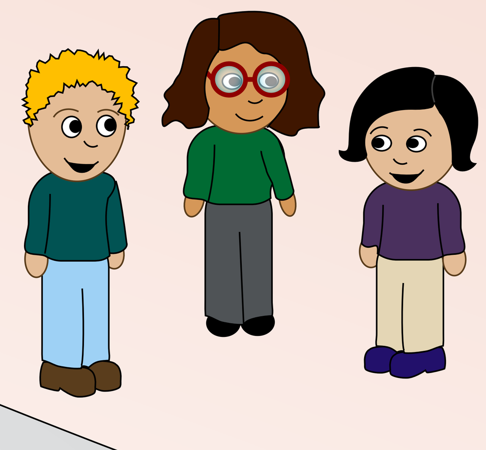
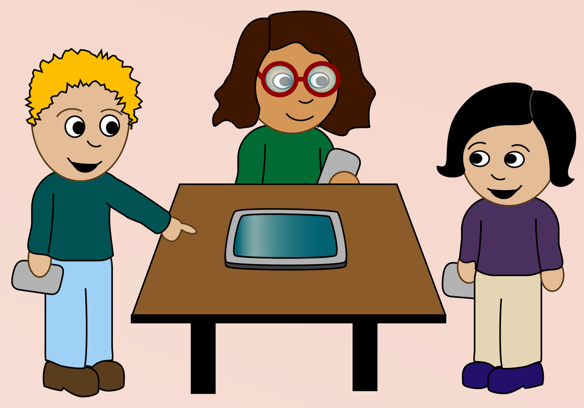
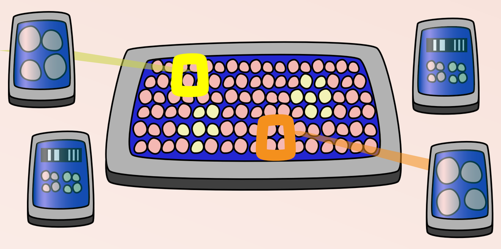
Scaffolding Cooperative, Multi-Device Activities in an Informal Learning Environment







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Research Context

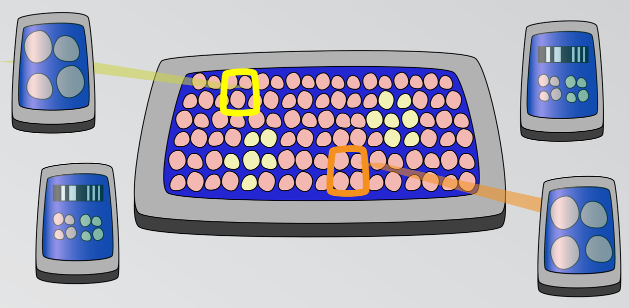
Scaffolding is a support provided to a learner to allow he or she to accomplish more than would be possible alone. Although there is a long tradition of using computers to scaffold **learning** in an active way (e.g. cognitive tutors), using computers to scaffold **cooperation** in shared learning scenarios is a more recent topic. Much of this work, though, has been conducted with remote and often asynchronous learning environments (e.g. bulletin boards).

This research is the first to set up a principled approach to studying computer-based scaffolding of cooperative processes in co-located synchronous learning environments.

Research Goal:

use software scaffolding to reduce uneven participation in synchronous, co-located cooperative activites

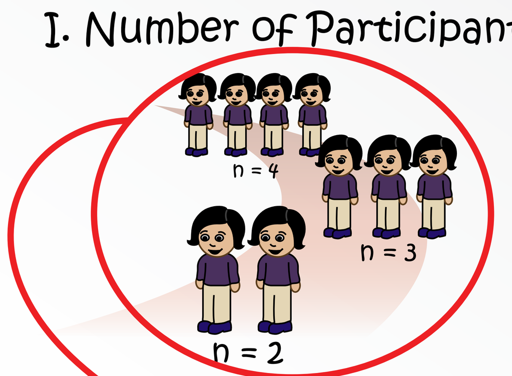
MUSHIlignancy



The exhibit, MUSHIlignancy, is a simulation of cancer growing within human tissue. Up to four visitors at a children's science center can interact with the simulation at the same time. They interact by using handheld computers to inspect and make changes to simulation parameters. The visitors assume different roles (e.g. surgeon, oncologist, radiologist) and must cooperate to eliminate the cancer without terminating the simulated patient.

Activity Structure Dimensions for Synchronous, Co-located Cooperative Scenarios

I. Number of Participants



Using n<=4

Prior studies of small-group coordination have found the greatest differences in cooperative behavior between groups of sizes 2, 3, and 4; at >=4 the differences tend to level off.

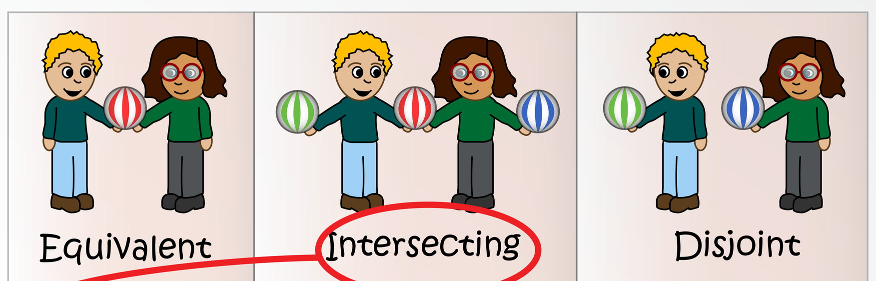
Assessment/Analysis

Will measure evenness of participation w.r.t. group size: suspect that evenness will be higher for n=2, n=4 than n=3.

Outcome

Establish the degree of impact that group size has on evenness of participation vis a vis other factors: could result in recommendations for group size.

II. Exclusivity of Resources



Here, resources == simulation parameters

Ideal scenario, based on coop. research, would be to "jigsaw" users by giving them sole access to unique parameters. For this study, though, we are limited in the # of parameters (e.g. cancer growth rate, blood flow, cell damage), so we provide intersecting roles: e.g., w.r.t. blood flow, surgeon can cauterize blood vessels feeding tumors, oncologist can tune mixture of antiangiogenesis drugs.

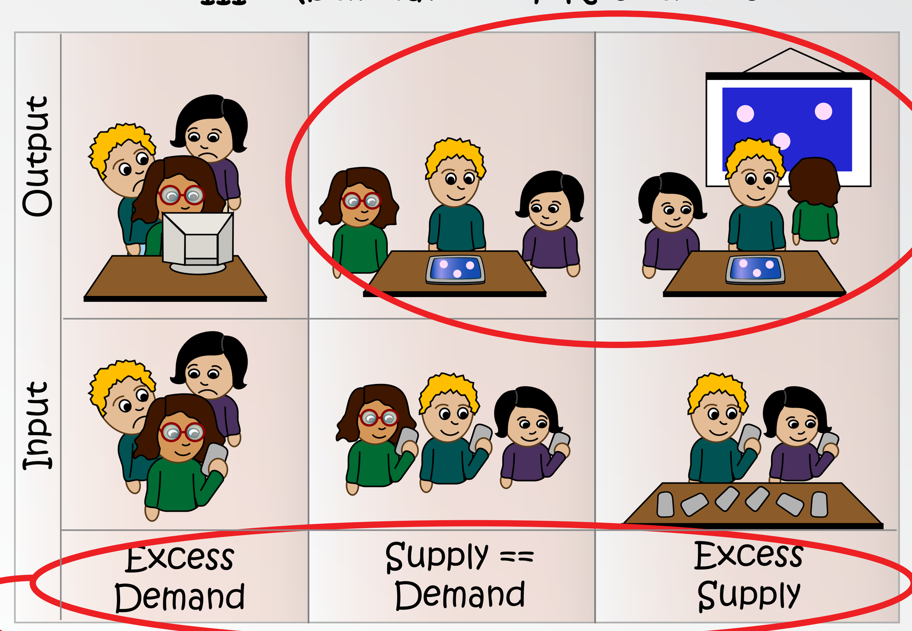
Assessment/Analysis

Can calculate degree to which different roles share parameters, & look to see if more even participation results when the roles currently at play share fewer parameters.

Outcome

Will leave a true assessment of impact of resource exclusivity on participation evenness to future work, but current work can provide intuition for how best to set up future study.

III. Abundance of Resources



Here, resources == access to simulation display, & to input

Providing all participants with individual interfaces (e.g. mice) has been shown to decrease conflict & even out participation, and Single Display Groupware has been used to provide simultaneous access to output. Here we provide handheld computers (which are wirelessly linked to the shared simulation), a tabletop display, and a projected display, so all participants can have access to input & output.

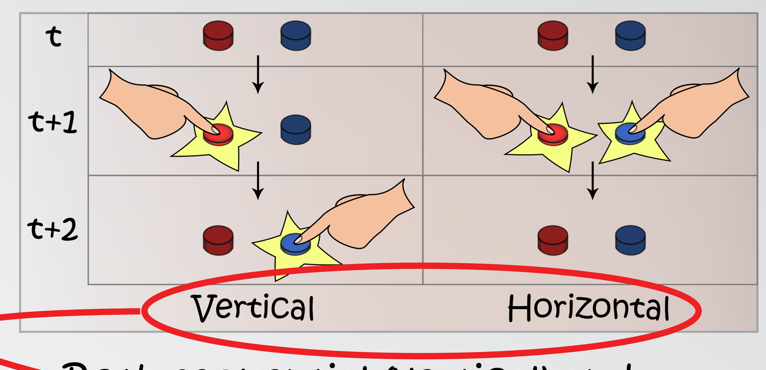
Assessment/Analysis

We can vary the number of handhelds provided (1-4), and the display paradigm (here - table top only, or tabletop + projector) & look at videotape data to count group size, # handhelds used by groups, # & types of displays used, & # participants without access.

Outcome

Assessment should reveal: average group size that approaches exhibit; if groups take advantage of individual interfaces in a free choice environment; if there are any ratios of interfaces-to-group size that result in better utilization of access points than others; if the addition of a projector supports peripheral participation when all input devices are in use. This information will be especially valuable to designers of multi-user exhbits in informal learning environments.

IV. Division of Labor



Both sequential (vertical) and simultaneous (horizontal) tasks

By having vertical or horizontal decompositions of labor, group members are compelled to cooperate if they are to complete certain tasks. Both types are present in this simulation, where some tasks are sequential (e.g. administering chemo before surgery) and others are simultaneous (e.g. administering two different types of chemo at the same time)

Assessment/Analysis

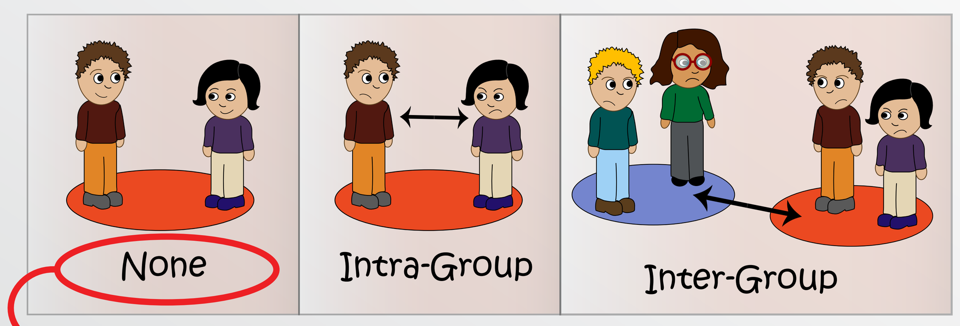
Because removing task dependencies would interfere with other features of the activity, I will not perform an experimental study of this dimension. Rather I will analyze log data for opportunities for task integration (horizontal or vertical) and assess how many of these opportunities were taken properly.

Outcome

The assessment will act as a pilot study to determine if users have more or less difficulty with either of these task decomposition types (as evidenced by failure to take advantage of opportunities). I will also look at the frequencies of sucessful task integration, to see if there are any notable patterns that correlate with other structural dimensions (most notably, I wish to see if successful integrations occur with the different accountability notifications of VII below).

Motivational Dimensions for Synchronous, Co-located Cooperative Scenarios

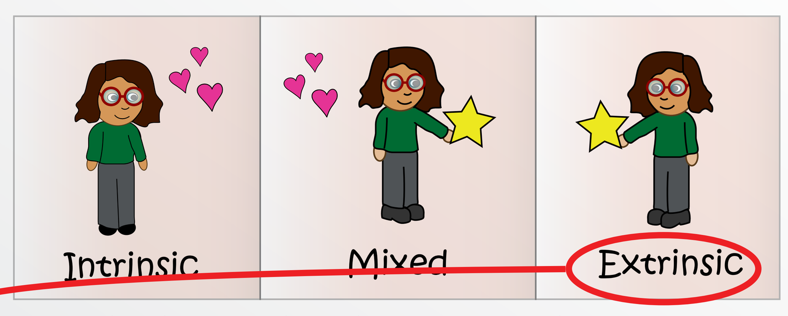
V. Competition Style



Not studying competition - yet

Research on small-group learning scenarios suggests that intra- and inter-group competition can be strong motivators for even participation within groups (although intra-group competition has the potential to decrease the quality of cooperation), but this is left for future work.

VI.Rewards



Extrinsic motivation: game-like structure with win/lose outcomes

Computer games have a long tradition of providing extrinsic motivation to players. If there is a single property common to most games, it is a win/loss outcome. We employ that here, with the simulation tuned to favor a death-by-cancer outcome unless the players can treat it successfully. A joint extrinsic outcome should promote even participation by players.

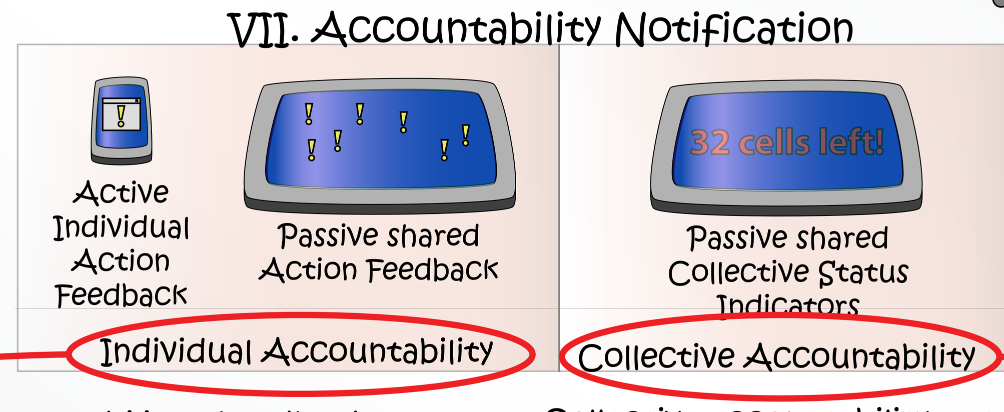
Assessment/Analysis

This is not game studies oriented research, so I will not study all possible extrinsic rewards. Rather, I will have two conditions: one where the simulation parameters are tuned to bias towards an ongoing fight against cancer (no win/loss condition) and one where the patient will die without player intervention. I will also administer surveys prior to playing to gauge visitor interest in oncology, as a rough measure of intrinsic interest, as it may be a confounding factor.

Outcome

A recommendation for the use of extrinsic rewards as a participation management strategy for synchronous, co-located cooperative activities. Another outcome: should also be able to gauge if intrinsic interest or extrinsic motivators played a larger role in participation behaviors.

VII. Accountability Notification



Individual accountability = handheld popups & indicators on the shared screen in response to user actions (i.e. feedback)

Collective accountability = status indicators on shared screen: e.g. # of cancer cells left to fight

Two strategies often used in encouraging even participation in cooperative learning groups are (1) highlighting the contributions of group members individually (individual accountability), and (2) highlighting the performance of the group as a whole (collective accountability).

Assessment/Analysis

Again, this is not game studies oriented research, nor is it a study of semiotics or information representation, so I will only vary the presence and absence of individual and collective accountability displays. There are four conditions: no accountability, individual only (where users get active popups on their handhelds explaining the impact of their most recent action, while the elements affected are passively highlighted on the shared screen), collective only (where the only feedback on actions is a collective measure of progress - e.g. the number of cancer cells remaining), or a mixed condition.

Outcome

A recommendation for which combination of accountability notification strategies (none, individual, collective, or both) has the greatest impact on evenness of group participation. Also, qualitative/anecdotal data collected re. participant responses to these strategies will be helpful in devising future research into the representation of accountability notifications.

Guidance Dimensions for Synchronous, Co-located Cooperative Scenarios

VIII. Guidance Delivery (Static/Dynamic)

IX. Guidance Specificity (Generic/Specific)

X. Guidance Target (Individual/Collective)

The emphasis of this research is on scaffolding cooperation processes in a learning context (as opposed to scaffolding learning processes directly). For brevity, the three guidance dimensions will all be discussed here. Guidance can be delivered in a static manner (i.e. the guidance is present at all times, like a label) or dynamically (i.e. the guidance is delivered only in certain contexts, like a popup). It can be generic (i.e. the guidance lacks details) or specific (i.e. the guidance contains detailed instructions). Moreover, in group situations the guidance can be targeted to a single individual, or to the group as a whole.

Assessment/Analysis

A full experimental study of all of these conditions (which can be used in isolation or in conjunction with one another, would require 256 different treatments, so this study will only look at 4:

Static-Generic-Individual
implemented as a general exhoration to cooperate with other users, provided to a user via the handheld when he or she logs in to the simulation

Static-Specific- Individual
implemented as detailed instructions on how to cooperate with other users given the role the user has assumed, provided to a user via the handheld when he or she logs in to the simulation

Dynamic-Generic- Individual
implemented general exhortations to cooperate with other users, provided to a user via the handheld in real-time when the simulation detects that he or she has not been participating

Dynamic-Generic-Collective
implemented general exhortations to the users to cooperate, provided to all users via the shared display when the simulation has detected that participation is uneven

Outcome

Although hardly exhaustive, this will generate a rank order among the four conditions that can serve as a basis for further explorations. It is expected that dynamic guidance will prove superior to static guidance, the individual delivery method will prove superior to the collective one, and the specific guidance will be better than generic.