Using Complex Instruction in content classes for prospective teachers

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Motivation

- Groupwork in mathematics is an excellent pedagogical tool to
  - Promote mathematical discourse and argumentation
  - Promote critical thinking and problem solving skills
  - Promote conceptual learning
  - Provide students with opportunities for autonomous thinking
Issues with groupwork

- Engagement and accountability
- Status and Identities
- Disposition (Cognitive-Affective barriers)
- Groupworthiness of the task
CI research posits that issues of status play a critical role in why some students’ participate and others do not. That is, how a student is perceived by their peers in the group with respect to their capability to make meaningful contributions effects whether the group will listen to that individual.

If a student is seen as low status, they are seen as unable to contribute to the intellectual work of the group, regardless of how well the student understand mathematics.

If a student is seen as high status, they will be allowed to take over and run the group, even if this student’s mathematical ideas are erroneous.
The development of small learning communities begins on the first day of class.

Immediately following introductions, and before going over the course syllabus, talk about the power of collaboration in learning mathematics.

Establishing classroom norms promotes synergy and successful interactions.

Convey to students how once norms have been established they should help one another remain true to the guidelines when a norm is not respected.

Featherstone, et al., 2011:
- No talking outside your group.
- Helping others does not mean giving answers.
- Everyone stays together: No one is done until everyone is done.
- Ask, “Why?”
- Call the instructor for team questions only
- Balance your talking with your listening
- You have the responsibility to ask for help and the responsibility to offer it
- No one of us alone is as smart as all of us together
- I can’t..., yet!
[Some] Complex Instruction strategies

- Assign competence to low status students
- Use multi-capability/varied entry-point tasks
- Use challenging/open-ended tasks
- Only respond to group questions
- Assigning group roles
Assigning Competence

- Assigning competence is a pedagogical move that draws public attention to students’ intellectual contributions to the group effort.

- Assigning competence means that the instructor makes a public statement about a specific mathematical move made by a particular student or group and then describes the mathematical significance of that move.

- By assigning competence, one can call attention to useful strategies that students’ discover and use while engaged in challenging mathematical tasks.

- Assigning competence also helps to equalize status in a group as it helps high status students appreciate lower status students as well as helps low status students recognize their potential to make meaningful contributions to their group.
Multiple Capabilities

Figure 2. An Example of Multiple Capabilities Treatment

In order to succeed at this task, your group will need to do the following:

- Problem solve
  - Invent multiple strategies
  - Limit yourself to pre-algebra mathematics
- Think from a K-12 student’s perspective
- Make connections between mathematical ideas
- Represent mathematical ideas in multiple ways
- Make generalizations
- Communicate mathematical ideas clearly
- Listen to, understand, question, and extend others’ reasoning
- Make mathematical arguments/justifications

No one has all of these abilities, but together, the members of your group have the abilities necessary to succeed at this task.

Figure 3. An Example of Mathematical Learning Objects (Goals) For Sample Task

- Learning group roles and practicing group norms
- Engaging in problem solving and generating multiple strategies
- Taking on students’ perspectives
- Making mathematical connections
- Experiencing rich mathematical tasks
Group Questions

• When students work together in groups, they are only allowed to ask group questions to the instructor. That is, the group can only ask questions that everyone in the group agrees is essential for completing the mathematical task and is one that no one in the group can answer.

• All too often, instructors are called to groups to respond to individual questions that students can answer if they interact with their peers. One can ask anyone what the question is, not just the person who summoned me over.

• By allowing only group questions, a norm of interaction is established where the students learn to rely on one another as resources rather than asking the instructor.

• This is a very powerful pedagogical move: Students, while perhaps initially resistant to the idea of only asking group questions, find that they have more “aha moments” and learn best when they communicate and grapple with the challenging mathematical tasks as a team.

• Furthermore, this frees the teacher to focus the energy towards building upon students’ mathematical ideas.
Assigning Group Roles

- The purpose of establishing these group roles is to create, teach, and enforce the norms of interaction that help promote autonomy, interdependence, and accountability in groups.

- Certain roles encompass more talking and directing, allow for a first turn to talk, or give access to the teacher.

- A continuous assessment of group assignments and role assignments may uncovered competencies, small group dynamics and class dynamics.
### Roles

<table>
<thead>
<tr>
<th>Facilitator</th>
<th>Resource Manager</th>
</tr>
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<tbody>
<tr>
<td>• Makes sure the group reads the entire task and that everyone understands it before proceeding</td>
<td>• Collects supplies for the team</td>
</tr>
<tr>
<td>• Gets the team off to quick start</td>
<td>• Cares for an returns supplies</td>
</tr>
<tr>
<td>• Makes sure everyone’s ideas are heard</td>
<td>• Organizes cleanup</td>
</tr>
<tr>
<td>• Keeps the time on task</td>
<td>• Ensures that team questions are actually so</td>
</tr>
<tr>
<td></td>
<td>• Only one who can call the instructor over a team question</td>
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</tbody>
</table>
Roles

Questioner/Reflection leader/Includer

- Encourages participation and enforces norms and roles
- Finds compromises
- Helps the group reflect on their work during the task and at the end
- Asks questions about the group’s activity
- Substitutes for absent roles

Reporter/Recorder

- Gives update statements to instructor on team’s progress
- Makes sure each team member records needed information
- Organizes creation of reports/presentations and focuses on clearly showing mathematical ideas, relations, contributions from all members
The Houses Task

- Let’s make groups of four.
- Today we are going to work on these norms:
  - Everyone stays together: No one is done until everyone is done.
  - Ask, “Why?”
  - Call the instructor for team questions only
  - Balance your talking with your listening
  - I can’t..., yet!
- Get familiarized with your role.
Checking in

- Are you all playing your roles?
- Are we following the norms?
  - Everyone stays together: No one is done until everyone is done.
  - Ask, “Why?”
  - Call the instructor for team questions only
  - Balance your talking with your listening
  - I can’t..., yet!
Report time

- Normally each group would present their report (poster) to the whole class.
  - Document camera
  - Poster gallery

- Today, Reporters will move to another table to present the group’s work
Reflection

- Was there anything in the presentation from another group that caught your attention?
- How well did you adhere to your role?
- What were the moves you noticed the “teacher” did?
**Houses Task – Poster presentations**

**PART 3:**

1. **Diagram out all the houses and count on of the edges of each house.**
   
   - Number of houses: $n$
   - Number of edges per house: 8
   
   **Equation:**
   
   $P = (n-2) \times 3 + 8$  
   
   - $P$ represents the perimeter of the houses.
   
2. **Diagram out all the houses and count on of the edges of each house.**
   
   - Number of houses: $n$
   - Number of edges per house: $n+4$
   
   **Equation:**
   
   $P = (n+4) - (n-2)$
   
3. **Diagram out all the houses and count on of the edges of each house.**
   
   - Number of houses: $n$
   - Number of edges per house: $n+2$
   
   **Equation:**
   
   $3n + 2 = P$

**Three Strategies for the House Activity**

1. **Strategy #1:**
   
   - Let $n$ = number of houses
   - $P = (n-2) \times 3 + 8$
   - $P$ represents the perimeter of the houses.

2. **Strategy #2:**
   
   - Let $n$ = number of houses
   - $P = (n+4) - (n-2)$
   - $P$ represents the perimeter of the houses.

3. **Strategy #3:**
   
   - Let $n$ = number of houses
   - $P = 3(n-2) + 4(n-2)$
   - $P$ represents the perimeter of the houses.

**Key Words:**

- $n$ = number of houses
- $P$ = perimeter of houses
- $x$ = number of outside houses
- $y$ = number of inside houses
- $z$ = number of corners
- $r$ = number of right angles

**Diagram:**

- House with $n$ houses
- House with $n+4$ houses
- House with $n+2$ houses

**Diagram:**

- House with $n$ houses
- House with $n+4$ houses
- House with $n+2$ houses

**Similarities:**

- All of our strategies simplify to an edge, where $n$ = # of houses
- Strategies #1 and #3 use $n$ in an additive and $P$ in #2, we focus on total # of edges and then summate the inside edges.
References

- Designing Groupwork: Strategies for the Heterogeneous Classroom (Cohen, Lotan, 2014, 3rd Ed.)

- Smarter Together! Collaboration and Equity in the Elementary Math Classroom (Featherstone, Crespo, Jilk, Osland, Parks, & Wood, 2011)
Thank you!

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