“Renewing ICT teaching and learning: Building on the past to create new energies”

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REFEREE PROCEDURE

The annual conference of the Southern African Computer Lecturers Association (SACLA) presents lecturers in tertiary departments of Computer Science and Information Systems with an opportunity to share experiences of teaching from undergraduate to doctoral levels. The theme of SACLA 2015 is ‘Renewing ICT teaching and learning: building on the past to create new energies’.

The research papers included in the PROCEEDINGS OF THE 44th ANNUAL SOUTHERN AFRICAN COMPUTER LECTURERS ASSOCIATION CONFERENCE (SACLA 2015) were each double-blind peer reviewed by at least two members of the programme committee. The program committee consisted of both local and international experts in the fields of computer science and information systems education, and having expertise and interest in subjects relevant to the theme of the conference.

All papers were initially screened by the programme chairs for fit to the SACLA conference. Papers were then sent for peer review. A total of 61 academics from 14 local and international institutions constituted the programme committee and reviewed papers for the conference.

The review process followed the double-blind peer review model. Every paper received at least two reviews. The programme chairs solicited additional expert reviews in cases where further clarity was warranted.

Only original, previously unpublished, research papers in English were considered and papers were reviewed according to South Africa’s Department of Higher Education and Training (DHET) refereeing standards. Papers were reviewed according to the following criteria:

- Relevance of the paper to the conference theme
- Originality of the research contribution
- Technical/scientific merit of the research
- Presentation and clarity of the paper

Before accepting a paper, authors were to include the corrections as stated by the peer reviewers. The double-blind review process was highly selective. Of the 55 academic papers received for consideration, 27 papers were accepted for inclusion in the Proceedings after the required changes were made. This constitutes a 49% acceptance rate of contributed papers. The papers accepted cover a wide range of relevant topics within the conference theme, and are reproduced within these proceedings.

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The Program Chairs: SACLA 2015
July 2015

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Investigating the Applicability of Belbin Roles on Participatory Levels in IT Student Teams

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ABSTRACT
In an attempt to improve the overall teamwork experience for our Software Engineering (SE) undergraduates, we investigated the relationship between participatory levels of team members and their Belbin roles. Previously, SE projects at undergraduate level tended to focus on the product delivered by a team more than on the team dynamics. We propose that the focus should be redirected to include team functionality. Teamwork projects should create opportunities for students to learn how to participate effectively in teams through experiential learning.

In this paper we investigate whether or not the Belbin team role theory can be applied to facilitate this. In working with the creation of teams using this theory we hope to improve the quality of teams through assisting the students to know their strengths and weaknesses and to delegate tasks to members according to their strengths. In this manner we hope to create functional teams where each student works to her strengths and avoid her weaknesses. We established the Belbin roles of each student and then investigated the participatory levels of the team members of multiple teams to which each student was assigned. We had different teams for each deliverable, which meant that the students did not work with the same people. We looked the prevalence of social loafers in each team to find out if there was any correlation between the Belbin roles and the number of social loafers. We found, using two years’ worth of data that there seems to be no correlation. This can be ascribed to a number of factors which are discussed in detail. Nevertheless, we intend pursuing the study with additional data as well as investigating factors that influence teams. We recognise that there is no ideal way of creating functional teams. This research contributes to information that may ultimately influence our teaching in ways that may enhance the quality of the teamwork and make it a positive learning experience for our students.

Categories and Subject Descriptors

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1. INTRODUCTION
Software Engineering (SE) projects are an integral part of Computer Science at undergraduate level, but many SE teams at undergraduate level, have difficulties for a number of reasons. Although the acquisition of teamwork skills is part of the SE projects, this aspect is often neglected in favour of the product.

In an attempt to enhance the teamwork skills, we investigated various aspects of teamwork. The idea being that if the teamwork skills can be improved, the overall experience will be enhanced. This could lead to a more positive experience of teamwork and assist students to realise that the process is as important as the product.

Tenenberg [38] proposes policies that could be put in place to enhance cooperation between members. Common self-serving behavioural patterns such as tit-for-tat as well as increased non-cooperation caused by the presence of persistent free riders is likely to be diminished through enhancing actions such as face-to-face communication, monitoring and sanctions.

Cain et al [15] emphasise that “Software development is a predominantly social activity” and reminds us that people are still the most important aspect of any SE enterprise. The success of the actions proposed by Tenenberg may be enhanced when the teams are assembled in ways that are known to be conducive to positive team experiences. For this reason we would like to establish whether the application of Belbin’s team role theory supports the creation of team environments where the members are more likely to apply principles associated with eliciting cooperation.

We compared the participatory levels of the SE students in teams and the Belbin roles of those students to establish whether there is a correlation. The participatory levels are established through self and peer assessment of the team members.

To identify the Belbin roles, the students complete a questionnaire designed to ascertain the specific roles of the respondents. If there is a positive correlation between participatory levels and the Belbin roles, the roles could be taken into consideration when creating student teams. We used data collected in 2012 and 2013. We recognise that only two years’ worth of data could be insufficient to establish any correlation, but it could indicate trends. These could be expanded upon as additional data is collected each year. A comparison between the presence of social loafers as well as the distribution of roles in teams was drawn.
This is based on earlier research where the presence of social loafers in a team was related to the presence of Diligent Isolates [28].

2. RESEARCH SCENARIO

This research was conducted during two consecutive presentations of a Software Engineering (SE) module offered at the University of Pretoria. This module is presented in the final year of a three-year Computer Science degree. One of the aims of the module is to consolidate the learning content of previous modules in order to design and implement a medium-sized software system. The module consists of two parts. During both parts the students undergo the complete SE life cycle. In the first part, namely the mini project, the simplicity of the waterfall model makes it eminently suitable. The mini project is completed during the first six weeks of the module. In the second part students are encouraged to experiment with a variety of agile methodologies. Our data was gathered only during the mini project.

2.1 Mini project

During the mini project the students complete the planning, design, documentation and implementation of a SE project. The students are given well defined assignments to complete during four short rounds. All the teams work on the same project. A prominent feature of the mini project is the introduction of difficulties and confusion in the learning experience. These complications are achieved by maximising risks and challenges. We expose the students to as many situations for experiential learning as possible. In each situation we set challenges which require the acquisition of SE knowledge and skills while having to deal with difficulties associated with working in teams that are likely to be dysfunctional. To maximise the actual learning that results from the opportunities created this way, we provide support. Apart from expecting the students to participate in structured reflection on their newly acquired skills, we inform them about the possible difficulties they may experience during their forthcoming rounds and give them guidelines on how to deal with expected difficult situations. We also encourage the students to seek help when needed. The different challenges introduced in the first part are summarised in Table 1.

2.2 Team creation

During the mini project the students are required to work in lecturer assigned teams. At the beginning of each round the students are assigned to new teams of 7 to 9 members. The allocation strategies differed from round to round. In some cases they were allocated randomly whereas in others certain criteria or a combination thereof were taken into account. These included Belbin roles (See Section 3, and participatory levels (See Section 5). In some cases the criteria were applied to form ideal teams whereas in other cases teams were deliberately assembled to be contrary to the ideal postulated by a theory.

Table 1: Challenges posed to the teams

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE</td>
<td>Unknown software engineering process</td>
</tr>
<tr>
<td></td>
<td>Changing and unclear requirements</td>
</tr>
<tr>
<td></td>
<td>Strict documentation requirements</td>
</tr>
<tr>
<td>Technical</td>
<td>Large project scope</td>
</tr>
<tr>
<td></td>
<td>New technologies</td>
</tr>
<tr>
<td></td>
<td>Intricate integration requirements</td>
</tr>
<tr>
<td>Teamwork</td>
<td>Large teams</td>
</tr>
<tr>
<td></td>
<td>Team instability</td>
</tr>
<tr>
<td></td>
<td>Team compositions that are not ideal</td>
</tr>
</tbody>
</table>

Table 2 shows the number of teams that were formed. The analysis reported in this paper relates to the composition of these teams as well as the behaviour of the students in these teams.

<table>
<thead>
<tr>
<th>Round Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>39</td>
</tr>
<tr>
<td>2013</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>34</td>
</tr>
</tbody>
</table>

When analysing the teams, cases where there were too few members in the team who provided the information used in the analysis, the teams were removed from the data set. We ended up analysing 69 teams; 36 teams of 2012 and 33 teams of 2013.

3. BELBIN TEAM ROLE THEORY

The personality of team members is recognised as an important factor contributing to how SE teams function [12, 20, 32]. Many general personality theories have been investigated in connection with team role assignment; for example the Keirsey Temperament Sorter [33], 16 Personality factor [1], Meyers-Briggs Temperament Indicator [16], The Five-Factor Model [37]. We think that Belbin’s theory that focuses on personal behaviour in a teamwork situation may be more applicable. Alban [2] reports that team conflicts were reduced where Belbin’s model was applied in team formation.

The foundation of Belbin’s theory was laid in the late 1960s and is based on research with over 200 teams [6, 9, 7]. Table 3 is a summary of the eight Belbin team roles. According to Belbin’s team role theory, teams in which a wide range of team roles are represented perform better than teams in which there is an imbalance of roles [30]. Ferreira and Langerman [19] observe that the Belbin roles of successful developers and business analysts support the theory. The psychometric validity of the constructs in Belbin’s theory as well as instruments to measure them was heavily criticised [13]. The issues have since been addressed [4, 39, 40] but it remains controversial. Recently Batenburg et al. [5] found no relationship between team role diversity and team performance.

4. BELBIN TEAM ROLE DATA COLLECTION

Every year our students complete the Belbin self-perception inventory [8] early in the module. This is presented as a paper based questionnaire. It consists of sections in which the students have to rank and rate a number of statements to indicate how applicable the statements are to themselves [10].

After completing Belbin’s test, scores are calculated for each of the eight roles. Ideally a primary and a secondary role should be assigned to a person. These should be the roles respectively with highest and the second highest scores. In our analysis we assigned roles to each student according to Belbin’s recommendations, but deviated when these roles could not be determined this way. If the highest score is not unique, all roles having the same score are assigned. This way some students were assigned more than two roles. In cases where there is one role with the highest score, but the second highest score is not unique, we did not assign a secondary role.

The students are aware of these scores and the roles that were identified. They were lectured on the characteristics of the roles and advised on how they could focus on their strengths and make
Table 3: A summary of the eight Belbin team roles [6]

<table>
<thead>
<tr>
<th>Type Type</th>
<th>Typical features</th>
<th>Positive qualities</th>
<th>Allowable weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinator CO</td>
<td>Calm, self-confident, controlled</td>
<td>A capacity for treating and welcoming all potential contributors on their merits and without prejudice</td>
<td>A strong sense of objectives. An average intellect or creative ability</td>
</tr>
<tr>
<td>Shaper SH</td>
<td>Highly strung, outgoing, dynamic</td>
<td>Drive and readiness to challenge inertia, ineffectiveness, complacency or self-deception</td>
<td>Proneness to provocation, irritation and impatience</td>
</tr>
<tr>
<td>Plant PL</td>
<td>Creative, imaginative, unorthodox.</td>
<td>Can solve difficult problems with original and creative ideas</td>
<td>Can be poor communicator and may ignore the details</td>
</tr>
<tr>
<td>Monitor-Evaluator ME</td>
<td>Sober, unemotional, prudent</td>
<td>Judgement, discretion, stubbornness</td>
<td>Lacks inspiration or the ability to motivate others</td>
</tr>
<tr>
<td>Implementer IM</td>
<td>Conservative, dutiful, predictable</td>
<td>Organising ability, practical common sense, hard-working, self-disciplined</td>
<td>Lack of flexibility, unresponsiveness to unproven ideas</td>
</tr>
<tr>
<td>Resource Investigator RI</td>
<td>Extroverted, enthusiastic, curious, communicative</td>
<td>A capacity for contacting people and exploring novelty</td>
<td>An ability to respond to challenge. Liable to lose interest once the initial fascination has passed</td>
</tr>
<tr>
<td>Team Worker TW</td>
<td>Socially oriented, rather mild, sensitive</td>
<td>An ability to respond to people and situations and to promote team spirit</td>
<td>Indecisiveness at moments of crisis</td>
</tr>
<tr>
<td>Completer-Finisher CF</td>
<td>Painstaking, orderly, conscientious, anxious</td>
<td>A capacity to follow through. Perfectionism</td>
<td>A tendency to worry about small things. A reluctance to “let go”</td>
</tr>
</tbody>
</table>

up for weaknesses of other members in their teams throughout the mini project.

Figure 1 shows the distribution of number of roles assigned to the students used in our analysis.

For each team the number of occurrences of each of the roles was recorded. This could be established retrospectively regardless of the strategy used when forming the team. Thereafter the number of different roles occurring in each team was counted, regardless of the number of students with that role. In our calculation we did not differentiate between primary and secondary roles. Figure 2 shows the distribution of number of roles counted in the teams used in our analysis.

5. PARTICIPATORY LEVEL THEORY

In order to test Belbin’s theory we needed a measure of team effectiveness. Rather than defining ways to determine team effectiveness or success, we only analyse the participatory levels of the team members, irrespective of the other factors.

In our experience, when students are expected to work in teams, the levels at which they participate are often unequal. In this section, we specify some of the prominent attributes of the levels of participation previously observed by Pieterse et al. [29]. We use these specifications to analyse the levels of participation of the students. We acknowledge that the level of participation of one individual depends on many factors and may change from one situation to another. It is also important to note that these levels are not discrete. The level of participation of an individual lies on a continuum between social loafing on the one extreme and diligent isolation on the other.
5.1 Social Loafer
The term social loafer refers to an individual whose contribution is perceived to be inferior to those of others in a team. The phenomenon that participants working in groups exert less effort than participants working individually was discovered by Ringelmann [21]. Since the term social loafing was coined by Latane et al. [24], it has been studied extensively [34]. The findings of Statt et al. [36] confirm that social loafing is not only situational, but is also in a complex manner related to a person’s psychology. The original meaning of the term implies that all team members will equally reduce effort when working together. In educational circles, however, the term is increasingly used to refer to individuals in a team who slack more than others [22].

5.2 Compliant Worker
We use the term compliant worker to refer to a team member that usually only does what is expected of him or her. Such an individual is relatively unquestioning and likely to accept the decisions of others without reflection. This behaviour has been identified as a coping mechanism to eliminate or reduce stressors related to high workloads [26]. It is also a commonly used strategy that team members may employ to avoid conflict in a team. Compliant workers will not disappoint the team when they are expected to complete specific tasks. In a situation where there is a lack of leadership or no specific expectations, these individuals may end up being social loafers.

5.3 Insightful Shaper
We call a member who takes responsibility to ensure that the required work is completed an insightful shaper. Such an individual is called insightful because she has usually reached innate creativity of the members of the team [42]. This participatory level is also named after the shaper team role as identified by Belbin [8]. The insightful shaper is someone who provides the necessary drive to ensure that the team stays focused and retains momentum. Unlike a diligent isolate, who is usually unwilling to delegate some of the work, an insightful shaper succeeds in motivating and allowing the other team members to participate. Bukusi [14] refers to someone who kindles the ability of the members to work collaboratively to see the team through to success as a smart leader.

5.4 Diligent Isolate
We coined the term diligent isolate to refer to an individualistic member who relies only on herself to complete the set tasks. We observed that some individuals willingly increase their effort when working in teams. They tend to complete their own tasks exceptionally well, and also endeavour to redo or improve the work of other members. This phenomenon is the opposite of social loafing. Williams and Karau [41] propose a social compensation hypothesis which states that people will work harder collectively than individually when they expect their coworkers to perform poorly on a meaningful task. This finding, as in the case of social loafing, suggests that all members of a team are inclined to work harder. We, however, noticed that an individual may compensate more than others. Smarusk et al. [35] call them poor leaders, and Dixon et al. [17] refer to them as lone wolves. A diligent isolate dislikes team work and often sees others as ineffective and incapable [18]. Such behaviour may discourage the participation of other members [27].

Liden et al. [25] hypothesise mistakenly that when individuals perceive a co-worker to be loafing, that perception would encourage their propensity to loaf. Surprisingly, they observed the opposite, namely that members actually increase their effort. Kerr [23] has found that if a co-worker constantly exerts herself on a project, partners are more likely to loaf.

6. Participatory Data Collection
We collected and analysed the data from responses provided by the students during regular peer reviews. At the end of each round the students were expected to complete a peer review in which they reflect on how they perceive themselves and how their peers perceive them. The main purpose of each peer review was to provide a structured opportunity to reflect on their teamwork experiences in the round. Raftory [31] emphasises the need for reflection at the conclusion of a group work experience. Through peer reviews, students get feedback from their peers. Anson and Goodman emphasise the importance of feedback because without it, students will not be able to learn to improve their behaviour [3].

The questions that the students had to answer guided them to reflect both on their own contributions and the contributions of the other members. These questions were exactly the same for all peer assessment opportunities and are discussed in detail by Pieterse et al. [29].

The responses to the peer reviews provided rich data which we analysed to establish the levels at which the students participated. We discuss how we determined participatory levels based on self-reporting in Section 6.1. In Section 6.2 we discuss how the levels of participation of the members were established based on peer-reporting. These were combined as discussed in Section 6.3.

6.1 Classification based on self reporting
In the peer review students were required to write a paragraph describing their contribution to the task of that particular round. The participatory level of each student in each round was determined by means of interpretive evaluation of this paragraph. We independently read each of the paragraphs. Based on this we categorised each student in one of the specified levels. After the individual analysis was completed, the two sets of results were compared. In the cases where there were differences, we reconsidered the classification to reach consensus. On average 32.4% of classifications had to be reconsidered.

In many cases it was easy to reach consensus. For example the following comment was classified as social loafer by one rater while the other identified it as compliant worker.

Because the SMS protocol I implemented did not work as expected and it was the only ‘wow factor’ we had for the system

The classification as social loafer was done assuming that if the implementation did not work, the person did not try hard enough. When considering the difficulty of the task it is possible that this implementation was not totally broken, but merely somewhat less than perfect. Because the student mentions that it was the only ‘wow factor’, it was important for them and not having a perfect solution was disappointing. This comment can therefore be interpreted to reveal that the person probably worked very hard but feels bad about her failure to produce a perfect solution. The consensus classification is compliant worker.

In some cases the classification remained challenging. For example the one rater classified the following comment as insightful shaper while the other rater was torn between diligent isolate and compliant worker:
I worked hard on crafting solutions to our most pressing problems while working the tasks given to me by our team leader. Specifically, designing the rule system that one of the other members used in his decoder; solving performance issues we were having with our application; writing the file manager (which is surprisingly difficult in javascript and phonegap) implementing a lot of the required functionality for our project.

The key phrase working the tasks given to me is typical of a compliant worker and yet it seems that this person feels that she implemented most of the system, including particularly difficult sections. She was attending to the pressing problems that may have been allocated to other team members. This is typical diligent isolate behaviour. Usually diligent isolates mention many specific things they have done. Attending to problems, however, need not be interpreted as actually doing them as a diligent isolate would do. It may as well be interpreted that the person is helpful and gave guidance and motivation leading to higher levels of collaboration, which is a characteristic of an insightful shaper. The consensus classification is insightful shaper.

### 6.2 Classification based on peer reporting

We analysed the data as a pair and took an holistic approach. We analysed one team at a time. For each team per round, the team members were classified into the four levels of participation. Various observations were made about the participatory levels of the members by analysing the data from different perspectives.

One perspective was based on the ranking of members in the team provided by each student for her team. The ranking was quantified. The two top members were assigned a value of 3, the two bottom members were assigned a value of 0, and the other members were assigned a value of 1. Table 4 shows an example of the data representing the ranking made by the members of a team rows represent the member doing the ranking and columns the member being ranked. This ranking was used as a guide to identify possible leaders (insightful shapers), and slackers (social loafers). If the majority of the members ranked a specific member low, it is likely that she was a social loafer. In this example Member 4 is a possible social loafer. Everybody except herself and Member 1 ranked her low. If the majority of members ranked a person high, it is likely that she was an insightful shaper. In this example Members 1 and 3 are possible insightful shapers.

Two other perspectives were based on the hours and the quality evaluation the students reported for themselves and their peers. Tables 5 and 6 is an example of this data provided by the same team. Here Member 4 did not estimate the hours she or her peers had worked.

### Table 5: Data showing how members of a team estimated the hours they worked

<table>
<thead>
<tr>
<th>Member</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member 1</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Member 2</td>
<td>20</td>
<td>10</td>
<td>15</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Member 3</td>
<td>10</td>
<td>6</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Member 4</td>
<td>96</td>
<td>60</td>
<td>90</td>
<td>20</td>
<td>75</td>
<td>60</td>
<td>75</td>
</tr>
<tr>
<td>Member 5</td>
<td>18</td>
<td>5</td>
<td>15</td>
<td>5</td>
<td>8</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Member 7</td>
<td>40</td>
<td>15</td>
<td>37</td>
<td>10</td>
<td>25</td>
<td>15</td>
<td>35</td>
</tr>
</tbody>
</table>

### Table 6: Data showing how members of a team rated the quality of each other’s work

<table>
<thead>
<tr>
<th>Member</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member 1</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Member 2</td>
<td>10</td>
<td>8</td>
<td>9</td>
<td>7</td>
<td>8</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Member 3</td>
<td>10</td>
<td>7</td>
<td>9</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Member 4</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Member 5</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Member 6</td>
<td>18</td>
<td>5</td>
<td>15</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Member 7</td>
<td>10</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

This data was used as a guide to determine how each member perceived how the others worked in relation to herself. Cases exist where students reported that everybody worked exactly the same number of hours and all delivered work of top quality. This type of information does not reveal any team dynamics and is likely to be idealistic. Many students had a more realistic estimate of the time they worked and the quality of their deliverables. If a team member reported that she worked significantly more hours than the rest of the team members, such a student is likely to be a diligent isolate, especially if the other team members concurred. According to this reasoning, Member 1 of the example was likely a diligent isolate. Where a team member reported that she worked more or less the same hours as the others, while the others reported that she worked harder or delivered work of a higher standard than the rest, the likelihood of this person being an insightful shaper is greater. If most team members indicated that an individual worked only a few hours, it is likely that she had slacked. Member 4 of the example was probably a social loafer. Although some members did not indicate that she had worked significantly less than all other members, in everybody’s view nobody worked fewer hours than she did. Similar observations can be made when focusing only on how the members rated the quality of the work delivered by themselves and their peers. Usually observations from the different perspectives support each other, but sometimes they are contradictory. Here we took observations from all perspectives into account when deciding holistically about the team dynamics and the participatory levels of the members. If there were multiple indications that a member had participated at a certain level, she was classified accordingly. For example, observations from all perspectives indicated that Member 1 was a diligent isolate; she was therefore classified as such. In this example the perspective of quality did not indicate that Member 4 could be a social loafer as strongly as the perspective of time spent. The fact that she did not answer all the questions in the peer review, is an additional indication that she may be a social loafer. We classified her as a social loafer based on taking all the indications into account. If a person did not stand
out in any way she was classified as a compliant worker. In cases where some members of a team did not complete the peer review, we classified those students based on what the other members reported about them. In cases where too few students in a given team provided information, the members of such teams were not classified.

6.3 Merging the classifications
We determined the correlations between the classifications based on self reporting and on peer reporting across all rounds for data collected and analysed over 2011 to 2013. The classification data was captured as ordinal variables with higher values corresponding to a higher inclination towards working. The distribution of the data was assessed for normality before calculating the Pearson’s correlation coefficients between the pairs of data for the different rounds. Due to slight deviations from normality observed in some cases and the categorical nature of the nominal variables, the non-parametric Spearman’s rho correlation was calculated to corroborate the parametric correlation results. Table 7 shows the Pearson’s correlation and Table 8 the Spearman’s rho correlation between the two sets of data. All correlation coefficients are significant and range from small (.3) to large (.8), indicating acceptable correspondence between the role classifications based on self reporting and peer reporting data. The two sets of data are similar enough to use either one for further analysis.

The level of participation determined by using the peer reporting is more comprehensive because we could classify students who did not respond, based on what the other members of their teams reported about them. Rather than just using the more comprehensive data, we decided to use the union of the two sets. Where there were discrepancies, we retained the classification based on self assessment because we have greater confidence in its accuracy. In our experience, students are more likely to be honest about their own participation than their peers. This may be ascribed to peer pressure and a desire to support team mates.

Table 7: Pearson’s correlation between the classifications

<table>
<thead>
<tr>
<th>Round</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 1</td>
<td>.670**</td>
<td>.369**</td>
<td>.298*</td>
<td>.468**</td>
</tr>
<tr>
<td>Round 2</td>
<td>.354**</td>
<td>.418**</td>
<td>.750**</td>
<td>.531**</td>
</tr>
<tr>
<td>Round 3</td>
<td>.459**</td>
<td>.628**</td>
<td>.781**</td>
<td>.597**</td>
</tr>
<tr>
<td>Round 4</td>
<td>.356**</td>
<td>.435**</td>
<td>.642**</td>
<td>.491**</td>
</tr>
<tr>
<td>Round 5</td>
<td>.421**</td>
<td>.408**</td>
<td>.413**</td>
<td>.402**</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 8: Spearman’s rho correlation between the classifications

<table>
<thead>
<tr>
<th>Round</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 1</td>
<td>.622**</td>
<td>.371**</td>
<td>.362**</td>
<td>.468**</td>
</tr>
<tr>
<td>Round 2</td>
<td>.367**</td>
<td>.432**</td>
<td>.724**</td>
<td>.523**</td>
</tr>
<tr>
<td>Round 3</td>
<td>.478**</td>
<td>.589**</td>
<td>.764**</td>
<td>.574**</td>
</tr>
<tr>
<td>Round 4</td>
<td>.332**</td>
<td>.481**</td>
<td>.670**</td>
<td>.503**</td>
</tr>
<tr>
<td>Round 5</td>
<td>.455**</td>
<td>.432**</td>
<td>.391**</td>
<td>.420**</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

6.4 Measuring teamness
Bukusi [14] describes teamness as follows:

The concept of teamness is not a typographic error. It is an intangible feature of a team’s performance and ability to succeed. Because corporate teams are mainly assembled for their technical skill and prowess this aspect of teamwork is often downplayed at the beginning, but inevitably shows up in the field when pressure and problems build up.

If teamness could be quantified, teams with high teamness are more likely to succeed. For this study we assume that the number of identified social loafers in a team is an indication of team malfunction. Teams in which social loafers could be identified are deemed less effective than teams without social loafers. The number of social loafers could be a measure of the opposite of teamness.

For each team the number of identified social loafers were counted. Figure 3 shows the distribution of number of social loafers counted in the teams used in our analysis.

Figure 3: Number of teams with number of social loafers

There were 22 teams with no social loafers in 2012, whereas in 2013 there were only 13. This is an indication that the teamness in 2012 was better than in 2013. It is not common to have more than one social loafer in a team. There is only one team in 2013 that had five social loafers. In this case two of the seven members completed the task on their own and did not bother to keep the rest of the team informed or to incorporate them.

7. VALIDITY OF BELBIN’S THEORY IN OUR CONTEXT
We investigated whether the number of Belbin roles in a team has an impact on the number of social loafers in a team. Figure 4 shows the average number of social loafers in teams against the number of Belbin roles in the teams. In 2012 the number of social loafers peaked at seven roles and dropped to zero at eight roles while in 2013 the number of social loafers was zero at three roles, peaked at six roles and dropped significantly at seven roles.

Figure 5 shows the average number of Belbin roles in teams against the number of social loafers in the teams. In 2012 there is an insignificant trend towards more social loafers as the number of Belbin roles increase. This trend is contrary to Belbin’s theory that more roles lead to better functioning teams. In 2013 there is no discernible trend.
Based on these observations, it seems that there is no correlation between the number of social loafers and the number of Belbin roles per team in terms of any of these perspectives. The lack of correlation is more evident in Figure 4. With this data and our measure of team effectiveness, we are unable to confirm or refute Belbin’s theory.

![Figure 4: Average number of social loafers per number of Belbin roles](image)

There are a number of factors that could have influenced the validity of our results. These include:

- We analysed limited data. Only a small number of short-lived teams over only two years were investigated. The results may become more conclusive once the amount of data is increased.
- The team role definitions of the students in the analysed teams may be inaccurate. Belbin [11] acknowledge that those who have been in the work environment for a longer period of time are likely to have more defined or polarised Team Role preferences while inexperienced individuals may be less sure of their contribution and their Team Roles do not seem so well-defined. The sample that Belbin used in his research consisted of Masters’ students, who are likely to have had more exposure to teamwork and who are significantly older than our third year students.
- Many of our students have difficulty with English and it is possible that some of the options in the Belbin test were not clear enough for them to answer the questions accurately.

- The participatory levels of the students in the analysed teams are vulnerable to misinterpretations. Despite our rigorous analysis, the classification is subjective and anomalies may occur.

8. RESEARCH OPPORTUNITIES

We are interested in conducting research related to the following topics for which we are seeking research collaboration in other institutions:

- The development of strategies to use identified participatory levels of students for early identification of teams at risk in the main project in order to be able to provide better guidance.
- Gathering of more data over a wider range of scenarios in order to produce more conclusive results.
- The creation of an instrument similar to the Belbin test, but having fewer role options, and which is geared to the lack of experience of our undergraduates. Care should be taken to ensure that the language used in the instrument is more accessible.

9. CONCLUSION

We described the participatory levels of students in teams based on several findings over a wide range of research areas. These levels are easy to understand and apply when the behaviour of students in teams is observed.

We described our method of data gathering and analysis to determine the participatory levels of students. It includes many aspects that are subjective in nature, ranging from the student’s views about themselves and their peers to the opinion of the researchers who analysed the data. Despite this, the resulting data seems credible.

We illustrated how the participatory levels of members in their teams can be applied when we investigated the validity of Belbin’s team role theory in our context. We believe that these participatory levels can be applied in research covering a large scope of topics related to team dynamics.

We failed to establish any correlation between the number of social loafers in a team and the number of Belbin roles represented by the members of a team. This failure is likely related to inaccurate information about the Belbin roles of the team members rather than being a consequence of misinterpretation of the levels of participation observed in the teams. Closer analysis is needed. It may be worthwhile to investigate whether the occurrence of certain combinations of Belbin roles is predictive of the presence of social loafers in a team.

Despite the inconclusive results we have laid some groundwork for research aimed at improving the teamwork experience of our students and refine our teaching of teamwork skills. We have also identified several research opportunities and seek research collaboration to enhance the credibility of our work.

10. REFERENCES


