

The Use of Story-Telling as an Assessment Task in Optics: A Collaborative Learning Approach in Optometry Education

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Abstract

Background: Collaborative learning utilising storytelling is an active learning strategy that has not been investigated in optometry education. We examined the relationship between academic performance and this learning style to determine if this assessment type can improve student engagement and academic outcomes in ophthalmic optics.

Methods: A student-centered learning assessment was applied to one cohort of students (n=37) enrolled in the first year ophthalmic optics course of the optometry program at the University of Canberra, Australia. Students were randomly paired and asked to utilise cooperative storytelling to create a visually engaging presentation about a randomly assigned optical principle for elementary school aged children. A comparative cohort of first year optics students received a passive learning written assignment (n=30).

Results: Mean percentage change in academic performance following the assignment, was significantly greater in the cooperative storytelling versus the passive learning group ($+13.0 \pm 5.8\%$, $p = 0.03$; $+3.0 \pm 5.0\%$, $p = 0.55$). Students who performed lower academically, identified as the lowest quartile pre-assignment, showed a significantly greater increase in scores from baseline for the cooperative storytelling group ($+18.6\%$, $p < 0.01$) relative to the passive learning group (-6.4% , $p = 0.42$). Most students judged that the cooperative storytelling activity increased peer interaction (65%) and that it assisted in their preparation for the follow-up written assessments (89%).

Conclusion: Assessment strategies that encourage collaborative storytelling increased student engagement in the optometry course, which may deepen comprehension and lead to improvements in academic performance and student experience.

Background

Learning environments should support different learning styles and promote student engagement by enhancing the quality of the student experience while meeting the learning objectives of a course. Cooperative learning activities promote student engagement by providing an opportunity for students to interact, discuss, problem-solve and build strong trusting relationships(1), which encourages self-directed learning and develops a deeper level of understanding(2).

Critical thinking and teamwork are important competencies that optometry graduates must demonstrate(3). Optics has traditionally presented cognitively challenging content for students that often is delivered in a lecturer-centered approach(4). This style promotes a superficial approach to learning, with students merely memorizing facts and failing to develop a deeper understanding of concepts and knowledge application. This may lead to poor student engagement with the course content and be reflected in poor academic performance. Active learning strategies in small groups have been employed frequently in healthcare education(5, 6) to encourage self-directed learning in students and increase student engagement with content, which can lead to deeper learning and comprehension(7, 8). These storytelling techniques include lecturers sharing experiences with their students, merging theory and

practice, and developing a professional identity(9), which all promote deeper learning. The University of Canberra has recently embarked on identifying ways in which contemporary modes of university learning and connectedness could be beneficially adjusted by a closer blending with Indigenous ways of learning and connecting. As storytelling is also an important part of learning in indigenous cultures, we developed a framework for indigenizing the curriculum with indigenous educator consultation. This involved changes to the delivery and assessment of units in the University of Canberra Optometry program that aligned with indigenous ways of learning including storytelling and experiential learning. Experiential learning theory involves knowledge acquisition through visual hands-on experience(10).

Our study aimed to explore the efficacy of a collaborative based approach to learning with first year optometry students utilizing storytelling to describe an optics principle aimed at elementary school children. The assessment was delivered in a first year optometry program cohort and outcomes from a student survey and academic performance gains were compared to a previous cohort of Year One students who received a standard passive learning assessment.

Methods

Participants

Participants in the study were recruited from the first year Ophthalmic Optics course in the Bachelor of Optometry program at the University of Canberra over a period of two years. The University of Canberra Discipline of Optometry offers a five-year undergraduate optometry program. In the first two years of the program, students undertake basic health and vision science subjects including ophthalmic optics. All students were invited to participate and informed consent was received by all participants. The study was approved by the University of Canberra Ethics review committee (Ethics approval #0096).

The Ophthalmic Optics subject is an introduction to optical principals and its application in a clinical optometry setting. Students were informed that a novel assignment task for their year was planned and would involve collaborative active learning strategies.

Our study examined the results from a cohort that completed a culturally safe, collaborative story-telling task compared against historical controls from a passive learning assessment task from the previous cohort. The cooperative learning task in this study involved students working in randomized pairs to create a 10-minute video on a randomly assigned topic provided by the lecturer to a target audience of school aged children (9–12 years old). Topics included fundamental principles of the behavior of light and lenses. Students were encouraged to reduce the concepts to basic levels of understanding and use storytelling techniques when presenting the designated optical principle with visual aids and props to promote learning by illustrating and adding meaning to the optical concepts(9). Students were informed of this assessment task in Week 1 of the semester, ten weeks before the due date.

The passive learning group consisted of historical controls, students who had completed the ophthalmic optics subject with a passive learning task one year prior to the cooperative storytelling group. The task

involved students researching and preparing an evidence-based written assignment on the optical properties of a selected ophthalmic instrument.

The teaching syllabus was identical for both cohorts, except for the type of presentation assignment. Grading of assessments across both groups was done by the same examiner (FS) and moderated by a second examiner. We compared the academic performance in two closed-book written assessments before and after the assignment across the two cohorts. These written tests assessed recall, understanding and application of the student's knowledge in optical principles. To measure student experience and engagement with the innovative assessment technique, we conducted a quality assurance survey using a five-point Likert scale (1 = strongly agree, 5 = strongly disagree)(11) among the cooperative storytelling group following the final exam.

Students from both cohorts had an assessment before and after the assignments. The pre-assignment assessment (Pre-test) consisted of a 30-minute quiz and the mid-semester exam covering content from Week one to seven. The post-assignment assessment (Post-test) also included a 30-minute quiz and the final written exam. All the tests, quizzes and exams were closed-book and conducted under examination conditions. We calculated the change between each student's baseline pre-test and post-test score (mean between pairs of tests), post-assignment mean change in score and analyzed data on the academic performance of the highest and lowest quartiles of the cohort.

Statistical analysis

Statistical analyses were performed to measure differences in academic performance between cohorts and among quartiles between the different learning assessments. All data was analyzed using SPSS (IBM corporation, version 17.0) and customized code in MATLAB (Mathworks 2018). Discrete variables were summarized as frequencies for each cohort and tested using the χ^2 test. Continuous variables were presented as mean and standard deviation when normally distributed. Differences in paired means were tested using two-sample paired t-test, otherwise the non-parametric Mann-Whitney-U test was applied. We used an Analysis of Variance model to examine the interactions between cohorts with Bonferroni correction for multiple comparisons; $p < 0.05$ was considered as significant. An additional analysis examined the interaction between assessment groups with cohorts stratified into quartiles based on final academic outcomes.

Results

Thirty-nine students were eligible for participation in the cooperative storytelling cohort; two students declined to participate (cooperative storytelling, $n = 37$). Grades were compared between the cooperative storytelling cohort and historical cohort (passive learning, $n = 30$). There were significantly fewer males than female students across the cooperative storytelling (35% males, $p < 0.01$) and passive learning (30% males, $p < 0.01$) cohorts, respectively (Table 1).

In the cooperative storytelling group, academic performance gains were significant, with a mean performance improvement of 13% in the post-test scores ($p = 0.03$) (Fig. 1) compared to baseline. The passive learning group had no statistically significant change in written assessment scores following the assignment ($p = 0.55$). The cooperative storytelling group had a significantly lower mean baseline pre-test ($-21.9 \pm 4.42\%$, $p < 0.01$) and post-test scores ($-12.3 \pm 5.79\%$, $p = 0.04$) than the passive learning cohort. The grades for the assignment task were significantly lower in the cooperative storytelling cohort ($-16.7 \pm 2.9\%$, $p < 0.01$).

We found that there were mean gains in academic performance for both the lower and upper quartiles for the students who received the cooperative storytelling intervention (lower + 18.6%, $p < 0.01$; upper + 15.8%, $p = 0.08$, Fig. 2). Gains were only statistically significant for the bottom quartile. The passive learning assignment cohort had no significant change in academic performance following the assignment for both the lower and upper quartile of students in the cohort (lower - 6.40%, $p = 0.635$; upper - 1.49%, $p = 0.419$) with the lower quartile having a numerically worse academic outcome following the assignment compared to the top quartile. We found no significant interaction between gender and cooperative storytelling intervention on academic performance of both students in the upper ($p = 0.86$) and lower quartile ($p = 0.66$). In addition, no significant gender effect was found for the passive learning cohort for students in the upper ($p = 0.38$) and lower quartiles ($p = 0.16$).

Table 2 presents the summary statistics of the qualitative assurance questions with a breakdown of the post-assignment survey results. Ninety-five percent of students judged the cooperative storytelling assignment helped strengthen their understanding of the content of the course and 89% of students judged the cooperative storytelling assignment helped them prepare for follow-up assessments in optics. Peer interaction was judged to have been improved by 65% of students and 73% favored this style of assignment structure from traditional written assignments. Thematic analysis of free text comments showed students strongly favored the interaction with their peers and that the task had a “creative edge” and “helped make the concepts more clear”.

Discussion

Ophthalmic optics is a foundation course for optometrists that underpins their knowledge about the behavior of light for the application of visual aids to correct structural and ocular-motor visual dysfunction. For this reason, students need to have a strong understanding of this topic to improve their practical proficiency. Similar to other advanced degrees, optics has traditionally been a hurdle topic for students in the early stages of their tertiary education that has led to a teacher-centric approach(12). This approach leads to superficial strategies of learning, including memorization of facts and formulae without progressing to higher levels of Bloom’s taxonomy, which restricts students from gaining a deeper level of learning. For this reason, we attempted to create and deliver an active learning assignment to encourage students to engage with the content in a more meaningful manner and hopefully, improve academic outcomes following the assignment.

The current study assessed the impact of a novel assessment style for ophthalmic optics on student engagement and investigated the relationship between assessment style and academic performance. The results showed that students who participated in the cooperative storytelling assignment had a statistically greater improvement in academic performance in written test performance following the assessment. The performance gain was maintained on subsequent written assessments post-assignment for the cooperative storytelling cohort. Conversely, students who participated in the traditional passive learning assignment had no significant change in academic performance following completion of this task. In addition, the effect of improvement in scores following the cooperative storytelling assessment was greater in students who had lower academic performance compared to academically high achievers. Finally, the cooperative storytelling cohort had lower baseline academic performance that may have led to the potentially greater gains than the passive learning cohort. Students were given access to all presentations to aid preparation for post-test assessments.

Our results confirmed previous studies that showed, on average, student's academic performance significantly improved when they engaged in small group learning assignments in medicine(13) and optometry(14, 15). In addition, Carini et al. investigated the association between student engagement and academic performance in multiple disciplines of tertiary education and found a positive correlation with grades and critical thinking(16). They also observed that student engagement produced greater outcomes for academically lower performing students. To our knowledge this is the first study in an optics course for optometry students, that investigates the effect of changing an assessment task from a passive based learning task to a team-based active learning strategy, on engagement and academic performance. Our study also demonstrated that the greatest gain in academic performance was in the academically lowest quartile of students and could be recognized as an effective strategy to raise understanding and performance in students struggling with optical concepts.

We also sought to explore the impact of the active learning strategy on student experience. Student experience is an important consideration when applying new teaching methods and the current study confirms student satisfaction with the cooperative storytelling model of assessment.

We utilized indigenous ways of learning into the Optics unit to respect the diverse learning approaches of our students and to promote equal opportunity for our learners. Our study showed that facilitating student learning by providing flexible, culturally safe, assessment styles allowed students who were visual learners to experience and reinforce their understanding of difficult optics principles. Significant performance gains by the students struggling with optical concepts may be related to motivational gains for students who exhibit different learning approaches to the traditional lecture style, that contains more superficial learning(17). Further studies identifying students optimal learning style may confirm this finding.

There are several limitations of this study. Firstly, the student cohorts between the assessment styles were non-contemporaneous and not controlled, which may have affected the outcomes. In addition, we conducted the assessment within the constraints of the university assessment policy that restricted us

from randomly assigning students in the same year different written assignments. Secondly, our sample size is small, which limits our ability to stratify according to different factors that might affect the outcomes, such as entrance scores for program entry. Therefore, our findings would benefit from confirmation in a larger cohort. Finally, the assessment grading was subjective and bias may have been introduced between cohorts. We minimized this bias by using the same examiner between both cohorts and a second examiner to adjudicate a random sample of assessments for moderation purposes. We also had a clear, well defined marking rubric that had been moderated by a separate member of academic staff.

Conclusion

Our study has demonstrated that improvements in student engagement and learning experience can be achieved by providing a collaborative visual learning assessment. Cooperative learning using storytelling in the delivery of content can achieve deeper learning, result in higher gains in academic performance from students who may initially struggle with optical concepts and empower students to build their identity as professional clinicians. This however, requires optometry educators to re-evaluate their learning activities and develop assessments that are flexible and encourage creative team based activities to reinforce learning.

Declarations

Authors' contributions

FS prepared the manuscript and collected the data; ML analysed data and edited the manuscript; NA interpreted the data and edited the manuscript. All authors read and approved the final manuscript

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Availability of data and materials

The datasets used during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The University of Canberra, Australia, ethics review committee (Ethics approval #0096) approved the study. All participants enrolled to participate following written informed consent.

Competing interests

The author declares no competing interests.

Consent for publication

Consent has been obtained by the University of Canberra Faculty of Health Research office.

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Tables

Table 1
Student demographics and test results

	CST	P value	PL	P value
N (% Male)	37 (35%)		30 (30%)	0.86
Raw percentage test scores, mean (SEM)				
Mean Pre-test 1 & 2	34 ± 16%		56 ± 19%	< 0.01
Assignment	74%		91%	< 0.01
Mean Post-test 3 & 4	47 ± 27%		59 ± 19%	0.04
Mean % score change from Mean Baseline Pre-test (SEM)	+ 13%	0.03	3%	0.55
Student Lower Quartile % score change from Mean Baseline Pre-test (SEM)	+ 19%	< 0.01	-6.4%	0.42
Student Upper Quartile % score change from Mean Baseline Pre-test (SEM)	+ 16%	0.05	-1.5%	0.63
CST = Collaborative Storytelling, PL = Passive Learning, SEM = Standard error of the mean				

Table 2
Post-survey student responses

Post Survey Question	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
1. The assignment helped me prepare for follow-up assessments in optics.	3	11	19	4	0
2. The assignment has helped strengthen my understanding of the content of this unit	13	14	8	2	0
3. This assignment has increased peer interaction	2	7	15	13	0
4. This style of assignment is preferred compared to traditional written assignments	3	9	15	9	1

Figures

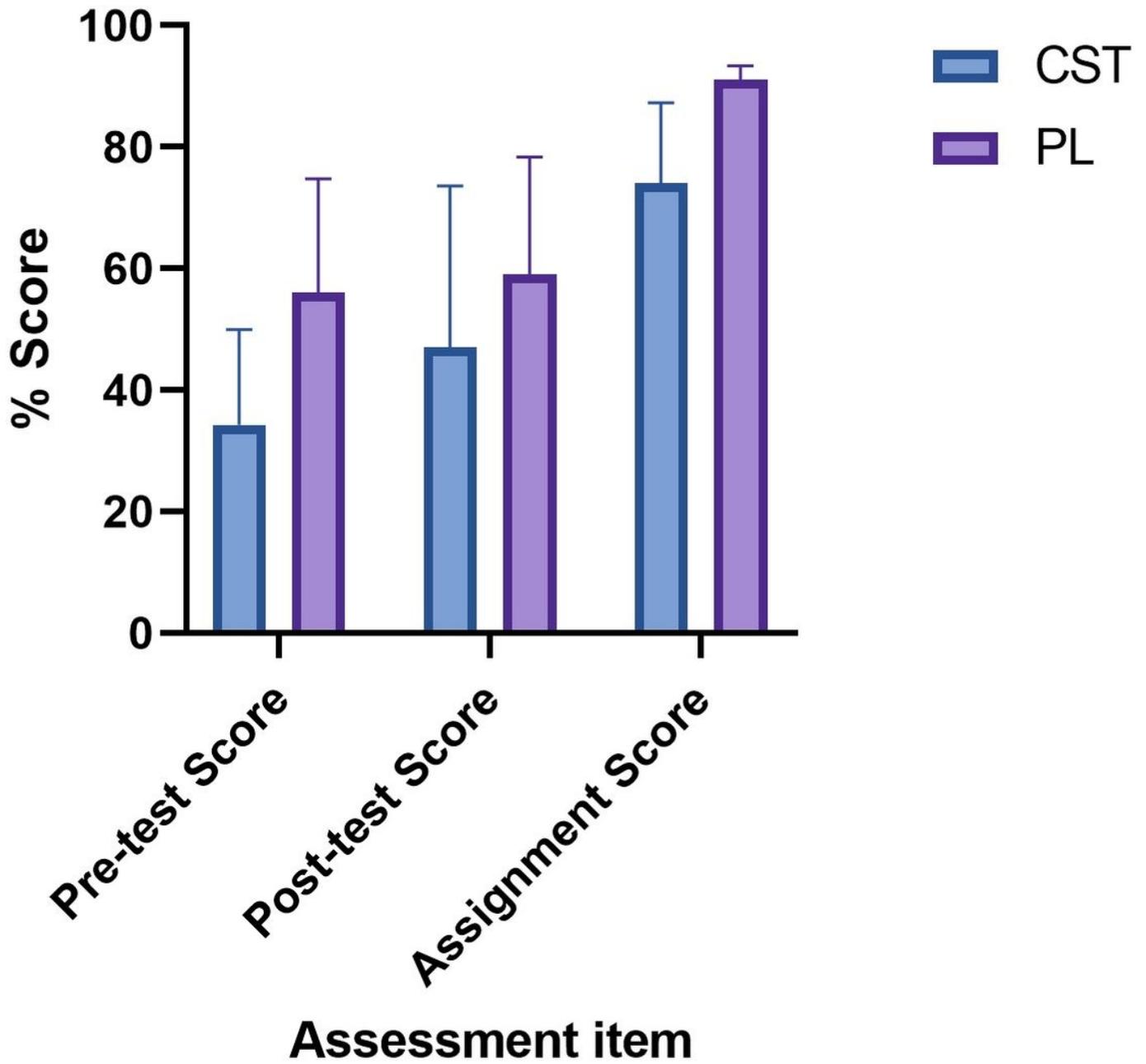


Figure 1

Pre-test, post-test and assignment score for the cooperative storytelling (CST) and passive learning (PL) cohorts

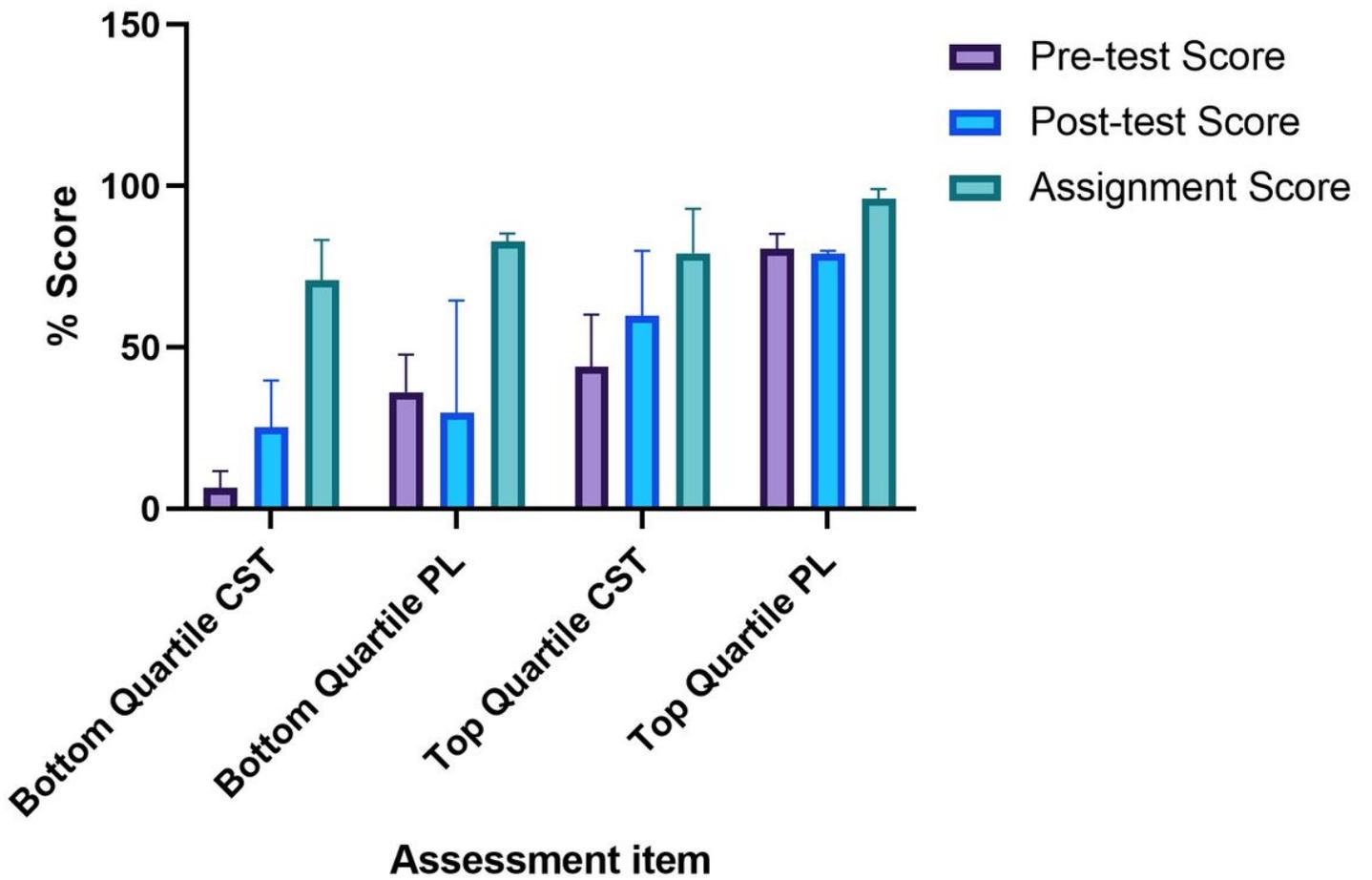


Figure 2

Pre-test, post-test, assignment scores for the cooperative storytelling (CST) and passive learning (PL) cohorts according to quartile