AN ASSESSMENT SCHEMA FOR STUDENT DEVELOPMENT PROJECTS WITH SOFTWARE INDUSTRY EXPERIENCE

IWSM MENSURA CONFERENCE

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ASSESMENT OF STUDENTS' WORK – WHY AND HOW?

- Evolution of the approach to evaluation of students' work:

  grading systems that asses level of assimilation of knowledge

  - project-based pedagogy
    - what's next?

- Trend of Computer Science education profesionalization
- Nowadays, project success is regarded as a multidimensional construct
- Lack of framework that evaluates its different facets of students' work
- Criteria used for commercial IT deliverables translated into an academic grading context

RESEARCH QUESTIONS

- **Research Question 1**:What constitutes a successful software project implementation and how can the success factors map to an academic setting?
- **Research Question 2**:What metrics and measures are used in industrial software development to evaluate the success of a systems project and the process followed?
- **Research Question 3**:Which metrics are pertinent to an academic setting and how to adapt them to the particularity of student projects?

LITERATURE REVIEW APPROACH

- ACM Digital Library
- IEEE Xplore
- ISI Web of Science
- ScienceDirect – Elsevier
- SpringerLink
- Wiley Inter Science Journal Finder

KEYWORDS

200 STUDIES

- availability of calculation method and data acquisition procedure,
- description of the reasons for and effects of using the metric,
- applicability of the metric at the team or company level,
- possibility to collect and use the metric in projects of any scope, size and complexity.

Selected metrics and measures that are thought to be generic with regard to:

- **application granularity**: metrics are pertinent to different types of student projects (individual/group work) and can be collected over different periods of time (fortnightly, for the entire semester etc.)

- **suitability to different settings**: measures are not bound to a certain sub-domain of computer science nor a development process followed (plan-driven, agile, or absence thereof).

SUCCESS IN ACADEMIC SOFTWARE DEVELOPMENT

PROJECT QUALITY	**Internal** - source code based **External** - product characteristics
PROJECT EFFICIENCY	Resource utilization and productivity of the team
SOCIAL FACTORS & STAKEHOLDERS' SATISFACTION	students' satisfaction and learning outcomes

INTERNAL QUALITY: SOURCE CODE QUALITY

Cyclomatic Complexity commonly used to evaluate code quality:

- Complex code is difficult to understand and more likely to generate errors
- Complexity has a direct impact on the quality of a product, its maintainability and ease of troubleshooting

Maintainability ranking single measure that consolidates different technical aspects of the software:

Lines of Code (LOC)	duplicated LOC	Cyclomatic Complexity	parameter counts	dependency counts

- underpinning system properties mapped to a set of 10 simple maintainability guidelines
- supporting tool – TheBetterCodeHub - checks compliancy against the guidelines at the level of a GitHub repository

INTERNAL QUALITY: CONTINUOUS INTEGRATION

- Effective teamwork in student projects requires regular use of a version control system
- Pacemaker: Commit Pulse - average number of days between commits and aiming
- Keep as low as possible to ensure even distribution of workload

Peacemaker Commit Pulse

$$PCP = \sum_{i=1,j=i+1}^{n,m=n-1} (C_j - C_i)/N$$

Ci, timestamp of a commit;
Cj, timestamp of the following commit;
N, total number of commits

EXTERNAL QUALITY

- ISO 25010 : software quality as a set of characteristics: **Functionality, Reliability, Usability, Efficiency..**
- Definition of metrics evaluating a subset of the product quality properties, depending on the assignment nature

Web technologies	Network Programming	Embedded systems
Usability, efficiency	Reliability, recoverability	performance efficiency - time behavior, resources utilization

- Metrics definition by students, requiring the following elements:
  - Frame them according to the Goals-Signals-Metrics process,
  - Write test cases for evaluation,
  - Specify the method of metric procurement, the procedure of its collection and interpretation, define supporting tools.
- Common set of metrics used for evaluation of projects
- "Jigsaw exercise": groups evaluate the external quality of software developed by other teams on deployed solutions

PROJECT EFFICIENCY

EFFORT
time spent by the team during development process

PRODUCTIVITY
team's output size in KLOC

MEASUREMENT UNITS

EFFORT REFERENCE

Function Point: informed high-level estimation of an underlying piece of functionality

TIME REFERENCE

15min intervals

PROJECT EFFICIENCY: METRICS

Hustle Metric: Functionality/Time spent	Processing Interval: Lead-time per feature	Work In Progress
$HM = \sum_{i=1}^{n} F_{pi} / \sum_{i=1}^{n} T_i$	$PI = T_{ship} - T_{acc}$	$WIP = \sum_{i=1}^{n} F_{pi}$
Fpi, number of functional points of an artifact; Ti, overall time spent implementing the functionality	Tship, timestamp when the feature is implemented and uploaded to repository; Tacc, timestamp when the feature is accepted for implementation	Fpi: function points of a task currently in progress
global productivity of the team	efficiency of the process capability to tackle problems	discipline of the team

SOCIAL FACTORS AND STAKEHOLDERS' SATISFACTION: TEAMWORK QUALITY

Teamwork quality is a measure of conditions of collaboration in teams: communication, coordination, mutual support, cohesion etc.

TEAM COHESION

shared bond that drives team members to stay together and to want to work together

- The team's attachment to the task
- The team's social connection
- Individual attachment to the task
- Individual connection to the team

The Group Environment Questionnaire

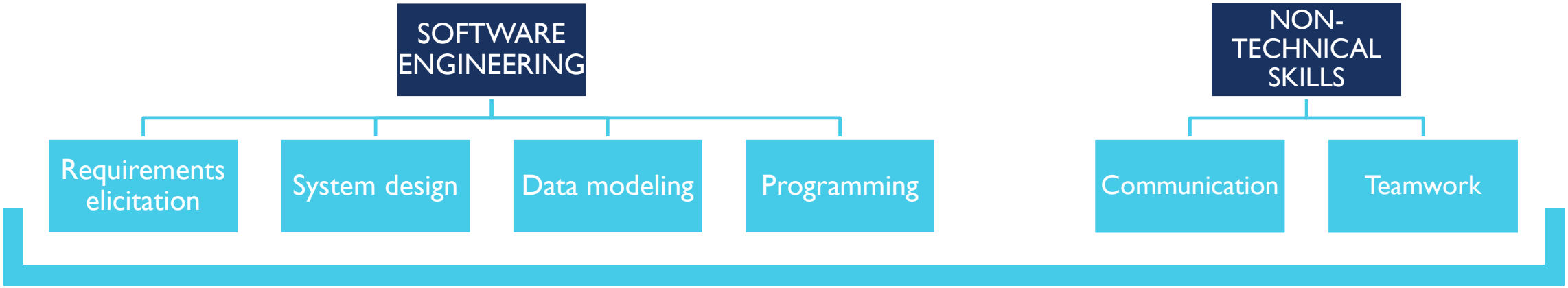
- team member's impact on the overall project's success (0 to 5)
- intent to keep a team member in a group (0 or 1)

TEAM MORALE

sense of common purpose and the amount of confidence felt by a person or group of people

- I am enthusiastic about the work that I do for my team.
- I find the work that I do for my team meaningful.
- I am proud of the work that I do for my team.
- In my team, I feel fit and strong

SOCIAL FACTORS AND STAKEHOLDERS' SATISFACTION: PERSONAL SUCCESS



4-Likert Opinion Pool

- Strongly agree
- Agree
- Disagree
- Strongly disagree

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Instructor's assessment of artifacts

- Requirements documentation
- Developed software
- Issue and project tracking software
- Team cohesion questionnaire…

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CONCLUSIONS

LEASSONS LEARNT

- Assessment scheme was applied to two Master courses of a similar set-up (long term group projects over a complete semester).
- Quality of input data for PROJECT EFFICIENCT dimension - difficulty to make students track their efforts.
- Possible shift to the output of the team's efforts, measured in percentage of realized project requirements.
- TEAMWORK QUALITY metrics give insight into team's dynamics and can help identify underperformers but collection of data is effortful if performed regularly over a period of time
- Not all criteria may be considered relevant or equally important on all student undertakings.

SCIENTIFIC CONTRIBUTION

- A reference to monitor and evaluate the success of students' work along threedimensions.
- Tool to evaluate or compare a software process in an academic setting.

THANK YOU

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