Using PEGs as an Alternative Approach for Course Projects

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Abstract

A high percentage of Computer Science (CS) courses in a typical curriculum for CS programs include, as a major part of the learner's effort, some sort of computing project. Often, the project is course-long and may be incremental in nature as new concepts are covered in the class. Regardless of the depth or time frame of the project, instructors tend to limit their choice of implementation to team projects or individual projects. PEGs (Peer Evaluation Groups) provide instructors with an alternative for computing projects that often supports learning goals more comprehensively than team or individual project approaches. This paper outlines the potential benefits of utilizing PEGs and outlines an effective approach for implementing them in a CS course.

I.   Learning Goals Supported by Individual Projects

Individual projects are most frequently found in early, introductory courses, when instructors are concerned that each learner develops basic skills. These projects are not necessarily course-long, nor are they necessarily incremental in nature (where they build on previous work). The project is usually defined in the same fashion for all learners (everyone does the same project with the same requirements and topic area). This often leads to concern that individuals collaborate less for fear of unscrupulous behavior by some members of the class. Conversely, it may also lead to concerns about persons who do fall prey to the temptations of that same 'unscrupulous behavior.' However, individual projects need not be prescribed as the same project for each individual and collaboration need not be entirely forbidden if we implement a PEG (Peer Evaluation Group) approach, as we shall see later. Regardless, the reality is that most individual projects are limited simply because instructors find it easier to implement.

All projects tend to support 'hands-on' approaches to learning and 'trial and error' learning. The assumption that is made is that all individuals will make the effort to go through the learning process. Individual projects tend to enforce the process for most learners, with the exceptions of those who fail to work on the project at all or those who chose to submit work that is not theirs.   Most learners perform work on their individual projects and do demonstrate some level of proficiency in submitting these projects. Thus, it is no surprise that individual projects are most useful in introductory courses. Individual projects provide a specific piece of work on which feedback can be given to encourage improvement and it provides instructors with a simpler method of evaluating individual effort and proficiency.

Unfortunately, individual projects tend to reduce interaction with other learners, increase procrastination, increase competition rather than collaboration, delay feedback, limit applicability of the project to the individual, and push the instructor into being the focus as the only viable 'helper' for learners who need it. This is not meant to imply that individual projects are always an inappropriate implementation of course projects. However, when one chooses the tool, there should be awareness of the potential shortcomings. In this case, it is obvious that any sort of collaboration between learners raises the specter of cheating. Individual projects isolate the learner and promote the over-promoted 'spirit of competition' that leads so many learners to do things for the grade, rather than for the knowledge. Further, learners are left to their own motivational devices. For most individuals, it is natural to procrastinate until the last possible moment. This same issue comes back to haunt the instructor when they (or an assistant) finds themselves set to evaluate and provide feedback on a project, on the same topic, for a large number of students. The result is that very little feedback is given to encourage learning or the feedback is delayed sufficiently to prevent the learners from gaining much by receiving the feedback. The projects, based on the same set of specifications, run the risk of feeling contrived and losing impact value for the learners. Of course, these limitations on collaboration lead learners to conclude that the instructor (or designated representatives) is the only viable resource for help.

II.   Learning Goals Supported by Team Projects

Team projects tend to occur consistently in upper-division courses and less frequently in lower-division courses. Obviously, the simple requirement to work in teams encourages collaboration between learners, which the main strength of this approach. Again, such projects may be course-long, or of a limited duration, they may be incremental in nature (with deliverables throughout the course) and they may be heavily prescribed by the instructor. Since team projects tend to occur in upper-division courses, latitude is sometimes given to the learners regarding the project specifications. Such projects are often included as a part of a course in an effort to encourage completion of a project that would likely not be possible if each individual were to attempt a similar project on their own.

Team projects provide learners with an opportunity to develop the teamwork skills they will need as they continue in their profession. The collaboration inherent to this process encourages learners to share effort and learning. Competition no longer focuses on an individual 'beating' others and tends to focus more on a team reaching particular goals. While groups may certainly procrastinate, it becomes less likely when peer pressure is used to encourage progress. Feedback and information can be gleaned more quickly from peers involved in the class than it would in an individual project. The pressure on the instructor is lessened because the number of projects is reduced, other resources are more readily sought out, and learners can approach the instructor as a group. Similarly, feedback can be given to each group rather than to each individual.

Again, team projects are a viable approach towards implementing a project. As with individual projects, team projects may be implemented in a range of approaches that will have a varied set of advantages and disadvantages. In general, team projects give rise to their own set of shortcomings and issues. One of the most unfortunate of these is the distinct likelihood that some members of teams will 'ride' on the backs of their team members. In other words, some members will do very little work, while other members, fearing a bad evaluation, work harder to cover for those who fail to do the work. The corollary to this issue is that it is difficult to accurately assess the individual proficiencies and efforts of learners in a team project. Additionally, one must consider team member conflict and incompatibility. It is also possible that the team project does the learner a disservice by preventing individuals from needed repetitions and experience for key concepts. For example, a first database course may be considered as a mid to upper division course in the curriculum and will often use a team project. However, concepts and tools for databases are such that each learner should receive a certain amount of exposure and interaction in order to facilitate learning. The natural division in effort in a team environment may lead to team members missing key components of the necessary learning for the course.

III.   Learning Goals Supported by PEGs

What is a PEG?

Peer Evaluation Groups are not necessarily a new concept and focus on the goal of providing useful feedback to learners quickly in order to support learning. Learning is facilitated when useful

feedback on effort is given to encourage further reflection and action to improve understanding. Unfortunately, most learners are left with minimal feedback given by instructors for projects, exercises and exams. All too often, this assessment fails to help the learner because it is not timely nor is it sufficiently affirming or informative. This is made worse if the project is not evaluated until the end of the term, when learners are simply ready to move on to a new term and new subjects. PEGs attempt to address this issue by teaming learner peers to provide feedback by reviewing each other's work. This feedback may be given in writing, in verbal discussion or in an electronic discussion group. The provided feedback often leads to a dialogue regarding how the work could be improved and encourages exploration of alternatives. Similar feedback by an instructor might not encourage such exploration since a learner might not think to look beyond the instructor's comments.

Using PEGs with Projects

PEGs have been used most often in supporting writing projects in language courses, thus it may initially seem unnatural to apply PEGs to a programming project (for example). However, the development processes for computing projects are not so different from the creative processes of writing that it would preclude their use here. In fact, PEGs provide us with a tool for combining the advantages of team projects with the advantages of individual projects.

The approach I have used successfully encourages each learner to complete an individual project that meets certain minimum requirements, but that allows self-selection within the area of implementation. For example, each learner might be required to develop a database, but they are allowed to choose the database topic. A timeline is given for the completion of various stages of the project. At the completion of each stage, they are required to submit their work to their PEG (usually a group of 3 or 4 individuals) for evaluation. Depending on the class setup, size and composition, this may be a series of face-to-face meetings, written evaluations, online discussion, etc. Each PEG member is required to give substantive feedback to each person in their PEG. Further, each person is expected to participate in a dialogue that responds to issues brought about by their peers on the project. It is not required that they adopt everything brought forth by the PEG, but it is required that they be able to defend any decision to reject or include peer suggestions.

An alternative to this approach has worked well in an online course. Rather than set a date for the time to submit the work for evaluation, learners are encouraged to provide their PEG with their ideas for the current stage to the group as early as possible in the time period. They then participate in dialogue as they develop that portion of the project. In this case, they were being encouraged to use the group as a resource to develop a better project for final evaluation by the instructor. Once participants became acclimated to the process, they found it to be a very useful and viable process.

Ten Keys to Making PEGs Work:

1. Sell the process!

Learners will not put effort into this process unless the instructor is convinced that it is useful and, in turn, convinces the learners that it is beneficial.

2. Model the process.

Most learners will have no experience in providing critical, but supportive, feedback to others. Similarly, they will not know how to accept and integrate such feedback. Take the time to be an informal PEG 'member' early in the process for each group. Early efforts here tend to pay off later.

3. Monitor the process.

Recording feedback in some way is important to enforce the integrity of the process. Some portion of the course assessment should be based on the feedback given by learners, as well as how learners integrate feedback. This is where an electronic forum may be extremely useful.

4. Don't be overbearing
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You should model the process, be available for questions and require materials to illustrate learner use of the process. However, you should not allow yourself to become too overbearing. Otherwise, learners may simply wait until you give your opinion, which defeats the purpose of the process.

5. Choose projects that are incremental in nature.

A project that has stages to it will encourage the integration of feedback in order to improve the project. The process of integration is a valuable part of learning that is circumvented when learners hand in a project for a grade but are not asked to improve the project based on feedback. This occurs when a course-long project is not submitted until the end of a course, there usually is no longer a reason to improve the product once the course is completed.

6. Choose projects that allow learner choices.

Obviously, you cannot expect PEGs to work if each learner is doing a carbon copy project. In an introductory Expert Systems course, for example, each learner could be expected to build a small expert system on a topic for which they have access to an expert. If there is duplication, the instructor should make sure those learners are not in the same PEG.

7. Give feedback throughout the project after peer feedback is given.

This prevents you from effectively stopping peer feedback. Give affirming, yet critical feedback to encourage improvement of the process. It is often best to give this feedback without assigning it a score or grade. Further, be careful not to belittle the suggestions given by any peer.

8. Recognize discomfort, but do not give in to it.

Some learners will express discomfort and unhappiness with their role as evaluator (or as the evaluated by their peers). Be sympathetic to their discomfort, but remind them that comfort does not

always lead to learning. If there is a real problem, deal with it. Otherwise, do not let it become an excuse to remove oneself from the process.

9.   *Choose projects that have sufficient leeway for varied approaches.*

Projects that have a prescribed solution or process are unlikely to encourage much positive feedback or discussion. Happily, most development has sufficient latitude in approaches.

10.   *Do not close your eyes to accepting learner innovations.*

Learners will not always suggest approaches that are accepted or the most optimal. However, rather than shooting down an idea before it has a chance to succeed, allow learners to attempt new approaches and discover benefits and detriments.

A Brief Example

An E-Commerce module developed by the author has successfully utilized PEGs for a course-long project. This course is not entry level, yet it introduces learners to a new sub-field in the Computer and Information Sciences. In this case, the curriculum is fully implemented as an electronic distance learning course and consists of adult learners working towards a Masters in Computing. The course is intense and run in eight weeks (for credit equivalent to a normal semester-long course).

In the first week, learners were asked to introduce themselves. Their introductions included information regarding experiences with E-Commerce and with courses in the Masters of Computing program. These responses were used to aid in grouping learners into PEGs of three or four individuals. In week two, learners were given discussion questions for their PEGs so that they could get comfortable with their peers and the PEG process prior to work on their projects. During this week and the next, the instructor maintained a 'visible' appearance in the PEGs to model the process.

The project focused on the development of an E-Commerce proposal that included product identification, marketing approaches and tools, site design, E-Commerce tools, payment methods, security and reliability issues, policies and a workflow. Each individual in the PEG was responsible for developing their own project for a product they selected. The project was divided into sections on a weekly basis so that the project was incremental in nature. This helped to insure continuous progress and encouraged use of the PEG throughout the course. The goal of the PEG was to encourage learners to use their peers for feedback so that they could improve their proposal prior to final review in the last week.

In the final week, completed proposals were 'presented' to members of a different PEG who posed as potential investors. A final evaluation was given by these learners and by the instructor. Project quality was generally very high and showed the benefits of individual effort and collaborative effort in the PEG.

Learning Goals Accomplished

PEGs combine the support for individual proficiency provided by individual projects with the strengths of collaboration found in traditional team projects. Each project is similar in nature and requirements, which gives learners a common theme from which to work. However, each learner is producing a proposal based on different products. This provides sufficient individuality to encourage personal effort without compromising effectiveness of collaboration with fears of inappropriate behavior.

Work on projects is paced throughout the class by providing milestones and timeframes for segments of the project and for peer feedback. This promotes continuous improvement and combats the natural impulse to procrastinate. The 'development-feedback-integration' process is encouraged so that participants know what to do with feedback as they receive it. The process also encourages the instructor to maintain familiarity with each group's work and provides a forum for instructor feedback that is less formal than that required for the completed project. In other words, the incremental nature of the project supports increased and timely feedback for the learner, both from the instructor and from their peers. There is a reduction in 'clumped' grading at the end of a project, where the emphasis is on the grade rather than the learning and there is less reliance on teacher-only feedback.

Peers learn from each other by viewing each other's work and by receiving comments about their own work. The process of critically reviewing similar work on different topics provides the learner with a chance to compare and contrast views and approaches. This results in increased learning via the simple exposure to different concepts within the context of a project with which they have some familiarity. Frequently learners will make note of ideas and resources a peer is using and they will investigate the use of a similar approach if they find value in it for their own project. Similarly, they may find that they will disagree with other approaches and find alternatives that fit their project better. The process of critiquing and receiving critiques helps to expose weaknesses and blind spots in work and gives individuals a chance to test whether their work withstands the various challenges their peers can bring forward.

Problems with PEGs

The defrosting period

As with any process that requires interaction, there is a period where participants are unsure of the level of investment they are willing to make. This, coupled with their relative unfamiliarity with the process, results in early results that may be discouraging to an instructor. Peer feedback may be superficial, breadth and depth coverage may be lacking, and participants may simply balk at the process. This is a natural part of the process. The instructor should be prepared to encourage constructive criticism and peer participation when it occurs and reward it with positive remarks. When these things are lacking entirely, the instructor needs to model them for the learners. Overall, the facilitator needs to be supportive and exude confidence in the process. Once it becomes apparent to the learners that the instructor intends for the process to continue and that she/he will clarify expectations, things will improve rapidly.

What happens when Joe doesn't show?

Ideally, a PEG consists of three or four individuals. In the course of natural events, learners will be unable or unwilling to participate in their PEG. Naturally, this affects the other members of the PEG, especially if the PEG has only three members. This issue is no different here than it is for team projects. However, there is more flexibility in this process to allow for adjustments. For example, if a learner ceases to attend a course, the remaining members of the PEG might be redistributed to other PEGs or combined with another PEG that is similarly afflicted. This option would not be feasible in a typical team project. In fact, PEGs in fifteen week courses may benefit by using a jigsaw type approach to give learners a chance to view other projects and gain feedback from a wider group of learners.

What is constructive criticism?

Successful PEG implementation relies heavily on peer critiques and is founded on the belief that constructive criticism can be an extremely positive learning tool. Given the likelihood that participants will be new to the process, early attempts should be expected to be clumsy and only partially effective. The instructor should allow the learners to fumble through their first critiques and give them a chance to explore how the process works. There should be clear guidelines regarding the process, but the instructor should not suppress experimentalism at this stage unless it jeopardizes the team/PEG in some fashion. Once learners have had a chance to experiment, the instructor should model constructive criticism for the learners. One of the most effective ways to do this is to carefully critique one piece of work from a volunteer in each PEG, or to critique each project. A thorough critique that emphasizes positives, issues and alternatives can help set a high expectation for the participants in the group once they see the benefit.

Procrastination within the incremental project

An incremental project is developed in the hopes of preventing excessive procrastination on larger projects. An incremental project using PEGs is built in the hopes that the peer evaluation process will put a positive pressure on learners to maintain a consistent application of effort in their work. While this does tend to work in most cases, there is still a tendency for participants to delay their work until the end of a cycle in the project. This results in a frenzy of activity and rushed critiques at the end of the cycle. Some of this comes from a natural desire for each person to produce a 'masterpiece' for their group before they submit anything. The rest of it simply comes from life choices and will always be with us. Delayed work submission and critiques need to be addressed since allowing continued delays defeats the purpose of the PEG, which is to develop a learning group that supports each person in the quest for a better project. One method of successfully encouraging the process is to enforce 'brainstorming' sessions within the PEG. This validates the process of discussing an idea without the need for a fully prepared presentation.

Instructor effort: pay now or pay later

The use of PEGs tends to be a very 'front-loaded' process. Set up and early maintenance of the peer groups requires a sizable amount of instructor time and effort. In some ways, PEGs prevent instructors from falling back on the innate desire to procrastinate since they must maintain contact

with the PEGs and be aware of progress. Further, the incremental nature of the process implies that there is a need for the instructor to give feedback to the learners more frequently. The facilitator ends up expending more consistent and continual effort in evaluating learner (and PEG) work during the course. But, the final project evaluation is no longer a daunting task since that evaluation has been a continual process. The learners benefit from feedback that they can integrate into their learning and the instructor benefits by redistributing the weight of their feedback processes throughout the course rather than on one or two specific events towards the end of the course.

The almighty grade

The mark or grade earned is often given a disproportionate amount of weight by the learner as they make decisions about their effort during a course. The net result is that, rather than deciding for themselves how their time and effort resources should be distributed, they make choices based on grading weights. Therefore, an instructor who wishes to encourage strong participation in PEGs is practically obligated to provide graded credit for student work within the PEG. A particularly good "sell-job" of the process may convince learners that positive participation rewards them with better marks in their projects. Further, non-traditional aged learners or learners who tend to be more 'social' learners may be more willing to accept the process as a way of improving marks indirectly. However, in order to emphasize that participation is a critical part of a course or project, the instructor should use evaluation of PEG participation as part of the grading structure.

IV. When PEGs are Best Used

The Peer Evaluation Group (PEG) is a wonderful tool to add to the teaching toolbox. However, we must remember a proverb about hammers; '*when we have a hammer, everything looks like a nail*.' PEGs are not the best solution for every course, every topic, every instructor and/or every learning group. There are environments where this approach will work extremely well, and there are others where it will be doomed to fail. PEGs in similar settings may see varied results, and instructors who are using PEGs for the first time should expect that they will expend additional effort in order to make them work.

Courses/Projects that include writing and design components

PEGs were initially developed with writing collaboration processes in mind. Thus, it is only natural that a Computer Science project that involves some amount of writing will benefit somewhat from the use of PEGs. It is only a mild extension to include any project that has a stronger design process. The design process is a creative endeavor that is impacted by individual insights and preferences, thus collaboration and feedback are important tools to encourage appropriate exploration. The personalization of design processes combined with PEGs provides learners with a wonderful opportunity to explore various approaches while maintaining responsibility for their own work.

Courses/Projects that would benefit from collaboration, but also emphasize individual skills

Frequently, instructors find themselves using the team approach simply because they recognize the strength of collaboration. Unfortunately, there is still a struggle with how one can encourage

individual skills development when such activity is repressed by the goals of a team project. A few examples might include Computer Science courses that introduce a new subtopic, yet are not introductory within the curriculum (e.g. first DBMS course, Expert Systems, Ecommerce, parts of early SAD courses, etc). It is important to remember that use of PEGs does not exclude the possibility of using team projects or individual projects as well in a class. It is possible that PEGs could be used early in a class and teams be used later in that same course.

Incremental projects

Definite increments in projects provide critical feedback 'deadlines,' which help to encourage continuous interaction and development of the project. The requirement that all members of a PEG be involved tends to reduce procrastination and increase a feeling of responsibility. A completely open schedule for a project of a given length often results in little or no interaction except for those groups that contain individuals who are willing to set up their own 'sub-schedule.' Thus, it makes sense to pre-empt the problem by simply setting up an incremental project at the beginning.

Projects that allow learner choice

Interaction will generally be of poor quality if there really is not more than one way of doing things. There is no need for discussion, feedback and exploration in this case. On the other hand, if everyone is required to do a project that supports individual choices within general ground rules, there will be sufficient room for productive discussion. The key is to develop projects that have sufficient similarity to promote in-depth discussion based on familiarity, yet sufficient difference to encourage a breadth of exploration.

Courses comprised of 'more experienced' learners

Experience can be measured in several ways. For example, non-traditional aged college learners tend more readily accept the processes in a PEG. However, traditional aged and younger students are also quite capable of working well in PEGs. Experience in the program or discipline also can aid learners in using PEGs. In other words, introductory Computer Science courses may be less appropriate because learners are getting accustomed to a new subject, faculty group and way of doing things. Adding the concept of PEGs at this point may simply distract from the purpose of the course. On the other hand, a first DBMS course is frequently offered later in the curriculum, thus participants should be more familiar with the overall discipline, the department and the curriculum. They should be more prepared to use this approach & be comfortable enough to provide critical feedback to their peers.

Courses that have access to forums for critical feedback by peers and the instructor

A forum for critical feedback and discussion is necessary for PEGs to succeed. While the instructor can simply encourage learners to find time to meet and discuss, it is far more productive for the facilitator to provide times, places or venues for this discussion. This becomes less critical later in the process as learners become comfortable with it and understand the purpose, but it is important early in the process to encourage follow through. Online discussion boards, decision support

software, class meeting times, forms for written feedback, as well as other tools can all be used to successfully promote the process.

V.   Conclusion

The PEG process is a valuable tool that provides a useful peer feedback loop and frequently results in higher quality individual projects in Computer Science courses. PEGs take advantage of both individual and collaborative approaches for learning, while individual or team projects frequently sacrifice one or the other approach. While PEGs tend to require intensive instructor participation early in the process, there is some relief for faculty when final project evaluation is necessary. Successful use of PEGs is most likely when the instructor sells the process to the learner group and models critical feedback skills for participants. Use of this tool is encouraged for courses that are not introductory to Computer Science, but may be introductory to a subtopic within the discipline.