Software engineering team diversity and performance

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Presented by Luke Young
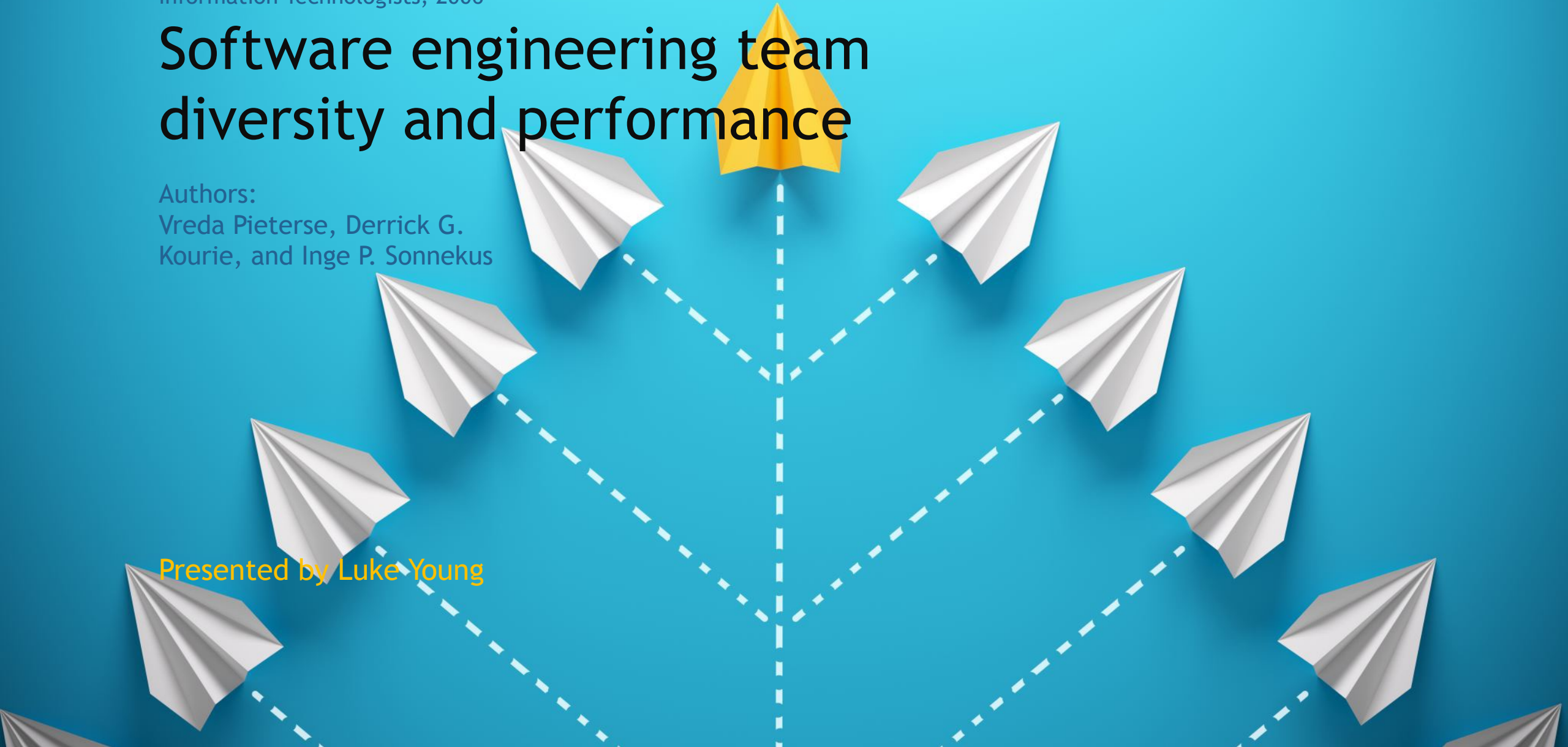
Abstract

Software engineering requires not only technical expertise, but people skills and teamwork as well

Investigates how raw team diversity and ability impact team performance at different stages of a software development project

Developed basic models to guide team composition and formation for this study

Personality strongly correlated to team success during the project's inception phase then gradually weakened, with the opposite holding true for ability

Literature Background

It is well known that many factors can affect a software engineering team's performance, and researchers have long been interested in how exactly and to what extent these various factors can have an affect.

Previous research has looked into factors such as skill diversity, managerial involvement, software development tools and methodologies, team size, and team role allocation according to personality.

Previous literature findings have shown that higher personality diversity corelates to better team performance.

Though creating software is a highly technical process, it is also very human-centric. Human factors are pivotal to a software development team's success.

Literature Background

01

Belbin [1981] conducted an extensive study defining eight team roles based on personality types and arguing that it is possible to create a winning team by selecting the right mix of members based on personality and skills.

02

An experiment by Rutherfoord [2001] found that heterogenous teams showed a more communicative and varied approach to problem solving as well as enjoying the teamwork more, consistent with Belbin's findings.

03

Bradley and Herbert [1997] emphasize that each personality type contributes differently to the effectiveness of the team and found that diversity in skills and knowledge combined with a balance of personality types make for the most effective teams.

04

Kiersey and Bates [1984] developed the Keirsey Temperament Sorter, modelled after the Myers-Briggs Type Indicator personality assessment, emphasizing the need for diverse personality traits in teams with their study.

Goal of Study

Software engineering cannot efficiently be done alone at the scale of today's projects. Teamwork is essential to a software project's success. This study aims to develop a simple model for team composition based on diversity in personalities and apply it to a real-world setting.

It is hoped that the insight gained from this pilot study can serve as the basis for finer-grained and more extensive investigation in the future.

Population Targeted

▶ The authors ran this study on third-year students majoring in Computer Science at the University of Pretoria. As part of their studies, students take a Software Engineering course requiring them to develop a sizeable object-oriented software product as a team of 4-5 members.

▶ Participants were informed about Keirsey personality types, the Belbin team roles, and about previous research showing the effectiveness of diversity in teams. Participants were then told to form teams with as high a diversity as possible in regard to their Keirsey personality type, race, and gender.

Keirsey-Bates Temperament Sorter Dimensions

Four different dimensions, each with two possible leanings.

Social Interaction: Introverts vs Extroverts

Information Gathering: Observing vs Intuitive

Decision Making: Thinkers vs Feelers

Work Style: Judging vs Sensing

Research Question

To what extent do team diversity and team ability influence a software engineering team's performance at various stages of the project?

Research Design – Team Diversity

122 third year Computer Science students at the University of Pretoria were asked to take two questionnaires to determine their Keirsey personality type and Belbin team role, then given one week to form teams of 4 – 5.

While strongly advised to seek higher diversity in their teams, students were free to not follow the advice given. Only teams where every member's Keirsey personality type was known were used in the study, resulting in 12 out of 24 teams and 82 of the total 122 students.

$$\text{Team Diversity} = \sum_{i=1}^{4} f(K_i)$$

$$f(K_i) = \begin{cases} 0 & \text{if all team members have the same preferences in dimension i.} \\ 1 & \text{if all but one team member has the same preference in dimension i.} \\ 2 & \text{otherwise.} \end{cases}$$

Team Number	1	2	3	4	5	6	7	8	9	10	11	12
Team Diversity	4	6	5	7	6	4	3	3	8	4	3	5

Table 2. Calculated personality diversity of the teams

Research Design - Team Ability

▶ Grades achieved on course exams were the metric used to determine team ability.

▶ Exams required students to be able to demonstrate their understanding of core concepts and apply their knowledge to solve new problems.

▶ An individual evaluation mark was calculated for each student based on their scores on three exams. The overall team ability was then computed by averaging the individual evaluation marks of each member.
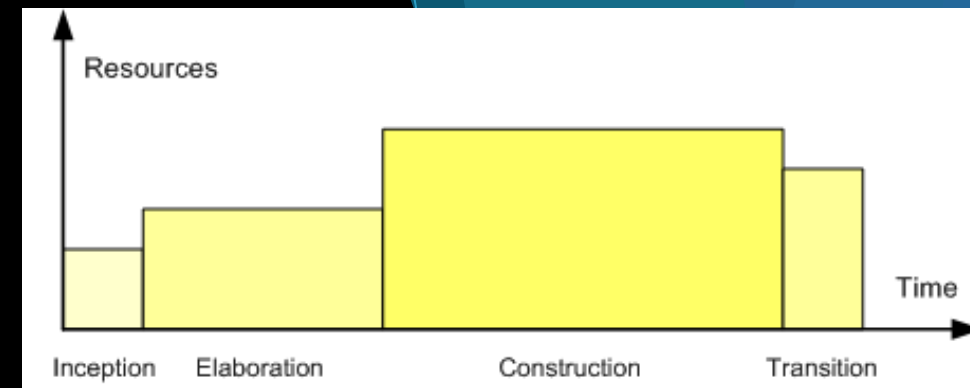
Team Number	1	2	3	4	5	6	7	8	9	10	11	12
Team Ability	51	55	75	71	61	52	65	70	71	67	44	58

Table 1. Average Ability of members of the teams

Research Design - Team Performance

▶ Teams followed the Unified Software Development Process, (1) producing a series of deliverables, (2) giving a series of demonstrations on their project functionality, and (3) culminating in a final exhibition of the software at a project fair.

▶ (1) Deliverables evaluated on correctness, comprehensiveness, and quality measures such as clarity and neatness of layout.

▶ (2) Software development was evaluated on compliance to the development plan, professional conduct of the team, and quality of the code.

▶ (3) Software exhibitions were evaluated on innovation, technical difficulty, customer satisfaction, and usefulness to industry.

Team	1	2	3	4	5	6	7	8	9	10	11	12
Performance Term 1	62	74	83	90	72	68	61	52	87	85	58	78
Performance Term 2	55	73	81	87	79	69	70	72	86	83	63	78
Performance Term 3	55	62	83	81	82	62	70	78	83	80	52	70
Performance Term 4	52	60	83	84	81	59	65	80	78	78	50	72

Table 3. Performance of the teams at the end of each term

Major Findings

Both personality diversity and average team ability impact positively on team performance.

- Team diversity mattered the most in the early stages of the project, declining over time
- Team ability mattered less initially but had a greater affect on team performance over time
- Team success increases if all members participate meaningfully

Teams with high diversity and high ability were among the highest performing

- Teams with low diversity and average ability were among the three worst performing
- A team with low diversity and poor ability also performed poorly
- One team with low diversity and fairly high diversity was among the three best performing

Correlation Between Variables

	Term 1	Term 2	Term 3	Term 4
Correlation Coefficient	0.8186	0.7261	0.5743	0.4849
Level of significance (P)	0.0563%	0.3746%	2.5348%	5.5341%

Table 4. Correlation coefficients between team diversity and team performance.

	Term 1	Term 2	Term 3	Term 4
Correlation Coefficient	0.5709	0.8091	0.9067	0.8825
Level of significance(P)	2.6221%	0.0722%	0.0024%	0.0073%

Table 5. Correlation coefficients between team ability and team performance.
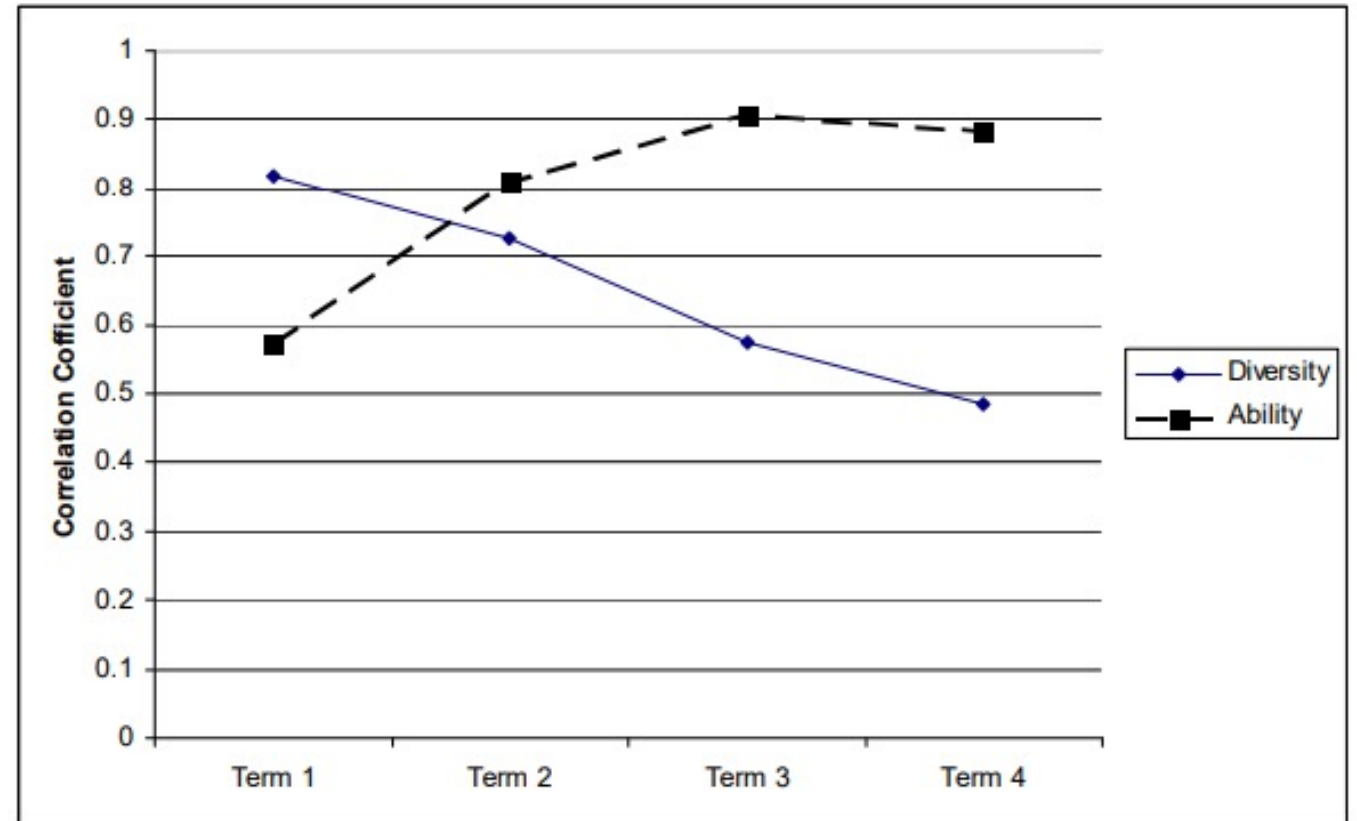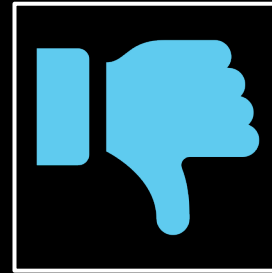

Figure 1. Correlation of team diversity and team ability with team performance.

Strengths and Weaknesses of Methods

Strengths:

- Objective, quantitative data allows statistical analysis of results

- Requiring participants to follow a defined software development process reflects real world software projects

Weaknesses:

- Small and limited sample size

- Can university students properly simulate the dynamics of a real-world software engineering team?

- What about modern development processes like Agile or Scrum development?

Conclusion

▶ Team member personality diversity is a strong predictor of success during the initial phases of a software project and should not be ignored.

▶ Further research is required to determine specific threshold values at which a high enough degree of team diversity has been attained to have a sustained impact on team performance.

▶ Further insight needed on the relative importance of diversity in relation to other team attributes like leadership and inter-team communication, as well as how individual personality types play a role.

Discussion Points

▶ What approaches can software engineering teams and organizations take to optimize team diversity and improve team performance?

▶ What challenges do software organizations face in trying to manage team diversity?

▶ What is a good level of team diversity?

Personal Thoughts

▶ From my professional experience, I definitely enjoy working in diverse teams much more than I do homogenous teams.

▶ While interesting to see the results of this study on university software engineering students, I would really like to see a similar study run on professional software engineering teams and what similarities/differences there would be.

▶ Would like to see how the software development process used affects performance. Do some personality types work better under different processes?