affect the performance of learners, especially reflective and sense of style, metacognitive have a significant upgrade capacity by using the system.

Keywords: Learning style, video portfolio, metacognition, authentic learning

Introduction

Video Portfolio has been widely used to improve the quality of supervision, evidence and transfer in education. Video recorders can capture many interactions. Recorded video can be assessed formatively with the goal of improved teaching, and they may also be assessed to yield a summative score or judgement [2]. Students can also reflect more deeply on their performance by reviewing a particular segment many times at a different location.

Metacognition is an important skill that could be improved by video portfolio. Black & William [3] stated that the four pillars of the e-portfolio (metacognition, authentic tasks, contextual feedback and student responsibility) seem to clear up the effectiveness of formative evaluation. Metacognition is a skill of self-monitoring and reflecting on our own mental process, and could contribute to critical-thinking skills. With good metacognition skills, students can find out important information needed to solve a problem by analysis and inference. They can also know their own demands and resources and consider using the appropriate strategies at different times to effectively learn. With the support of video portfolio, students can have opportunities to practice self-monitoring and reflect critically on their experience.

Currently, video portfolio has been adopted to solve this problem. However, in the classroom, it is difficult to include authentic context in the video recordings that represented students' performance. To ensure the recorded videos look good with rich and proper background for review and reflection, the background needs to change accordingly depending on what themes and students are going on.

We propose a novel approach to let students' whole body, which was captured by a *Microsoft Kinect* appear in a rich and context-sensitive scene. Students could watch themselves appeared in the screen with a specific background that is designed by instructors, and perform what they learnt. Later, students can review their own performance under the

guidance of their teachers or alone. Rich background with their figures of the video portfolio could allow them perform reflection and enhance metacognition. Moreover, learning style was taken seriously in recent years. When teaching style coincides with students' learning style, their learning could be easier and effective [19]. We also examine what kind of learning style that students have could benefit from the approach significantly.

1. Related Work

1.1 Metacognition

Metacognition is extremely important, but really difficult to teach and assess. Part of the reason why student cannot effectively use strategies and cannot become an active and independent learner is the lack of metacognition. To become self-directed learners, learners should develop their metacognition [22].

Flavell [10] found out from the study of human cognition that learners usually displayed bad cognition due to their inability to monitor their cognition process and adjust it later to match specific objectives. Metacognition is the ability of an individual to self-supervise, in terms of their problem-solving ability, and is an important prerequisite [13]. With good metacognition, students can clearly understand self-monitoring, self-discipline, self-correcting, and self-assessment while they are solving problems. Schraw, G. & Dennison, R.S. [20] divided the concept of metacognition into five steps which could be improved individually:

- Planning: Planning, goal setting, and allocating resources prior to learning.
- Information Management Strategies: Skills and strategy sequences used to process information more efficiently (e.g., organizing, elaborating, summarizing, selective focusing).
- Comprehension Monitoring: Assessment of one's learning or strategy use.
- Debugging Strategies: Strategies used to correct comprehension and performance errors.
- Evaluation: Analysis of performance and strategy effectiveness after a learning episode.

Nevertheless, metacognition is situation dependant. Each individual is required to manage specifications while considering their strategy and adjusting their train of thought toward the situation that their strategy is going to used [13]. The video portfolio of what they performed could be useful if students can perform in authentic learning environments.

1.2 Authentic learning

On the other side, authentic tasks are vital to the e-portfolio that could result in the effectiveness of formative evaluation [3]. Suchmon [21] found that humans' cognitive activity is limited by the social context of their activities. However, knowledge learned in a school system is different from the cognitive ability that is obtained from reality [13]. The true meaning must be realized via practical actions, and students should know how to solve unknown problems by using environmental resources [14]. Therefore, concepts and rules must be understood through real experiences, which is not easy to be fulfilled in the classroom.

Similarly, metacognition should be cultivated in authentic environment. Brown, Collins & Duguid [4] pointed out that people invent effective strategies to solve problems in situations due to interacting constantly with a specific situation.

When students perform situational tasks, they can reflect on their learning results after

learning through video portfolios. From video tape to digital memory, video recorders have been widely used to improve teaching and learning in the classroom. To change the method of cognition and enhance learning effect, authentic learning environments should be added to the classroom, allowing students perform in authentic environments and producing video portfolios for enhancing metacognition.

1.3 Portfolio

Portfolios are widely used to help students learning. Portfolio assessments of learning outcomes are more realistic and dynamic presentation than the written records examination, and the students can know their results clearly via portfolio [13]. Albert Bandura's Social learning theory mentioned that learners change individual behavior through observing and imitating others. Learners can better understand and analyze their advantages and disadvantages via comparing themselves to others. Through portfolios, teachers and parents can also view the child's advances, and give them timely help [5],[15],[16],[23]. In short, Paulson Leon & Paulson Pearl [17] mentioned that promotion of reflection, self-evaluation, self-understanding and the ability of metacognition is the most important objective that learning portfolios could be.

Portfolio is individualized data [1], purposeful data collection [18], visual process presentation [9], and authentic performance results [18]. Chang [6] revealed that the system of network learning files can produce many effects such as helping to control the learning process, reflecting on the advantages and disadvantages, and enhancing the growth, progress, and benefit of learning. Currently, video portfolio has also been frequently utilized to assist students learning and its effectiveness has been proved hugely. This study try to enhance the way that video portfolio was taken in the classroom. Students' performances and the according backgrounds are mixed together and recorded simultaneously as the video portfolio. Comparing to the portfolio recorded by DVRs, the video portfolio which is generated by our proposed approach could provide students authentic context.

1.4 Learning Style

Besides examine the impact that the proposed idea could be, this study also wants to realize if there is any difference while students with different learning styles. Here gives a brief description of learning style. Learning styles are various approaches or ways of learning. They involve educating methods that are presumed to allow individual to learn best. Several dozen learning style models have been developed. One of the most common and widely-used categorizations of the various types of learning styles is Fleming's VARK model [12]: (1) visual learners have a preference for seeing, (2) auditory learners best learn through listening, and (3) kinesthetic or tactile learners prefer to learn via experience—moving, touching, and doing. One learning style is neither preferable nor inferior to another, but is simply different, with different characteristic strengths and weaknesses [7].

Category of learning style allows teachers to prepare classes to satisfy students' preferences. Students can also use the model to identify their preferred learning style and maximize their educational experience by focusing on what benefits them the most. The proposed method to produce video portfolios might be only suitable for students with specific types of learning style. This study also statistically examines what kind of students could benefit from the new approach.

2. System Design and Implementation

2.1 System Architecture

In order to record student's learning activities, we used an L-shape authentic learning platform with a vertical screen to display situation and a horizontal interactive touch table to allow students to immerse into situation and perform interactive tasks.

When we put teaching materials into the L-shape platform to do authentic learning, Kinect let the image of students into the vertical screen, and students can see their true performance. While learning activity to proceed, HyCam2 (screen recording program) is called additionally to videotape the screen. In this way, we have the materials for students to review and reflect after class.

To make students reviewing those recorded video portfolios easily, learning objectives and the Learning adventure book videos were cut into small episodes. Besides, those videos and meta-information were stored in a database. Then, we used the programming languages, PHP and MySQL, to store those data and provide students personalized review.

Fig.1 L-shape platform using situation

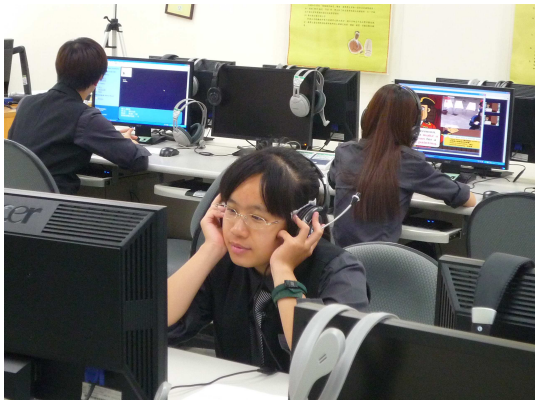

Fig. 2 The system using situation

2.2 Instructional Design

Our teaching material is a designed situational game which makes students feel immersive in learning and interact frequently with their peers. Under this learning environment, teachers and students can carry out the group activities on the both sides of the platform. Through the help of teachers and the cooperative learning with peers, students can engage in learning activities and gain learning outcomes. The game allows students to view their own learning process to enhance metacognition. Here we choose English as second language learning as objectives, and integrate the materials into game-based learning activities.

After students complete the learning activities, we classify and cut the videos propriately, and let students have their personal video portfolios. Those videos are divided into three parts: evaluation, films, learning adventure book. Evaluation is categorized by learning objectives of self-evaluation and self-performance. Films are related to learning objectives, personal films and situations. The personalized video portfolios present the films of students plus narrative description. Following are the steps that students review the video portfolios. Firstly, they login the system via entering their own accounts and passwords. There is an easily understood instruction which contained all the evaluation, films, and learning adventure book on the left side of the screen. We reminded students to fill out the "learning objectives of self-evaluation" to realize how much they have learned in that objective. If there is inadequate, the system will recommend students intimately to review the video portfolio again. The demonstration of teachers and outstanding films of peers will be marked with special tags for students' references. Secondly, students watch their own

videos, then complete the assessment, evaluate and reflect on their academic performance. After finished the two stages, students could choose any video which they were interested in or want to enhance. They can click the Learning adventure book to review the content they have learned quickly and completely. Finally, if students feel that the review and reflection completed, they can end the learning.

2.3 The design to boost metacognition

The experience of metacognition usually happened in the moment of cognitive failure. In the process of trying to solve the problems, we sometimes would know whether our performance was smoothly or not [11]. If students can make reflection to realize their own shortcomings, they would find out that there were many shortcomings can be improved. In this way, students can trigger the learning motivation. However, students usually forget or neglect their personal performance due to tension. Therefore, we should have a complete record to allow students review their personal performance.

The system could provide a possible solution. The system used the screen recording program to record the performance when a student carries out activities. In this way, we don't be afraid not filming to the front of students and don't need extra-manpower to control the camera. Students can use the system after class on their own computers. The films of the record of student carrying out activities will import into the system. We utilize the "video categories" to meet the demand of viewing learning performance. Students can click their peers' films to exchange study, or click the sample films of teacher in the "learning objectives" to review again. Furthermore, we make books of "Learning adventure book" by their learning record in situational stage. Using these books, it makes students clarify the overall concept. Besides, we added the learning adventure book and evaluation into our tools which included students' self-reflection and feedback of teachers.

Through the image recording and complete planning, the system brings some new possibilities for situational learning.

- Self-assessment of the effectiveness of learning: By fill out the "self-assessment of learning objectives," students can reflect on their learning situation, and more understanding of what objectives should be completed, and then click on the "learning target film to strengthen their own lack of part. In this way, students can promote their metacognitive skills of self-reflection, self-evaluation, and self-understanding.
- Self-monitoring:"Personal videos" provide students watch their performance and observe something they did not notice before and the part that they did not perform well on. Fill out the "Assessment of self-expression" assists students to view their performance again, and to stimulate students' understanding and reflection.
- Imitation and learning: Students see videos of other peers can learn the advantages of others, strengthen the impression of learning content, reflect on their own whether the same needs to be improved.
- Integration concept: An "learning adventure book" that presents the whole activity in a storybook style not only increases the lesson's appeal but also enhances the students' level of understanding. The student is the protagonist, providing them with a spectacular sense of actually being there. It can also be provided for the parents, so they could know what their children have done.

3. Experiment and Results

Here we would like to examine whether the proposed system could impact on student's cognition and metacognition. Besides, we also examine what kind of learning styles that

students processed could significantly benefit from the proposed system.

3.1 Procedures

We designed an experiment to find out the outcome of our system. The experiment was held at a university in Taiwan. The subjects were 15 university students. Before conducting the teaching activities, they first do a Metacognitive Awareness Inventory (MAI) scale of the Regulation of Cognition to detect their habits and the degree of metacognitive awareness [20]. This is a 35-question questionnaire. In addition, there is another questionnaire (Learning Styles) with 44 questions to understand the students' behavior and habits of learning [8]. Then the subjects conducted a 40-minute learning activity. Five days later, we invited them to use the system again. Before using the system we provided 5-minute introduction to the system and experimental procedures. Next, we let them use the system for 20 minutes. After using the system, the subjects conducted the same MAI questionnaire that was to understand the effectiveness of learning after using the system and compare the correlation between effectiveness of metacogniton and learning style. Besides, we let them write satisfaction questionnaire to realize which functions are efficacious. Besides, we also videotaped the whole learning process to gain the observational data.

3.2 Result Analysis

Table.1 Learning styles and its corresponding point of pretest and posttest questionnaire

		Planning		Information Management Strategies		Comprehension Monitoring		Debugging Strategies		Evaluation		Overall	
		M	P	M	P	M	P	M	P	M	P	M	P
Active	pre	24	0.788	34.7	0.458	22	0.143	18.7	0.532	20.5	0.346	23.9	0.554
	post	24.5		36.2		25.7		17.5		21.8		25.1	
Reflective	pre	21.8	0.03*	33.2	0.021*	21.2	0.005*	19.4	0.313	19.8	0.086	23.1	0.011*
	post	26.3		38.4		26		20.2		22.2		26.6	
Sensing	pre	22.8	0.023*	33.5	0.019*	21.4	0.001*	19.2	0.8	19.9	0.009*	23.4	0.01*
	post	26.4		38		26.5		19.4		22.5		26.6	
Intuitive	pre	22	0.742	35.5	0.874	22.5	0.874	19	0.656	21	0.626	24.0	0.144
	post	20.5		34.5		22		17.5		19		22.7	
Visual	pre	22.9	0.141	34.6	0.151	22.1	0.023*	19.2	0.676	20.9	0.216	23.9	0.103
	post	24.7		37.4		25.5		18.8		22		25.7	
Verbal	pre	22	0.228	31.5	0.158	20	0.029*	19	0.68	17.8	0.131	22.1	0.144
	post	26		38		26.8		20		22.3		26.6	
Sequential	pre	22.5	0.05*	33.3	0.109	21.2	0.005*	18.9	1	19.4	0.037*	23.1	0.046*
	post	16		37.2		25.9		18.9		21.8		26.0	
Global	pre	22.5	0.537	33.8	0.187	22.5	0.178	19.6	0.907	21.3	0.741	24.0	0.479
	post	24.6		37.5		25		19.5		22.3		25.8	
Overall	pre	22.7	0.044*	33.8	0.033*	21.5	0.001*	19.1	0.878	20.1	0.041*	23.4	0.028*
	post	25.6		37.5		25.9		19.1		21.6		25.9	

*stand for significant different

Table 1 show that five abilities in the questionnaire: *planning*, *information management strategies*, *comprehension monitoring*, *debugging strategies*, and *evaluation*. A paired *t*-test was used to examine the effect. There is a significant difference between pretest and posttest in *Comprehension Monitoring* ($p=0.001$, $p<0.05$) indicating that assessments of learning strategies were effective after using the system. There is a significant difference between pretest and posttest in evaluation ($p=0.041$, $p<0.05$) indicating that their performance and ability of strategy analysis were improved after using

the system. There is a significant difference between the pretest and the posttest in planning ($p=0.044$, $p<0.05$) indicating that *ability of goal setting* and *planning* was improved after using the system. There is a significant difference between pretest and posttest in *information management strategies* ($p=0.033$, $p<0.05$) indicating that students can improve their abilities of organization and information reconstruction effectively. However, there is no significant difference between pretest and posttest in *debugging strategies* indicating this system cannot assist students in correcting their strategies.

In five parts and the overall effectiveness of metacognition compared with learning styles, general discussion excluding no significant differences in the debugging strategies. The data show that *sensing style* has significant differences in all metacognitive skills. Reflective styles for planning, information management, strategies and comprehension monitoring have significant differences. Sequential style for the planning, comprehension monitoring and evaluation has significant differences. Visual and verbal style only in comprehension monitoring has significant differences.

4. Discussion

We find that the system has significant differences in information management strategies. We explore from the data of MAI and system usefulness questionnaire, and we find that there is effective assistance for students via teaching by situational games and films of peers who perform well or teacher's demonstration. Nevertheless, the significance of evaluation is barely satisfactory, exploring several students whose achievement is relatively low in this part. We find that they are not accustomed to reflect on their performances.

About learning style, experimental results show that there is mostly significant in reflection. This means that students who usually had a habit of independent thinking and judgment are able to exert the skills of self-reflection and learning from peers. Students with Sequential style have significant effectiveness as a whole. This may be because the system designed as entire teaching content but planned completely as different learning objectives. This makes students who accustom to understand and learn individually can easily get started. Students with Intuitive style have almost no significance in all respects. This may be that these films are too much alike to these students who don't like repetitive things. Therefore, they won't click these films respectively to do comparative learning. Furthermore, there is a particular finding. The Sensing style has quite significance in all respects except in the part of Debugging Strategies. The part of Debugging Strategies has quite demand of thinking and changing the learning strategy. Wherefore students who are thoughtful (EX: students with Reflective style), their performance will be relatively better. According to the satisfaction questionnaire of system, students who have been learning styles with Sensing and Visual have relatively high preference for the system. This is obviously due to this system that is suitable for their usual customary way of learning, so there is no obstacle in the learning.

5. Conclusion

We propose a novel approach to produce video portfolios in the classroom, allowing student's whole body, which was captured by a *Microsoft Kinect* appear in a rich and context-sensitive background. Students can review their own performance under the guidance of their teachers or alone to enhance their cognition or metacognition. Experimental results show that the proposed approach could significantly enhance students' metacognition on Reflective, Sensing and Sequential styles. In the future, we would suggest

that providing references to students whose self-reflection ability is relatively inadequate. We also suggest that adding some interactive elements in the system to make students not lose their attention while reviewing these video portfolios.

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