Integrating Active/Collaborative Learning in Computer-Centered Course Curriculum

Dr. Magesh Chandramouli, Purdue University Northwest

Dr. Chandramouli is an Associate Professor of Computer Graphics Technology in Purdue University Northwest. Dr. Chandramouli has been invited to deliver keynote speeches and guest lectures in various countries around the world. Formerly a Frederick Andrews Fellow at Purdue University, West Lafayette, he completed his doctoral studies from the Department of Computer Graphics Technology. He completed Master of Engineering at the National University of Singapore and Master of Science from the University of Calgary, Canada. He completed his Bachelor of Engineering from the College of Engineering, Guindy, India. Dr. Chandramouli has published journal articles in prestigious international journals and has presented papers in respected national and international conferences. He has received federal, regional, and international grants for his work in areas including virtual reality, STEM education, Human Computer Interaction, and Genetic Algorithms in Graphics.

Emily Hixon, Purdue University Northwest

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A predominantly 'computer-centered pedagogy' can create issues related to reduced communication and teamwork during classes. This paper explains a team-based collaborative learning exercise successfully implemented in computer graphics technology (CGT) courses in a Midwestern university. Based on the data compiled and analyzed from final exam and quiz results from the modeling and animation courses taught over the past several years, poor performance in the required CGT courses also affects the performance in higher-level courses. Sophomores and junior CGT majors struggle with technical graphics concepts and jargon. This affects their performance in advanced CGT courses (causing retention issues) and also affects their career prospects.

The ability to work in team-based environments has been frequently listed as one of the highly desired competencies involved in preparing students for career success. Typically CGT courses are highly 'computer-centric' and involve labs, projects, and even exams require students to spend considerable time working on computers, leaving little or no time for communication and teamwork. Hence, as a practical alternative, this team-quiz activity was developed that entailed students to thoroughly review the materials and prepare quiz materials based on that. The detailed quantitative and qualitative feedback collected from the post-activity surveys demonstrate the effectiveness of this collaborative activity and its usefulness in promoting teamwork, while simultaneously facilitating review of course materials.

Keywords—Team-based Collaborative Learning; Computer-Centered Courses; Computer Graphics

Introduction and Background

There are different areas of the production pipeline where a Computer Graphics Technology (CGT) graduate may find employment. The production pipeline represents the basic framework used to develop the animation. It is at the heart of the digital creation process, be it an animated movie or a video game or typically any CG (Computer Graphics) project. The entire process of production from start to finish involves a lot of personnel including storyboard artists, modelers, animators, technical directors, character animators, effects animators, production coordinators, directors, and many more. The efforts of such a variegated mix of personnel must culminate seamlessly into the final result—the animated game or movie. This is easier said than done and impossible without a coordinated and concerted effort on the part of all those involved. The production pipeline provides the reference framework to design and develop the overall project. From the aforementioned discussion it is evident that 'teamwork' is a valued asset not only in the CGT discipline, but also has been advocated as an important professional skillset over the past decades.

Besides being one of the highly-ranked and desired skills by employers in prospective employees, teamwork's importance is also supported by notable works by several authors. Dunne & Rawlins (2010) state, "teamwork is becoming increasingly important within higher education". In their work titled "Why the high attrition rates for Computer Science students: Some thoughts and observations", Beaubouef, and Mason (2005) put forth some critical concerns that are also pertinent to CGT courses. Typically, CGT courses focus more on visual and auditory learning, and there is relatively lesser emphasis on collaborative learning.

Collaborative learning is described by Panitz & Panitz (1998) as "encompassing all elements of group work and learning situations where students cooperate in order to accomplish a specific learning

objective". It is identified, along with critical thinking, communication and creativity, as one of the "Four C's" critical for success in the 21st Century (NEA, 2012). To help students develop these higher order thinking skills, there is an imminent and critical need to use pedagogical efforts that promote active learning (AL) (Keller & Litchfield, 2002; LeWalter, 2003). Active learning can be defined as "instructional activities involving students in doing things and thinking about what they are doing" (Bonwell & Eison, 1991, p. iii). Bonwell and Eison (1991, p. 2) identify some common characteristics of active learning strategies:

- Students are involved in more than listening.
- Less emphasis is placed on transmitting information and more on developing students' skills.
- Students are involved in higher-order thinking (analysis, synthesis, evaluation).
- Students are engaged in activities (e.g., reading, discussing, writing).
- Greater emphasis is placed on students' exploration of their own attitudes and values.
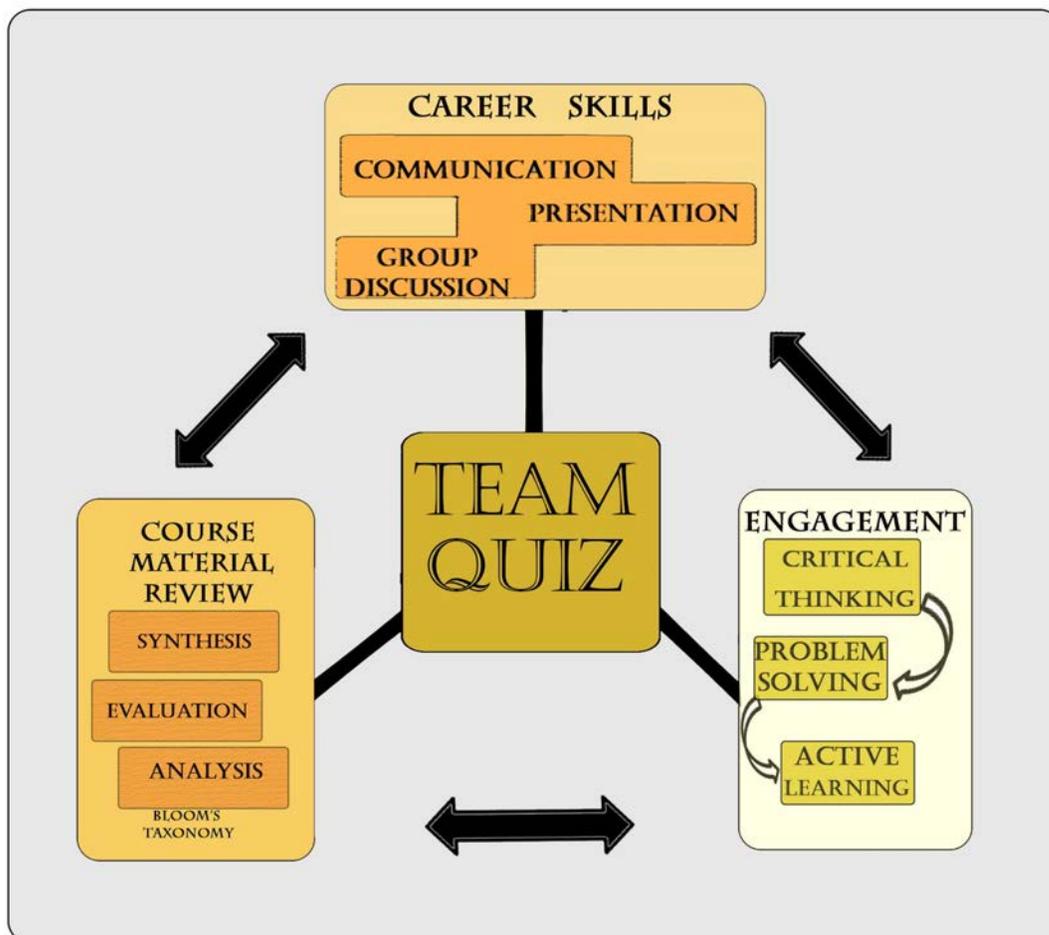
Figure 1: Team-Quiz Components with Learning Outcomes

The instructional strategy documented in this study provides an active, collaborative approach (Figure.1) for addressing some observations made by the author in CGT courses over the past several years:

- o The graphics production pipeline is inherently teamwork-based and it is important for CGT students to have collaborative skills.
- o Often times, students who are otherwise proficient in CGT (3D Modeling, Lighting, etc.) are restricted in terms of communicating with teams and sharing their creativity due to the lack of communication and presentation skills.
- o Students have trouble understanding basic CG (Computer Graphics) concepts, and vocabulary is extremely valued in today's competitive market. A lack of understanding of concepts and terminology can hinder the employability of CGT students.
- o CGT students lacking such skills tend to produce low-quality course projects and senior-design projects due to lack of a firm grasp of fundamental CG concepts.

Explanation of Instructional Strategy

As explained in the above discussion, in order to promote collaborative team-based learning, instead of the conventional mid-semester examination a team-based examination was proposed. The class is divided, typically, into six groups of 4 (approximately) members each. This was implemented in the following CGT courses at a Midwestern university:

CGT 11200: Sketching for Visualization
CGT 21600: Vector Imaging in Graphics
CGT 24100: Introduction to Animation
CGT 34100: Motion for Computer Animation

All these courses have a significant lab and project component that entails hands-on practice and demonstration of software skills in the respective industry-standard software used. Each one of the above courses also has significant theoretical concepts that need to be well understood in order to create good-quality outputs that demonstrate a proper understanding of

- the software skills for the respective software, and
- graphics principles and principles of visual composition.

Often times, students get highly preoccupied with the software component only and tend to underestimate the theoretical concepts. For instance, in order to create good images, an in-depth understanding of the elements of visual composition including the following is required:

- Positive Space & Negative space
- Line of action
- Rule of thirds
- Tangency, etc.

Similarly, in animation courses, poor pre-production and storyboarding cannot be compensated with software skills alone. Lack of such conceptual foundations will seriously affect the final quality of the work generated. Hence, in these team quizzes, in addition to software-related questions, the theoretical aspects covered through mid-semester are given importance. In this instructional approach, students work in teams to develop questions based on the course content. Each team is required to create 40 questions based on the content covered in the course up to that point. The questions can be multiple choice, true/false, or fill-in-the-blank, which are entered onto individual PowerPoint slides that can be displayed to the class.

One of the most important observations made during this team-quiz exercise over the years is the realization by the students that coming up with meaningful questions is much more challenging than answering the questions themselves. During the actual team-quiz, improper questions can cause issues between the teams. To avoid that, a 3-phased approach is used to refine the team questions and eliminate errors systematically.

- Draft 1: Each Team presents initial draft & instructor provides feedback
- Draft 2: Teams work to address concerns from Draft 1 and submit revised draft (Draft 2)
- Final Draft: All teams work to ensure 'error-free' final draft based on earlier feedback

The instructor meets with each team individually and discusses their questions and explains to them why a specific question may not be appropriate. The important criteria that influence the formation of questions include:

- Properly distributing the questions among all materials (for instance, if 5 chapters from a book were covered up to that point in time, approximately 8 questions should be included from each chapter to make up the total 40 questions)
- Questions should be carefully thought out so that they are challenging enough and also accurate
- All questions should be cross-referenced (to lecture materials posted by instructor)
- Questions should be worded carefully to avoid ambiguity
- Questions should be thoroughly checked to avoid redundancy and repetition

The following information is based on typical numbers involved in team make up. On the day of the actual team-quiz (Figure 2), each team gets to ask questions to another team twice and each team gets to answer questions twice. In total, there are six rounds typically. Each round involves 3 teams

1. The team asking questions
2. The team answering questions
3. The Moderating/Scoring Team

Figure 2: Sample Team-Quiz Activity in One of the Courses

The idea behind the moderating team is the promotion of critical thinking and informed decision making, which are essential skills in real world teams. Despite all the corrections and refinements during the initial to final drafts, if the answering team thinks that a specific question is invalid or incorrect, they can ask the moderating team to check the validity of the question.

The cross-referencing mentioned earlier is very useful under such circumstances. As the questions are based on materials covered earlier, the moderating team carefully checks the question, its wording and the accuracy of the answer. If the question is found to be incorrect, the answering team is awarded the point for that question. The moderating team is also responsible for scoring. In order to avoid any discrepancy, the team answering the questions also keeps an eye on the scoring as it happens (scores entered on whiteboard and also on a scoring sheet) and finally one member representing the answering team initials the scoring sheet before the moderating team hands it to the instructor. The following table shows a sample distribution of the team during the 6 rounds. As can be seen from the Table 1, each team gets to be the answering team two times, the team-asking questions two times, and the moderating team two times.

Table 1: Sample Team Distribution during the Actual Team-Quiz Rounds

Round #	Team-Asking Questions	Answering Team	Moderating Team
Round #1a	Team #6	Team #3	Team #5
Round #1b	Team #3	Team #6	
Round #2a	Team #4	Team #2	Team # 6
Round #2b	Team #2	Team #4	
Round #3a	Team #5	Team #1	Team #3
Round #3b	Team #1	Team #5	
Round #4a	Team #6	Team #1	Team #4
Round #4b	Team #1	Team #6	
Round #5a	Team #5	Team #2	Team #1
Round #5b	Team #2	Team #5	
Round #6a	Team #4	Team #3	Team #2
Round #6b	Team #3	Team #4	

The team matchups for each round are generated just prior to the team quiz for each course. Also, the answering/asking team combination is announced just prior to each round so that the teams do not know which team they may be paired with in advance. Each round has 20 questions and the scores are recorded by the moderating team.

For instance, in Round #1 above, Team #6 first asks 20 questions to Team #3 and then Team #3 asks their team's first 20 questions to Team #6. Even within the teams, individual responsibilities are allocated properly:
- 1 student is responsible for asking (reading out the questions)
- Another student is responsible for ensuring the accuracy of the questions
- Another student is responsible for checking the scores entered by the moderating team

Methodology

An IRB-approved study (IRB Protocol #1703018980) was conducted to evaluate the overall effectiveness of the team-quiz activity and to understand the general student perception of this collaborative exercise.

Students in four CGT courses who participated in the team-based midterm exam were asked to complete a questionnaire (see Figure 3 below) after the activity. Seventy-seven students completed the questionnaire.

Figure 3: IRB approved Team-Quiz Questionnaire

(The following is the survey content to be administered through Blackboard Course Portal)

Sex/Gender: Class status:
__Female   __Freshman
__Male   __Sophomore
__Transgender   __Junior
__Prefer not to state   __Senior

What is your age?
18 to 24 years   25 to 34 years   35 to 44 years   45 to 54 years   55 to 64 years   Age 65 or older

Please provide your ranking to the following questions about the Team-Quiz activity:
1-Strongly Disagree   **2**-Disagree   **3**-Neither Agree nor Disagree   **4**-Agree   **5**-Strongly Agree

	Ranking				
	1	2	3	4	5
1. Team-Work and collaborative skills are extremely important to succeed in today's work environment.					
2. I prefer the Team-Quiz in place of the standard mid-semester examination.					
3. The Team-Quiz helped me review the materials covered.					
4. The Team-Quiz helped me build my team-working skills.					
5. The Team-Quiz was well-organized in terms of the format - Multiple Choice, True/False, Fill in the blank questions.					
6. I liked the fact that students were allowed to form their own teams instead of randomly assigned teams.					
7. This collaborative activity is more enjoyable and less stressful than standard mid-semester examination.					
8. On the whole, the team-quiz activity helped me review the course materials better and also helped me build team skills.					
9. Please provide any additional comment/feedback that you would like to add:	Textual Feedback:				

Your participation is voluntary and will not affect your course grade in any way. Your responses are confidential and these questions do not involve any identifiable information.

Results and Discussion
Descriptive statistics were calculated for students from all courses combined (see Table 2 below) and for students in each individual course (See Table 3 below).

Table 2 : Descriptive statistics for each item (all courses combined)

	N	Mean	Std. Deviation
q1	77	4.75	.463
q2	77	4.65	.839
q3	77	4.51	.641
q4	77	4.34	.771
q5	77	4.48	.598
q6	77	4.08	1.085
q7	77	4.62	.689
q8	77	4.42	.750

Table 3: Descriptive statistics for each item by course

class		q1	q2	q3	q4	q5	q6	q7	q8
CGT 112	Mean	4.75	4.85	4.55	4.50	4.50	4.10	4.70	4.40
	N	20	20	20	20	20	20	20	20
	Std. Deviation	.444	.489	.510	.688	.513	1.021	.571	.598
CGT 216	Mean	4.76	4.52	4.44	4.32	4.52	3.84	4.64	4.44
	N	25	25	25	25	25	25	25	25
	Std. Deviation	.523	1.085	.583	.690	.510	1.106	.490	.768
CGT 241	Mean	4.77	4.77	4.64	4.41	4.59	4.23	4.77	4.50
	N	22	22	22	22	22	22	22	22
	Std. Deviation	.429	.429	.581	.796	.590	1.232	.429	.598
CGT 341	Mean	4.70	4.30	4.30	3.90	4.10	4.30	4.10	4.20
	N	10	10	10	10	10	10	10	10
	Std. Deviation	.483	1.252	1.059	.994	.876	.823	1.370	1.229

These results suggest that students viewed the activity favorable overall and recognize the importance of teamwork and collaboration for success in today's workforce. Student ratings indicate that overall, students preferred the team quiz over a traditional midterm examination and found it to be more enjoyable and less stressful. They report that the activity helped them review the course material and develop collaborative skills, though the development of team-working skills was rated somewhat lower by one of the courses (CGT 341).

Correlational analyses were conducted to examine the relationship between survey items (See Table 4). It was of particular interest to see if there are correlations between item 1 and some of the other items. That is, do students who believe that teamwork and collaborative skills are important also believe that the team quiz was more valuable. This is supported, though the correlations are only moderately strong.

Table 4: Correlations between Items

		q1	q2	q3	q4	q5	q6	q7	q8
q1	Pearson Correlation	1	.045	.382**	.383**	.433**	.248*	.365**	.451**
	Sig. (2-tailed)		.696	.001	.001	.000	.030	.001	.000
	N	77	77	77	77	77	77	77	77
q2	Pearson Correlation	.045	1	.383**	.307**	.287*	-.042	.337**	.381**
	Sig. (2-tailed)	.696		.001	.007	.011	.718	.003	.001
	N	77	77	77	77	77	77	77	77
q3	Pearson Correlation	.382**	.383**	1	.607**	.455**	.245*	.348**	.679**
	Sig. (2-tailed)	.001	.001		.000	.000	.032	.002	.000
	N	77	77	77	77	77	77	77	77
q4	Pearson Correlation	.383**	.307**	.607**	1	.442**	.125	.416**	.642**
	Sig. (2-tailed)	.001	.007	.000		.000	.277	.000	.000
	N	77	77	77	77	77	77	77	77
q5	Pearson Correlation	.433**	.287*	.455**	.442**	1	.164	.508**	.517**
	Sig. (2-tailed)	.000	.011	.000	.000		.153	.000	.000
	N	77	77	77	77	77	77	77	77
q6	Pearson Correlation	.248*	-.042	.245*	.125	.164	1	.075	.170
	Sig. (2-tailed)	.030	.718	.032	.277	.153		.517	.140
	N	77	77	77	77	77	77	77	77
q7	Pearson Correlation	.365**	.337**	.348**	.416**	.508**	.075	1	.511**
	Sig. (2-tailed)	.001	.003	.002	.000	.000	.517		.000
	N	77	77	77	77	77	77	77	77
q8	Pearson Correlation	.451**	.381**	.679**	.642**	.517**	.170	.511**	1

	Sig. (2-tailed)	.000	.001	.000	.000	.000	.140	.000	
	N	77	77	77	77	77	77	77	77

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Students' qualitative comments also provide further insights into their perceptions of the team-based quiz activity (See Table 5).

Table 5: Comments from Students

Due to space limitations only part of the results are shown here;
Not corrected for grammar/spelling - student comments shown as is

- I really did enjoy the team quiz. Having a team quiz will actually communicate well with my teammates and learn the subjects better
- The only complaint I had with the team quiz was the phrasing of some questions that a team had asked. Perhaps have a template for questions of the multiple choice?
- This was more enjoyable then a regular midterm, I felt less stressed and should be continued to be done.
The team-quiz was a great experience for me when dealing with people and communication. Opportunities like this help us learn by experience, which in my opinion, experience is the best way to learn because that way we can learn from our mistakes and use what we learned with life. Life is known to have many surprises, and these type of experiences will come in handy one day, we just don't know when.   -

- Overall, the team quiz was okay. I see why we had to do the team quiz and the purpose behind it. It was a way to help all of us to get prepared for the future exam; it was pretty useful and I didn't mind working with other people.
- If we could do this for the Final Exam that would be great. Or we could do a practice team quiz in the week before the final exam to help us prepare.
- I really enjoyed the team quiz. I think It really helps with reviewing the material.
- The final should be in this format as well.
- I really enjoy the team quiz idea, personally if it was just a mid term quiz I probably wouldn't had study hard if not at all. Having the team quiz makes me study more just because I do not want to let the team down or ruin anyone elses grade from me beng selfish. I would enjoy this even more if more classes do this.
- I enjoyed how we worked as a team and were able to split the work evenly. It was better and less stress then a test. Also having to come up with questions forced me to go over the material and was great review.
- I enjoy the team quizzes. I do like that we get to pick our own groups.
I did enjoy doing the team quiz more than taking an actually mid term as it's less stressful and also it can be a little fun depending on who the team members are.</p> <p>It does help a little with the team work as one of us is like the leader and kinda assign each member a task they would like to do.
I learn more with the Team Quiz then with a Midterm test.

Overall, both the quantitative and qualitative results show the following:
- Students feel that the team quiz activity helped their learning.
- Students found the team-quiz exercise to be less stressful than a traditional usual midterm exam.
- Students found this to be a good way to review the course material.

One limitation of the study is related to the number of students in each course. As can be seen from the tables above, the average number of students in each course is less than 20 (considering 77 student respondents in 4 total courses). Thus, limited conclusions should be drawn from the statistical analyses within each course.

Conclusion:

This paper explained the team-quiz activity in which students from different CGT courses participated. In order to promote collaborative team-based learning, instead of the conventional mid-semester examination a team-based examination was utilized. The class is divided, typically, into six groups of 4 (approximately) members each. The instructor meets with each team individually and discusses their questions and explains to them how specific questions can be clarified and improved. Although, the entire activity from start to finish is carefully monitored by the instructor with continuous feedback and grading of team-performance, independent team work and individual responsibility are also emphasized. This activity can be replicated in other CGT courses as well other disciplines. The results suggest that it can be an effective means to strengthen CG course pedagogy. This approach will facilitate assessment of tactile learning methods in CGT course curriculum and help with a continuous 'Course Improvement Plan'. Ultimately this approach can help students learn course content and develop valuable collaborative team-working skills necessary for their success in today's workforce.

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Author Bio

Magesh Chandramouli: Dr. Chandramouli is an Associate Professor of Computer Graphics Technology in Purdue University Northwest. Dr. Chandramouli has been invited to deliver keynote speeches and guest lectures in various countries around the world. Formerly a Frederick Andrews Fellow at Purdue University, West Lafayette, he completed his doctoral studies from the Department of Computer Graphics Technology. He completed Master of Engineering at the National University of Singapore and Master of Science from the University of Calgary, Canada. He completed his Bachelor of Engineering from the College of Engineering, Guindy, India. Dr. Chandramouli has published journal articles in prestigious international journals and has presented papers in respected national and international conferences. He has received federal, regional, and international grants for his work in areas including virtual reality, STEM education, Human Computer Interaction, and Genetic Algorithms in Graphics.

Emily Hixon: Dr. Emily Hixon, is the Director of Center for Faculty Development and Leadership at Purdue Northwest and Professor of Educational Psychology and Instructional Technology in the School of Education and Counseling at Purdue Northwest. Her degrees are from Indiana University Bloomington in Instructional Systems Technology (M.S. and Ph.D.) and Educational Psychology (M.S). She has developed and taught online, hybrid, and traditional courses for undergraduate and graduate students. She also works as a faculty developer helping faculty to develop online courses and more effectively use technology to support and enhance student learning. She publishes in the areas of online course development, effective technology integration, and faculty development.