Journal of Teaching in Physical Education, 2010, 29, 227-244

A Didactic Analysis of Student Content Learning During the Reciprocal Style of Teaching

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Peer-assisted learning (PAL) strategies, such as the reciprocal style of teaching, have been shown to be effective in developing motor skills. Despite this research, little is currently understood of how PAL strategies influence the teaching-learning process. The purpose of this study was to use a didactic methodology (Amade-Escot, 2005) to examine the content taught and learned by two pairs of undergraduate students participating in reciprocal style (Mosston & Ashworth, 2002) episodes of indoor climbing. The didactic protocol included collecting data regarding student intentions, actions and interpretations of content, and the identification of problematic episodes in the teaching-learning process or Critical Didactic Incidents. The participants' improved their knowledge and performance of lower complexity climbing skills. Participants' failure to construct more sophisticated climbing content was as a result of deficiencies in the peer observer's in-task error diagnosis feedback and teaching style imposed constraints on teacher intervention.

Keywords: didactic contract, spectrum, content development, climbing

The strategy of using peers as a component of instruction has become increasingly prevalent within contemporary physical education models. Sport Education (Siedentop, Hastie, & van der Mars, 2004) and co-operative learning (Dyson, 2001) are examples of popular curriculum models that are premised upon peer-assisted learning (PAL) strategies (Rosenshine, 1979). These PAL strategies can be in the form of direct instruction such as peer tutoring (Webster, 1987) and the reciprocal style of teaching (Mosston & Ashworth, 2002), or those that use a group co-operative learning strategy (Slavin, 1991). A recent review of PAL strategies suggest that direct styles of PAL, such as peer tutoring and the reciprocal style of teaching, are effective instructional strategies to help students with and without disabilities to learn motor skills (Ward & Lee, 2005). Research has also supported the efficacy of the reciprocal style of teaching in developing cognitive knowledge of motor skills (Ernst & Byra, 1998), and positive social and affective outcomes (Byra & Marks, 1993; Goldberger, Gerney, & Chamberlain, 1982). Despite this growing body of evidence to support the use of PAL strategies there remains a paucity of knowledge

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of how these strategies operate to influence the dynamics of the teaching-learning process. Specifically, little is currently understood of how PAL strategies influence the evolution of content that is taught and actually learned. If a goal of pedagogical research is to understand, refine, and adapt an instructional approach, this void needs to be addressed.

Reciprocal Style of Teaching

The reciprocal style of teaching (Mosston & Ashworth, 2002) is a commonly used PAL strategy in physical education. Within this teaching style, the teacher demonstrates and explains the task, and the learners then practice the task in pairs. Within each pairing, one student acts as the doer (i.e., performs the stated task) while the other student acts as the observer. The role of the observer is to evaluate the performance of the doer and to provide feedback based on a priori criteria provided by the teacher. The role of the teacher is to interact with the observer, but not to provide direct feedback to the doer. In the reciprocal style two learners are provided equal opportunity to adjust the behavior interactions taking place within pairs, as they act on the decision-making power allocated by the style (Mosston & Ashworth, 2002). A basic issue to be confronted is whether such an arrangement can foster mutual benefits to learning for both members in the pair without inhibiting individual achievement. To address this question, the behaviors of both learners must come into consideration by examining the effects of feedback, which is the hallmark of the interaction between the doer and observer in the reciprocal teaching style.

The effect of the reciprocal teaching style on psychomotor gains has been examined in several studies in which a control group experimental design was employed (Goldberger & Gerney, 1986; Goldberger et al., 1982). In these studies, the learners who practiced under the conditions of the reciprocal style clearly improved their performance of a hockey accuracy test (product scores). Although these studies provided some indication of the effectiveness of the reciprocal style in facilitating student performance gains, they were limited by the nature of their design (i.e., focus on product scores) in their potential to provide insight into the dynamics of the teaching-learning process that operate in this style. A research methodology that may have the potential to provide a richer description of the dynamics of content development that occurs during reciprocal style episodes is didactics (*didactique*; Amade-Escot, 2000a).

Didactics

Didactics differs from other ecological approaches to understanding teaching and learning in its assumption that the content of tasks is the key driving mechanism in the teaching-learning process (Amade-Escot, 2006). The didactic program takes into account the characteristics of the content by examining the functioning of the didactic system, which is defined as the irreducible three-way relationship linking teacher, students, and the knowledge to be taught and learned (Amade-Escot, 2000a). The purpose of didactics is therefore the study of the microsituations of the specific development of content and its function in the teaching-learning process.

Only through this analysis can assertions be made about teaching behaviors and the influence these behaviors have on student learning. During PAL contexts, such as the reciprocal style of teaching, an auxiliary didactic system operates (Johsua & Felix, 2002). This auxiliary didactic system is made up of the observer, doer, and the content embedded within the instructional tasks.

Theoretical Roots of Didactics

The epistemological roots of didactics are centered within social constructivist theories of learning and the assumption that knowledge is constructed within situated social contexts (Amade-Escot, 2000a). In other words, the meaning that participants attribute to the situation in which they are involved depends on their status and role in the immediate context, as well as in the social and institutional context in which the microcontext takes place (Schubauer-Leoni & Grossen, 1993). This theoretical position posits that learning does not occur in isolation, but rather is an active, social, and creative process that requires students to develop their own understandings of particular subject matters (Lave & Wegner, 1991). Through this process, individuals use their own previous knowledge, the knowledge of others, and the guidance from teachers to effectively learn new knowledge and skills (Griffin, Brooker, & Patton, 2005).

The epistemological assumption of a situated social context of learning undergirds the core concepts and methodological framework of didactics. Within didactics there is an assumption that when a teacher provides instructions and brings a piece of knowledge into play there occurs negotiations between the teacher and student who will have the responsibility for managing that task or activity and what behaviors will occur within the task. According to Brousseau (1997) this system of reciprocal negotiation of the content to be learnt resembles a "contract" (p. 48) and is dynamic in its evolution. The theoretical concept in didactics is not to evaluate the contract as good, bad, true, or false, but the description of the mechanisms through which the teacher and students decipher their respective expectations (Amade-Escot, 2000b). Didactics research has shown that there is often a misalignment between the intended content to be taught and the actual content learned even when there is no real dysfunction within either the managerial or student social system (Amade-Escot, 2000a). Within didactic analysis this modification of content is referred to as a stretching of the didactic contract and occurs as a result of negotiations between the teacher and students that impacts the content taught and learned. From a didactic perspective, modifications or stretches in the didactic contract are pertinent and valuable, as the students test their capabilities in the aim of achieving the goal of the task. However, some of these modifications may become more critical to content development than others (Amade-Escot, 2000a). These critical breaches in the didactic contract are referred to as critical didactic incidents (CDIs) and form the basis of the didactic research methodology.

Research using didactics has demonstrated empirical progress in understanding facets of the teaching-learning process in physical education (Amade-Escot, 2000a). Despite this progress, studies that have examined the teaching-learning process during PAL strategies remain the weakest focus of didactic research (Amade-Escot, 2006). The aim of this study was to begin to address this paucity of empirical knowledge. Specifically, the purpose of the study was to use a defined

didactic research methodology (Amade-Escot, 2005) to examine the development of content knowledge and performance of two pairs of students participating in seven reciprocal style episodes of indoor climbing. Two research questions were addressed: (a) What (mis)alignment existed between the content intended to be taught by the teacher, and the content actually learned by the participants?; and (b) What factors operated within the didactic milieu of the reciprocal style episodes to shape the content actually learned by participants?

Methods

Setting and Participants

Students. Two pairs of undergraduate students enrolled in an indoor climbing physical activity class at a university in the Rocky Mountain Region of the USA were the focus of this case study. A priori criteria were established for the selection of the four participants who would form the two, single-sex reciprocal style climbing pairs. These criteria included minimal prior climbing and reciprocal style experience, a willingness to form a climbing partnership with another member of the group for the duration of the class, and agreement to comply with designated data collection protocols. Six (3 male, 3 female) of the 18 students in the indoor climbing activity class met the participation criteria and consented to participate in the study. Students in the final pool were contacted privately and asked to indicate any preference in pairing with one of the other consenting students. The final single-sex pairs were selected based upon commonality in these expressed pairing preferences.

Teacher. The teacher participant was a preservice teacher who had completed two teaching practicum experiences toward his degree in physical education teacher education. The teacher had received extensive training and experience using styles A-H of the Spectrum of Teaching Styles (Mosston & Ashworth, 2002) as part of an undergraduate physical education assessment and methods class. The teacher had four years of recreational climbing experience. Before commencement of the intervention, the teacher completed six hours of training on the content and delivery of the reciprocal style climbing episodes. This training included teacher reproduction of the intended reciprocal style climbing episodes with the researchers as participants. To verify the fidelity of the reciprocal style training each practice episode was coded using a Style Analysis Checklist (Sherman, 1982). Analysis of the training sessions by the primary researcher revealed teacher mastery of both content and delivery of the intended reciprocal style episodes.

Procedures

Intended Climbing Content

The indoor climbing activity class met for eight 50-min sessions. The first seven sessions were dedicated to the reciprocal style episodes of the intervention. The purpose of the seven reciprocal style episodes was for participants to learn

appropriate movement techniques related to safe and efficient indoor bouldering climbing. Bouldering techniques are designed for short route ascents (less than 12 feet in height) that do not require partner rope and belay support. The framework for indoor bouldering content was based upon contemporary practices of beginning bouldering climbing techniques and included the fundamental skills of setting contact points with the hands and feet, establishing a stable base of support, and straight arm climbing through initiating a transfer of force through the hips (Sherman, 2004). The intended climbing content of each reciprocal style episode and the performance criteria used to determine successful performance is presented in Table 1. In session 8 each participant performed a summative route climb that included four attempts at a route designed to elicit the intended content of all the reciprocal style episodes. No feedback was provided to the climbers during the summative route climb. All climbing route patterns were designed to allow for technique repetition during a single ascent and the position of the hand and foot holds was altered across episodes to align with the intended climbing content.

Table 1 Reciprocal Style Episode Intended Climbing Content and Success Performance Criteria

Session	Intended Content	Successful Performance Criteria
1	Setting precise points of contact—feet	Inside edge of big toe placed on largest part of hold without extraneous foot movements which produce a scraping noise against climbing surface
2	Setting precise points of contact—hands	Largest portion of hold grasped with hand without readjustment after initial contact
3	Establishing a stable base of support	Hip pushed close to climbing surface between moves to provide statically balanced position over feet.
4	Straight arm climbing—Transfer of force through hips	No elbow flexion required of reaching arm to advance to the next handhold. Hip rotated into climbing surface as arm extends to next hold
5	Straight arm climbing—Same side hip rotation	No elbow flexion required of reaching arm to advance to the next handhold. Hip rotates 90° toward climbing surface as same side hand reaches to next hold
6	Straight arm climbing—Room to pivot	No elbow flexion required of reaching arm to advance to the next handhold. Front of big toe placed on largest portion of hold to allow foot pivot
7	Straight arm climbing—Review of key components	No elbow flexion required of reaching arm to advance to the next handhold. Front of big toe placed on largest portion of hold. Stable base of support and same side hip rotation.

Reciprocal Style Episode Format

The first reciprocal style episode followed a modified version of Byra's (2004) applied task progression for familiarizing students to the reciprocal style. All subsequent episodes followed established reciprocal style protocol (Mosston & Ashworth, 2002). Each episode began with a brief introduction of the style and roles of the students and teacher. Next, a teacher demonstration of the focus content elements followed by a reemphasis of the critical elements through the observer task sheet was presented. Following the demonstration and explanation participants were given the opportunity to ask content clarification questions. Climbing performance then began with the first movement of the first climber (doer) up the route. Once the route climb had been completed (either by safe descent from the top of the route or a climber drop onto the safety pad below), feedback was given to the doer by the observer regarding his/her performance in relation to content criteria (task sheet). The doer was then given the opportunity to complete the route a second time. Following the second route attempt a similar feedback exchange occurred before roles were reversed. During route climbs the role of the teacher was to provide the observer role-related feedback. Teacher feedback was only directed at the climber during a potential safety compromise. To verify the fidelity of the reciprocal style intervention, each episode was coded by the primary researcher using a Style Analysis Checklist (Sherman, 1982). This analysis checklist includes task procedures and role descriptions for both the teacher and pair of learners. Data coding revealed the episodes to have greater than the recommended 80% fidelity between the teacher, learners, and behaviors specific to the reciprocal style of teaching.

Research Design and Data Collection Methodology

The general principles of the interpretivist paradigm (Erickson, 1986) under gird the data collection and analysis process of the didactic methodology used. Although participant behavior during episodes was observed and categorized using a specific system of content analysis, from a design perspective, the study was situated within a "quasi-ethnographic framework" (Amade-Escot, 2005, p. 135). The participants contributed to the interpretation of the observed behavior by acting as informants during a collaborative data collection process. The data collection methodology reflects this ontology by providing a dialectic stance between intrinsic data (participant) and extrinsic data (researcher), which is used to guide the analyses. A description of the changes in the didactic contract (examination of CDI emergence) is obtained by comparing the teacher/observer's a priori intention for the episode (intrinsic data source) with direct researcher observation of participant climbing behaviors (extrinsic data source).

Extrinsic Data Source

A digital camcorder and cordless microphone worn by the teacher was used to couple the verbal interactions of the observer and doer with the video of the evolving didactic processes during the reciprocal style episodes. All verbal behaviors recorded on videotape during episodes were transcribed verbatim. The observation data (verbal interactions and actions) were chronologically transcribed within a

"matrix-display" (Miles & Huberman, 1984, p. 37) that allowed examination of the evolution of content taught and actually performed. Route climbs were coded using a move-by-move analysis of the climber's performance in relation to the intended content elements required to successfully perform the task (e.g., setting quiet feet). Within climb and postclimb, observer feedback statements were also content categorized.

Intrinsic Data Sources

A priori data collection included brief semistructured interviews with the teacher before the episode and with the peer observers following the initial teacher demonstration. The purpose of these *pretask* interviews with the teacher and observers was twofold: (a) to collect information on their interpretation of the learning objectives for the upcoming episode, and (b) to clarify their didactic intent for the task. These pretask interviews lasted approximately five minutes and were conducted by the primary researcher in close proximity to the climbing wall. Sample questions posed included what are the main objectives of the tasks you are going to teach/observe today? How do you think your student/partner is going to perform in the tasks? Do you foresee any problems with your student/partner attempts at the content of these tasks? A posteriori data collection included postepisode stimulated recall interviews with peer participants. These 20-min interviews were again conducted by the primary researcher and staged on a separate day from the instructional episode. Each participant was given an independent opportunity to comment on their experiences as both an observer and doer. Video segments from the most recent reciprocal style episode were used to showcase the participant's actions as both the observer and doer. The stimulated recall questions were designed to elicit the participant's interpretation of the knowledge at stake, and how their interactions with their partner (the observer) influenced their understanding of the task. Sample questions posed included what skills cues is your partner performing well/could be improved? How did this performance differ from what you expected or communicated?

CDI Identification and Analysis

At the core of didactic analysis is the identification of Critical Didactic Incidents (CDIs). A CDI concerns an event or incident where the students and/or teacher struggle in the process of creating a common interpretation of the content of the task and where the intended learning goal of the task is significantly altered (Amade-Escot, 2005). Marsenach et al. (1991) provided characteristics that formed the basis of the CDI identification protocol used in this study. These include: (a) an episode of gymnasium interactions where most of the students on most of the trials (more than 80%) failed to achieve the performance outcomes intended of the task; (b) during the episode the teacher/peer tried by multiple methods (e.g., task refinement, verbal and nonverbal feedback) to help the students learn the intended content of the task; (c) the outcome of the episode was unsuccessful (the evolution of the situation did not allow the students to solve the problem they encountered); and (d) the researcher provided specific and detailed descriptions of the teacher and participant behavior during the task. This description included the didactic intent for

the task, process and/or product measures of participant performance, and teacher/peer observer activity during the task. A learning task that was determined to be a CDI is presented in Figure 1. The didactic intent articulated by both the teacher and peer observer during pretask interviews was that Mike would climb consistently with straight arms (more than 80% of moves). The episode was categorized as a CDI as despite consistent peer feedback toward the intended content Mike's success rate at straight arm climbing remained low (16%). Detailed descriptions were also provided of both climber peer observer behavior as the episode progressed. Interpretation of the CDI included analysis of climber/observer behaviors that contributed to failure in straight arm climbing as the episode progressed (e.g., stable base of support). All CDIs were initially identified by the primary researcher. The reliability of CDI identification was obtained through a peer-debrief of sample episodes. The peer was a faculty member initially trained on the observation coding system utilizing a sample route climb CDI episode. The peer then conducted the same coding protocol during an independent move-by-move analysis of different episodes identified as CDIs. Interobserver agreement was found to be 0.80 for the coding of participant climbing technique behaviors across route climbs. For example, the independent coding provided 80% agreement on the number of moves the climber performed with straight arms across two route ascents. From an analysis perspective, the interpretation of CDIs looks to identify some regularity in the form of patterns (Amade-Escot, 2000a) where the peer observer/teacher coach dealt with breaches in the didactic contract.

Results

Research Question 1

What (mis)alignment existed between the content intended to be taught by the teacher, and the content actually learned by the participants? The intent of the seven reciprocal style episodes was for the participants to master the bouldering techniques of setting precise points of contact with the hands and feet, establishing a stable base of support, and consistently climbing with straight arms by initiating a same side hip rotation during each arm reach. Analysis of climbing performance across episodes revealed that participants initially experienced difficulty setting points of contact. To enable quiet feet positioning participants would often show over-reliance on the arms, which led to the early onset of fatigue and compromised overall stability during latter moves of the ascent. As the episodes progressed the participants developed a more stable base of support through a hip orientation closer to the wall. This stable base of support enabled the participants to set more consistent precise points of contact as the episodes progressed.

The percentage success of participant performance of straight arm climbing across reciprocal style episodes are presented in Figure 2. Straight arm climbing persisted as the most problematic piece of content, with none of the participants consistently performing this technique appropriately across the episodes. Contributing to this lack of success was participants' tendency to set their base of support too low in relation to the next handhold. This low foot position forced an extension of their maximum hand reach which necessitated a resultant bend in the arm to complete advances to higher holds. The consistent failure to complete a full same-side turn by pivoting to bring one hip into the wall also minimized the

Content Elements	Climbing Moves						Percentage success	Post-Ascent Feedback	Climbing Moves						Percentage success	Post-Ascent Feedback
	1	2	3	4	5	6			1	2	3	4	5	6		
Quiet Feet	-	+	+	-	-	-	33%	(+)	+	-	-	+	-	+	50%	NP
Glued Hands	+	-	-	+	+	+	66%	(+)	+	+	+	+	+	+	100%	NP
Room to Pivot	+	+	+	-	-	-	50%	(-)	+	(-)	+	+	+	+	83%	(+)
Stable Base	-	-	+	-	-	+	33%	NP	+	-	-	+	-	-	33%	NP
Hip Transfer	+	+	-	-	-	(-)	33%	(-)	+	-	-	(+)	(+)	+	66%	(+)
Straight Arms	(-)	-	(-)	-	-	(-)	0%	(-)	-	-	(+)	-	(+)	-	33%	(+)

+ = Successful performance, - = Unsuccessful performance, (+) = Positive feedback statement by observer, (-) = Corrective feedback statement by observer, NP = No feedback provided

Figure 1. Episode 6 Move-by-move Analysis of Mike's Climbing Performance and Joe's Observer Feedback during the Straight Arm Climbing Task.

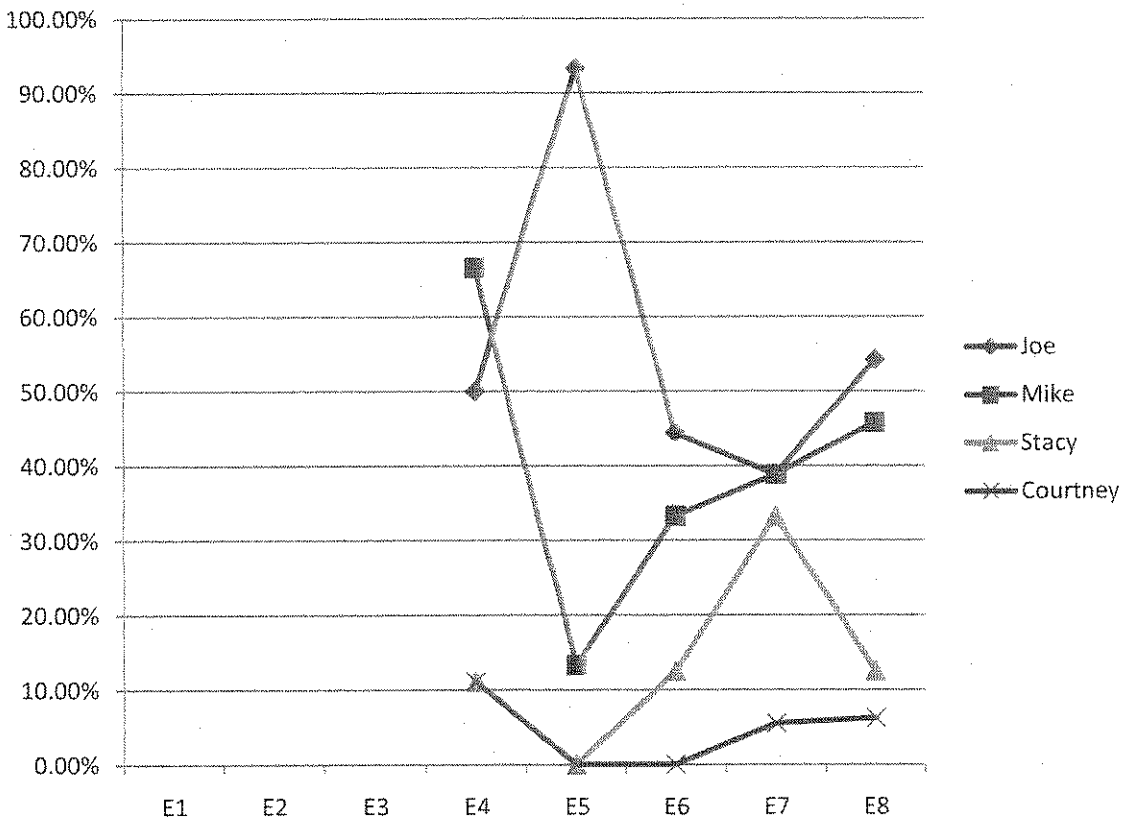

Figure 2. Participant Percentage Success at Performance of Straight Arm Climbing Across Reciprocal Style Episodes and the Final Summative Route Climb.

climber's reach and resulted in a final bent arm pull. This failure to adopt same-side hip rotation was primarily as a result of an outward facing foot placement, which limited pivoting potential.

Research Question 2

What factors operated within the didactic milieu of the reciprocal style episodes to shape the teaching-learning process? Results of CDI analysis revealed three main factors influencing the content taught and actually learned by the four participants across the seven reciprocal style episodes: (a) teacher demonstration and explanation, (b) observer feedback, and (c) teacher intervention. A move-by-move analysis of climbing performance was conducted for each participant across all episodes, however, due to space limitations only one sample CDI is included in the results to illustrate a reoccurring theme (See Figure 1).

Teacher Demonstration and Explanation

Patterns of data across episodes revealed that the teacher's initial explanation and demonstration of the intended climbing content consistently aligned with the a priori didactic intent for the episode. For example, during the introduction of straight arm climbing content the teacher articulated the need for the weight bearing arm to be straight:

> The concept that we are going to do today is straight arm climbing. The most important part is the turn to reach concept, so to help your arms stay straight you are turning with the same side arm...as you are turning to reach with your right arm keep your elbows locked so your arm bearing the most weight is straight (Teacher, live observation, episode 4).

Episodes were designed to scaffold new climbing knowledge upon content from previous episodes. The teacher often elaborated this scaffolding process by presenting new information as a refinement of previously presented content. For example, the didactic intent of episode 5 was to further develop straight arm climbing presented in episode 4 by incorporating a turn of the hips to transfer force from the legs. The teacher clearly articulated this scaffolding of knowledge:

> Today we are going to work on some refinements of straight arm climbing. Straight arms just like last time: your elbows lock when you weight is on them. The second part is hips moving in as you turn, so your hips are close as they were last time. This time you are getting more push from the legs as the side of your hip is coming into the wall as that side turns in (Teacher, live observation, episode 5).

Following a verbal explanation of the task, the teacher performed a demonstration of the task as he described his movements and provided verbal sequencing cues. CDI analyses revealed that the initial teacher demonstrations were highly aligned with the explanations provided:

> Start with your arms straight, you will turn... see how my arms are straight as I am going to the target, now I readjust my feet, same side in: as I am reaching with my right arm I am turning in with my right hip. Readjust my feet, same thing, readjust, same thing, again, keep your arms straight (Teacher, live observation, episode 4)

The efficacy of the teacher simultaneous demonstration and explanation were highlighted by the participants. For example, Courtney commented, "the teacher demonstrations are good because it gives us a clear picture of what exactly we are looking for when we refer to the skill criteria on the sheet." Following the task presentation, the auxiliary didactic system was formed with the observer given the responsibility of providing feedback related to the doer's performance of the criteria as presented by the teacher.

Observer Feedback

Within-Climb Feedback. During each style episode feedback could be provided by the observer during the actual route climb or as a summative commentary between ascents. Within-climb feedback occurred less frequently than postascent feedback and was generally limited to generic statements referent to the critical elements listed on the task cards. Although some of this feedback provided general error detection statements, for example, "Watch your hips, get them in" (Mike, live observation, episode 4), the statements often failed to diagnose the critical failing element. For example, during episode 2 Joe (observer) noted that Mike (climber) was having problems setting points of contact with his feet. Joe's solution was to

begin prompting Mike to scan ahead for suitable foot placements, "That's it... get your feet set...scan ahead...good" (Joe, live observation, episode 5). While these in-task feedback statements focused Mike's attention to the intended piece of climbing content, a lack of scanning ahead was not the critical failing content element in Mike's inability to set quiet feet. Mike continued to struggle with setting quiet feet, as his problems establishing a stable base of support (hip to the wall) went undiagnosed.

Postascent Feedback. Observers provided more specific feedback related to all skill elements during the postascent debrief. Interview data suggest this phase of the episode afforded the observer more time to compare and contrast the climber's performance with the delineated skill criteria on the task sheet. Both Joe and Stacy highlighted the challenges faced by the observer in providing the climber effective within-climb feedback:

> It is hard for me to break it all down when (the climber) is going from one move to the next. (Joe, stimulated recall, episode 2). With the time you have to look at the skills in front of you, its easy to go down the list and comment on the things she is doing, or not doing...its not like you have to keep watching every her every movement and tell what is going on . . . (Stacy, stimulated recall, episode 6).

Patterns across episodes revealed that the postascent feedback would often include recall of specific problematic moves. For example, Mike provided Joe a very specific chronology of success at the glued hands content during his first route climb in episode 2:

> ...On R1 and R3 you had much better contact with the hands ...You used your thumb to really lock onto R1, but on R5 you moved your hand a little bit (Mike, live observation, episode 2).

For the male pair, as the episodes progressed, the feedback episodes became more dialogic as the observer used both solicited and unsolicited input from the climber to clarify or formulate feedback statements. Joe (observer) explained why this occurred:

> In the end, I just can't tell what he is feeling...so it is important for me to be able to double check what I am thinking. I know how I felt while climbing, but he (the climber) could be feeling something different (Joe, stimulated recall, episode 2).

Evidence suggests that this dialogue developed a more complete understanding of the interconnectedness of the climbing content elements. An example of how this dialogue facilitated more accurate error detection occurred in episode 6. A move-by-move analysis of Mike's climbing performance and Joe's observer feedback statements during episode 6 is illustrated in Figure 1. A CDI ensued for Mike's performance of straight arm climbing during this episode (16% success rate). During Mike's first ascent of the route Joe articulated that Mike was not climbing with straight arms. Mike (climber) offered the response, "Yeah and I felt my feet were grinding into the wall as I tried to turn my hip (lesson observation, episode

6). Joe confirmed that he had noted the same thing, and that Mike would get better transfer force through his hips if he placed his feet with an appropriate amount of room to pivot. This was an accurate error detection of one of the elements required to perform straight arm climbing. The resultant outcome was a significant increase in Mike's 'room to pivot' performance during ascent 2 (50% to 83% success).

Despite evidence for the efficacy of peer dialogue in developing more sophisticated content knowledge, this discourse did not facilitate increased error diagnosis. During episode 6, Mike continued to struggle in his attempts to climb with straight arms as adequate room to turn was not the critical failing element. His unstable base of support was the primary cause of his failure and this element remained undiagnosed by Joe throughout the episode (see Figure 1).

Stacy and Courtney capitalized on their opportunities to provide more feedback between climbs as the episodes progressed. Many of the feedback statements, however, remained limited to general appraisals of the listed skill elements, with the dynamics of communication retaining a unilateral theme with the observer being the sole voice of authority in error diagnosis and correction. Although these feedback episodes were effective in facilitating learning of lower complexity content (setting points of contact), they rarely served to reduce the occurrence of CDIs during the more complex straight arm climbing episodes. The pair highlighted that their limited content knowledge of climbing may have been the cause of the ineffectual feedback for the higher complexity content. Courtney commented, "For someone who doesn't have much experience with climbing it is tough, because the teacher's examples are the only thing that I have to draw from, so sometimes I feel a little unqualified" (stimulated recall, episode 5).

Teacher Intervention

To maintain the fidelity of the reciprocal style, the teacher was not permitted to provide content-related feedback to the doer and observer at any point during the episodes. The teacher's efforts to assist the observer were limited to prompting the observer to consider the feedback they provided in terms of comparing and contrasting the climber's performance with the delineated skill criteria (use of the task sheet). For example, the teacher would often provide the observer the prompt, "Is there any of the skill criteria on the sheet that the climber did not perform as effectively?" Patterns across episodes revealed that these prompts were effective in increasing frequency of criterion-related feedback statements. They failed, however, to enhance the accuracy of observer error diagnosis and correction. For example, during episode 7 Courtney was struggling to climb with straight arms as she was failing to turn her hip into the wall due to her inappropriate foot orientation. Stacy's postascent feedback included:

> You did a really good job, your feet and hands were really sticking to the holds, you set up a good base on every move (Stacy, live observation, episode 7).

The teacher asked Stacy if there was anything else Courtney could improve. Stacy pondered the sheet before responding, "Think about turning your hips, but you did a better job" (Stacy, live observation, episode 7). Stacy diagnosed appropriately that Courtney had encountered difficulty transferring force through her hips, yet failed to attribute this difficulty to Courtney's foot orientation which interfered

with her ability to turn her hips into the appropriate position. Moreover, Stacy's statement that Courtney was making progress contradicted Courtney's reoccurring failure throughout both ascents. When asked of this exchange in a stimulated recall of trials, Stacy stated that this form of questioning by the teacher made it easier to provide Courtney with corrective feedback. "When the teacher prompts us it means that there is something more to say...There is a genuine response there, I'm not just throwing things out to keep him happy and I can be honest with Courtney" (Stacy, stimulated recall, episode 7). Despite this perceived comfort, the complexity of the content and the pair's unwillingness to engage in more meaningful dialogue limited the efficacy of the observer feedback.

Discussion

The results of this study suggest that a series of seven reciprocal style episodes were efficacious in facilitating participant learning of the basic indoor climbing content of setting points of contact and providing a stable base of support. Analysis of the teaching-learning process across pairs revealed that the reciprocal style episodes were ineffective in developing participant content knowledge and performance of higher complexity indoor climbing content including climbing with straight arms. This finding is congruent with previous didactics research which has shown higher complexity content to present significant challenges to the teaching-learning process during PAL tasks (Wallhead & O'Sullivan, 2007).

A pedagogical factor that facilitated alignment between intended and actual content learned by participants across episodes was the clarity and accuracy of the teacher demonstration and explanation. Shulman (1987) defined a teacher's pedagogical content knowledge (PCK) as being able to "elucidate subject matter in new ways, reorganize and partition it and clothe it in examples and demonstrations so that it can be grasped by students" (p.13). Results of this study suggest that the teacher demonstrated effective PCK in presenting the intended climbing content as the demonstrations and descriptions provided the participants a clear visual criterion of performance success required for peer observation. The teacher training protocol used within the study protocol may have contributed to this PCK development. The teacher was provided an opportunity to engage in situated reflective practice on the content and delivery of the reciprocal style episodes before the intervention which has been shown to be an important factor in the development of PCK (Rovegno, 1998).

The results of this study also provide further evidence that peer observers within the reciprocal style of teaching are able to provide accurate error detection in relation to intended content elements (Ernst & Byra, 1998). The participants in this study were able to verbalize appropriate error detection feedback statements during posttask dialogue which facilitated peer learning of lower complexity content. During the episodes the learners were afforded the opportunity to adjust their feedback interactions, as they acted upon the decision-making power allocated by the style (Mosston & Ashworth, 2002). The male pair acted upon this relative autonomy to develop more elaborative content discourse practices that facilitated a more complete understanding of the connectedness of the intended climbing content. This finding supports previous research which suggests that more detailed explanations by students involved in discussions is associated with greater gains in knowledge than simple descriptions of the performance (Palincsar, 1998).

Wallian and Chang (2007) proposed that from a situated learning perspective, the development of peer dialogue and discourse is essential for the development of knowledge and practice. The greater relative increases in content knowledge demonstrated by the male pair may be explained by the consistent use of sign interpretation (Wallian & Chang, 2007). Within this semiotic approach, learner activity is defined as an active process where speculative meaning attribution is linked with expectations that orient the decision-making process. The learner goes from an information seeker to an event interpreter as assumptions are shed, beliefs revised, and complex inferences reshaped (Wallian & Chang, 2007). During episodes the male pair adopted the strategy of using sequenced observer feedback cues which were formulated from their partner's preexisting interpretations of specific skill elements. In this way, the observer assumed the role of event interpreter by using situated verbal prompts to direct the climber's attention to information they believed would formulate success in the task. The practice of the female pair to retain a typical reciprocal style anatomy of a unilateral observer description of climber performance facilitated interpretations and attributions of the intended content to take place on an individual level. Feedback statements were offered as speculations that were never confirmed, and thus sign interpretations by both participants were never agreed upon (Wallian & Chang, 2007). The result was a more limited conceptualization of the intended content elements which served to extend CDIs when more complex content was at stake.

Despite the more elaborate content discourse practices of the male pair, the intended content of straight arm climbing remained problematic for all participants. This failure was rarely diagnosed during peer discourse, and when referenced, its significance was downplayed. A potential explanation for this failure may emanate from the complexity of the content and didactic obstacles that imposed barriers to student learning (Amade-Escot, 2006).

A potential didactic obstacle to the performance of straight arm climbing was the route climb designs used in the study. The routes were designed to elicit qualitative performance of the critical skill elements through a sequence of holds attainable for all participants. The disadvantage of such route designs is their potential lack of utility if the focus of the climber is solely to ascend the route. This didactic barrier emphasizes that the direct transmission of knowledge sometimes fails to provide authentic experiences necessary to the learning process if educators do not create learning communities in which students experience relevant understanding (Prawat, 1996).

Research on peer teaching has found that in-task teacher interventions were critical to reducing CDIs realigning the didactic contract (Wallhead & O'Sullivan, 2007). The anatomy of the reciprocal style episodes, although efficacious in terms of stimulating feedback frequency, may have limited the teacher's influence on realigning CDIs. The reciprocal style protocol does not provide the teacher an opportunity to provide skill-related feedback directly to the doer, as it prescribes that the teacher must only communicate with the observer to offer feedback based on consideration of the skill criteria (Mosston & Ashworth, 2002). In the presence of observer misdiagnosis of the critical failing element, this lack of teacher intervention served to increase the frequency and duration of CDIs for the more complex intended climbing content. This study is not without limitation which warrant acknowledgment. The stimulated video recall of episodes provided the participants an opportunity to self-reflect on their performance, which is not a

component of the landmark reciprocal style. Participants used these stimulated recall opportunities to confirm their observations, and at times, comment on elements of the climber's performance or behaviors of which they were not initially cognizant. Self-assessment through video recording is a possibility in the self-check teaching style (Mosston & Ashworth, 2002), which remains one of the least researched reproduction teaching styles within the spectrum of styles (Byra, 2006). Further study of the self-check style may shed light on the influence of these self-analysis data collection protocols on content learning.

Conclusions and Recommendations

This study serves to extend our understanding of the teaching-learning process that occurs within PAL strategies. The reciprocal style episodes improved participants' knowledge and performance of lower complexity climbing skills primarily through effective teacher demonstration and explanation and postascent observer feedback that was aligned with the task criteria provided by the teacher. The coconstruction of knowledge was enhanced when dialogue, in the form of sharing ideas, occurred between peer participants. Higher complexity climbing content remained problematic throughout the episodes due to the multifaceted nature of the content and resultant peer difficulty in the diagnosis of critical failing elements. This fact, tied with the limited opportunity for content-based teacher intervention within the style protocol, facilitated misconceptions which were agreed upon and persisted without challenge (Topping, 1998).

Mosston and Ashworth (2002) stress the importance of finding a teaching style that best suits the learning context, and recommend the selection of teaching styles on consideration of the learner's stage of motor development, level of movement skill learning, and the ability of the learner to comply with the requirements of the task. Findings of this study suggest that the reciprocal style may be an appropriate choice of teaching strategy when the intended content is relatively simple (e.g., less than three critical elements required for successful performance) and the students have had sufficient experience with the style to develop comfort in sharing feedback. The findings of this study also highlight the potential importance of flexibility or mobility among styles. A period of teacher-initiated practice style on a problematic piece of content before a reciprocal style episode may serve to remedy the breach in the didactic contract, while still retaining the integrity of power allocated to the peer observer. The strategy of using style combinations within a particular style canopy to overcome content misalignment issues remains an understudied area of research and warrants further study.

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