Toward improving collaborative behaviour during competitive programming assignments

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EduHPC'2019
Denver, CO, Nov 17th, 2019

Universidad de Valladolid

Gamification and HPC

- Gamification: Introduce game components in non-game environments
- Programming contests: A gamified activity
- HPC techniques: Code optimization, parallelization
- Difficult: Complex interactions among them and with the machines
- Results can be easily measured in terms of performance
- Success can be automatically measured ans ranked (on-line judges)
- Programming contests are adequate and easy to implement for HPC learning
- Successfully used in a Parallel Computing course for several years [FresnoEtAl.17]

Competition and collaboration

- Observation: Competitive behaviour sometimes interferes with usual students collaboration

- They become reluctant to help other groups to protect their rank positions
- It can even interfere with simple questions about programming language or tools
- Collaborative and competitive processes are interrelated [Jonasson.18]
- Combining competition and collaboration is particularly effective in the gamification context [Sailer.19]

Objectives

- Encourage collaborative behaviour during competitive activities

- Introduce collaborative gamification in HPC programming contests
- Tool/s for students interaction and participation
- Promote and measure both social and technical interaction
- Design reward elements and evaluation mechanisms for volume and quality of participation
- Pilot experience: Parallel Computing course

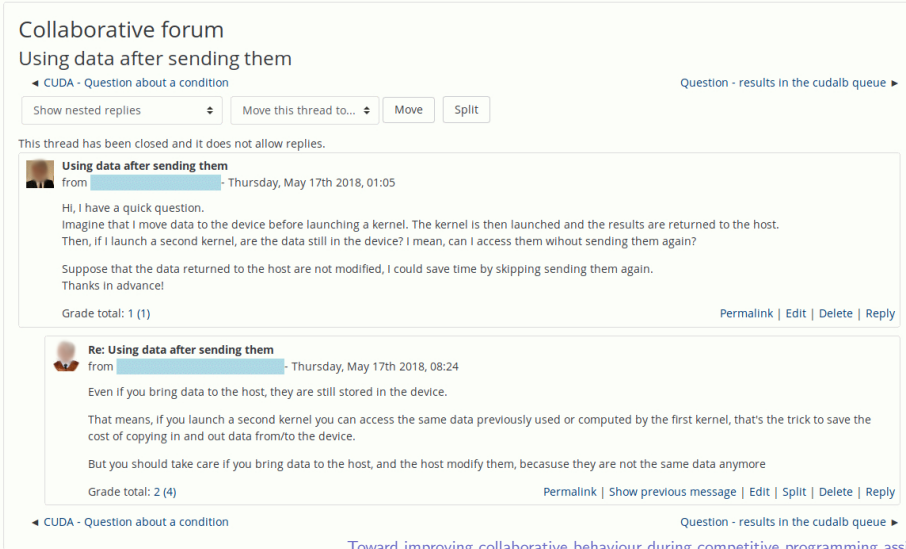
Approach

- On-line platform for interaction: Text-based forums
- Enhance it to support peer-to-peer acknowledgement of social and technical help
- Register and measure participation volume and peer-to-peer acknowledgement
- Teachers participation to guide discussions and help students to find solutions
- Reward elements:
  - Prizes and badges
  - Quantitative evaluation of participation

Forum implementation

- Moodle platform: Forum activity module
- All students enrolled in the course are registered: Receive emails for posts
- Moodle's forum: Peer-to-peer grading mechanism (numerical values)
  - A participant can grade as many posts as desired
  - A participant can grade each post at most once
  - A post can receive as many grades as participants
  - No reaction, no grade
- We introduce a new grade scale with visual labels (acknowledgement tokens)
  - Value 1: Like/Educational (Thumbs-up icon )
  - Value 2: Useful/I'm using it (Wrench icon )

Forum example



Rewards

- Design rewards for contributing information that is useful for other members
- Promote perception: Ranking loss in the competition due to information disclosure can be compensated by a higher cooperation grade
- Social acknowledgement: Directly implemented with the tokens
- Badges for achievements: Similar to the competitive part
  - Achieve a number of acknowledgement tokens
  - Post the first question about technical problems (secret)
  - Correct answers to initial teacher questions
- Extra grade (up to 10%), formula taking into account:
  - Participation volume (posts and threads)
  - Number of acknowledgement tokens awarded
  - Number of acknowledgement tokens received
  - Number of posts with at least one token received

Pilot experience

- Implemented in a Parallel Computing course
- Computer Engineering degree, 3rd year, Major elective course
- The course already implements competitive gamification
  - Three programming contests: OpenMP, MPI, CUDA
  - No changes to the competitive part
- 50 students enrolled: Approximately 50% of the 3rd year students
- Badges and forum presented to the students before contests, teachers introduce basic questions to break the ice

Participation

- Threads and posts:
  - 16 threads (11 started by students)
  - 92 post of students
  - 30 students published one post or more
  - Post per student, mean 3.06, maximum 10
- Acknowledgement tokens:
  - 108 tokens awarded (74 Like, 34 useful)
  - 19 students with at least one token awarded
  - Tokens per student, mean 4.79, maximum 12
- Different student profiles
- Expected distribution of posts and tokens:
  - More level of implication and assistance implies more posts with more tokens

Alternative channel

- The existing student's Telegram groups 
- Teachers of any course are not invited or told about, very "relaxed" atmosphere
- Specific course group: From general comments to very specific questions
- Participation of previous students of the course
- Part of the collaborative activity was derived to this group, despite the appeal of badges or potential grade improvements
- It partially explains the participation numbers
- Why do they use it instead of the forum?

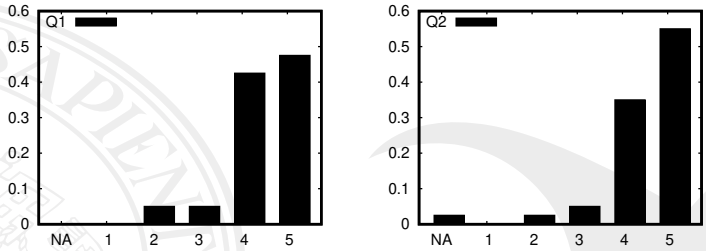
Students perception: Survey

- Specific survey for the students to get direct feedback
- Try to measure improvement of motivation, subjective learning, impact of the collaborative activity, etc.
- Conducted 15 days after the activities (avoid direct influence of emotions)
- 10 questions:
  - 8 questions in Likert's scale (5 levels, 3 means neutral)
  - 1 questions with multiple answers (reasons for using the Telegram's group)
  - 1 free-text question for comments
- Survey filled up by 80% of the students

Students perception: Results I

Q1: Satisfaction with the general experience kind of activities, grading methods, etc.

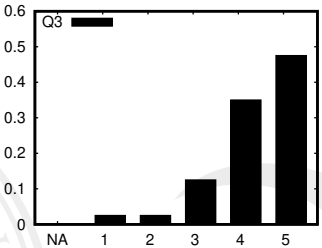
Q2: Relative weight of contests, assignments, theoretical exams in the grade is right.



- Good perception of the activities and grading system

Students perception: Results II

Q3: The competitive parts (contests, badges) are adequate, make the course more interesting, and encourage a more active participation.

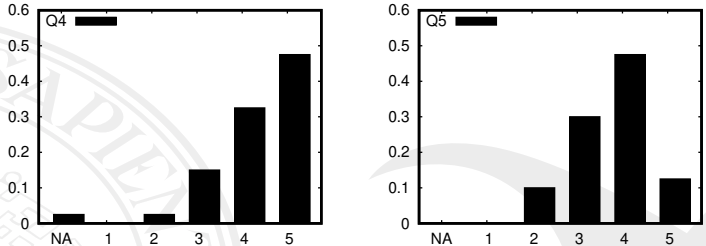


- Most students think that the competitive part improves participation
- Some students think that collaboration is still sometimes degraded or can be improved (comments in Q10)

Students perception: Results III

Q4: A tool for communication among students is appropriate for this course.

Q5: The *Collaborative Forum* or the *Telegram group* have really improved or promoted the collaboration among students.



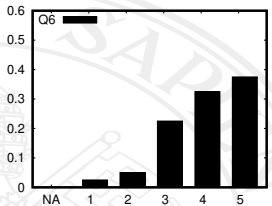
- Most students think that a tool for communication is really important
- Some are not sure that the ones used really solve the perceived problem
- Most students think that the tools can be improved (comments in Q10)

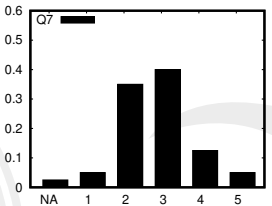
Students perception: Results V

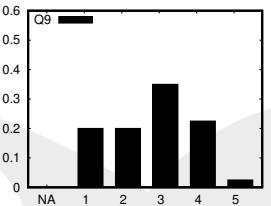
Q6: *Telegram group* is a better option than the *Collaborative Forum*.

Q7: *Collaborative Forum* has been used less or more than the *Telegram group*.

Q9: Have you used, participated, or queried frequently the *Collaborative Forum*?





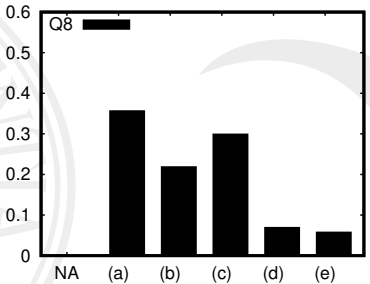


- Students prefer the Telegram group, it has been used similarly or even more
- Students think they have not participated too much in the forum

Students perception: Results VI

Q8: Reasons to prefer the *Telegram group* (multiple answers allowed):

a) Faster and more comfortable to query or to receive feedback.
b) *Collaborative Forum* is more intimidating.
c) More people in the *Telegram group*, including older students.
d) Teachers do not have access to the *Telegram group*.
e) Other reasons (please, explain them in Q10).



Conclusion and future work

- We present an approach to encourage collaborative behaviour in competitive learning activities
- Approach: Collaborative gamification to complement the competitive gamification
- Main tool: Enhanced on-line forum (Moodle platform)
- Design of specific rewards: Prizes, badges, grading mechanism
- Results indicate the approach reinforces and complements the competitive part
- Problems and limitations observed
- Future work:
  - Using a more agile tool for student's interaction
  - Design more powerful rewards
  - Calibrate the effect of the teachers participation
  - Generalize: Testing the proposal with more groups and different courses