Engaging students in statistics education: situated learning in statistics projects

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Abstract

Teaching an introductory statistics course to undergraduate students is a great challenge. Inspiring students and maintaining students' attention puts a burden on statistics developers and – teachers. Taking a statistics course as a student is even a bigger challenge: students in general do not like this mandatory course, as they fear the formulas will be too difficult to understand and they find the content matter too abstract. Lastly, they fail to see the added value of statistics for their future careers.

One of the major challenges in statistics education is the high level of complexity and the distance between in-class examples and 'real world' experience. Statistics would become more accessible if students could learn how to put research results to use, i.e. context-specific situations. One way to engage students in learning statistics is to organize group projects. This situated learning approach is implemented in introductory statistics courses in a small scale Liberal Arts & Sciences College in the Southwest of the Netherlands. Real life questions derive from societal organizations in the region where the college is based; students form groups, write a research proposal and – upon the approval of the organization involved – carry out the study and report the results; the statistics professor provides supervision.

This paper provides an insight in the results of two small-scale qualitative evaluation studies concerning statistics projects, whereby the focus is the students' perspective. The outcomes indicate that student engagement improves and the added value of statistics unfolds; the learning becomes more contextual, active and culturally based in a 'community of learning'. Moreover, students find ways to construct their own learning. Lastly, students learn how to develop critical thinking skills that are put to use in other fields of study.

Key Words: Statistics group-projects, situated learning, added value of statistics, project based learning.

1. Introduction

What would happen if students were not restricted to the classroom to do their learning? What if statistics lectures were firmly grounded in the everyday practice of society, students could learn 'on the job'? Would it improve their learning or, would they miss out on too many theoretical notions? In this paper the results of two evaluation studies are reported, whereby the focal point is the students' perspective. Before reporting on the results of these studies, I will give some theoretical notions on this type of learning.

Actually it is not a new notion of learning, as Lave & Wenger already described their findings in the early 1990s (1991). In their view learning is a process that is successful, provided the learner fully participates in the 'community of practice' that undertakes a learning activity. In traditional ways of learning, for instance in large lecture halls with weekly lectures and an exam at the end, the learning is decontextualized thereby obstructing the learning process. This is especially true for statistics courses. Statistics in most higher education programs is mandatory, it takes place during the first (few) semester(s) of the students' program and it contains abstract constructs and formulas. Teaching such courses is especially challenging for both lecturers and students and the students could do with some context, clear and understandable examples and calculations, applications to the world around them, the world they live in. It would help them understand the use of statistics and, even, the added value. This cannot be done unless social interaction is introduced in the classroom i.e. 'situated learning'. According to Lave & Wenger, situated learning takes place as a function of the activity, context and culture in which it occurs. They argue that the learning takes place unintentional, whereby students construct their own knowledge. This constructivist approach was also put forward by Brown, Collins & Duguid (1989).

Teachers face a challenge, as it is their task to motivate and inspire their students to learn, help them understand the statistical course content and fairly assess the student outcome. One way of doing this is by introducing student projects (Hydorn, 2007; Verhoeven, 2011, 2012). It is a way to hit two birds with one stone: students learn to practice statistics in every day life and they learn to appreciate the added value of statistical models in society (see also Sisto, 2009; Smith, 1998).

Group projects in the Netherlands are typically used in small Liberal Arts colleges, where group sizes are smaller than in large university settings and it is less complicated to set up these projects. The learning goals that underpin these projects are: students learn how to correctly apply statistical techniques to societal and business situations, they learn how to interpret results and develop recommendations, how to communicate the results, and how to collaborate effectively in small groups.

Additionally, group projects may be based in the direct community, thereby strengthening the students' embeddedness in society. This urges students to think beyond the box and not only focus on empirical questions but also on questions as to how research results can be used beneficially for the community. The setting up and supervision of group projects is very challenging, both for students and teacher, as the latter should not take supervision lightly. Especially when regional questions from 'real' clients are involved, besides focussing on the application of statistical techniques, the communication of the process and results needs special attention. Supervisors need to move away from traditional teaching methods to unconventional supervision and working together with students into addressing genuine research problems (Thompson, 2009; Verhoeven, 2011).

Previous results revealed that students who are taking part in research projects have had more prior math and stats experience, they feel more confident that they can obtain the necessary knowledge and skills, they see the added value of statistics and there attitude toward statistics is more positive. Most importantly however, students who participated in research projects get higher grade than those who did not (Verhoeven, 2012, 2011, 2009). However, it is important to gain insight in the background of these quantitative results and acquire knowledge on the experiences of the students partaking in these projects. This paper discusses the results of a *qualitative* study in an answer to the question 'how do first year students at a Liberal Arts & Sciences college experience the statistics projects and what recommendations can be given for future supervisors?

2. Method

This paper describes the results of two qualitative evaluation studies. Firstly, ten in-depth interviews were conducted with students who took part in statistics projects no longer than 2 years ago. Secondly, course evaluation data from the past 7 years were re-analyzed with a focus on statistics group projects.

Participants and design

First of all, in order to gain insight in the perceptions and opinions of the students partaking in statistics projects, in-depth interviews were set up with 10 students who participated in statistics projects in a small Liberal Arts & Science (LAS) college between 2010 and 2012. Each interview lasted approximately 30 minutes. Besides, the interviewer filled in an answering form during the interview. The interview was taped and transcribed verbatim.

Secondly, qualitative evaluations were used as part of the semester course evaluations for Introductory Statistics courses (at the same LAS college). This qualitative assessment was re-analyzed for eight course evaluations from 2005 – 2012 (n=180), supervised by one supervisor.

Operationalization and procedure

For the in-depth interviews a topic list was used where (besides the research topic) a number of aspects of the statistics projects were discussed:

- The group work: communication, collaboration, division of work and planning (i.e. deadlines);
- Aspects of learning statistics: what did the student learn and how, how was the work load and what added value, if any, did the student see to learning statistics in the traditional way;
- Aspects of assessment: group work, presentation, writing the paper and keeping a log. Again the question was asked what added value, if any, did the student see to assessing statistics in the traditional way;
- Strength & Weakness: what would the student do again, what would he/she never do again?
- Possible suggestions and recommendations for change or improvement.

The additional answering-form provided room for remarks on the setting of the interview and nonverbal observations. The transcribed data were then analyzed using basics from the Grounded Theory (Boeije, 2009). For the re-analysis of course-evaluations, the qualitative part of the (semester) student evaluation form was used, containing two open questions on what students liked most and what suggestions for improvement they would make. The answers were analyzed using the aforementioned method.

3. Results

Group projects for introductory statistics courses are typically set up during the first year of college. After forming groups of (mostly) five students, a research question is developed, a proposal is written and presentations take place towards the midterm break. During this first part of the semester, the theory of research and statistics is also covered in more traditional lectures, and assessed during 3 small exams. After the midterm break, lectures are replaced by group-supervision. Data-collection and analysis take place and the groups present the results. The group is assessed on several aspects, such as group work, presentations, paper and research log. In order to minimize free rider tendencies, besides group assessment of the paper, each student is held accountable for a particular part of the paper, for which he / she received an individual grade. The interviewees set up six inner city projects, two of which had a genuine client, and two student surveys. Topics concerned client satisfaction, shopping behavior and location choice of supermarkets, a primary school evaluation study, two attractiveness studies (survey and experiment), students' smoking habits and concentration levels.

Interview results

Figure 1 shows the diagram of the results of the qualitative analysis. Students' experiences can be split up in four main constructs. The first three constructs are learning experience, added value and group dynamics. Communication, as a fourth important construct is linked to both learning and group dynamics.

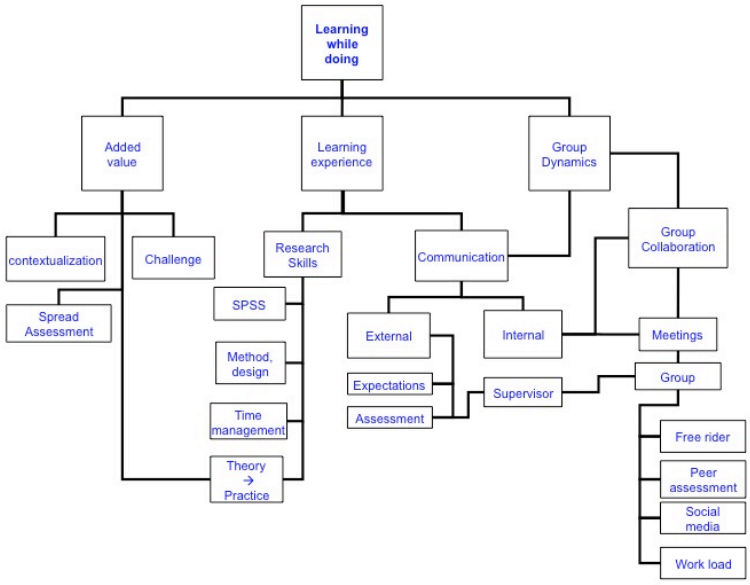

Figure 1 Diagram interview results of 'experience with statistics projects'

Group dynamics and communication: 'meetings or tweets'

Most interviewees talk about acquiring experience with group collaboration, negotiating, division of work and dealing with conflict. Being a first semester student in most cases makes this experience a hard lesson to learn: 'overwhelming'. Two major negative experiences were mentioned: group conflict and free riding. First of all, being relatively new to a group means you have to negotiate your position and this sometimes leads to conflict. The mediating role of the supervisor is much needed here. Secondly, students get annoyed when someone does not live up to the group division or leaves others to do the work and still get the group grade. Usually students solve this within their group, afraid as they are to get downgraded for group work. Most groups experience free riding behavior, but in two

cases the groups provided great friendships. Students report to some hard work but most of them make the deadlines.

A growing use of social media for communication is noticeable, as students create Facebook pages for the project-logistics, use Twitter and SMS to exchange quick and short information bits and Dropbox for the exchange of documents. The popularity of social media results in a reduction of phone communication and use of the official 'learning environment', whilst the email communication remains unchanged. Face-to-face group- and supervisory meetings still take place about twice a week. Convenience meetings are a growing phenomenon, e.g. with students living in the same dormitory.

Internal and external expectations

Not only do groups have high internal expectations, they also expect the support from their supervisor. They want clear guidelines, regular meetings and fair grades. Critical remarks are made on the scheduling of the statistics projects, the group grade (especially when free riding is an issue) and unclarity on expectations. When working with a regional client, one student reports that it helps if a client has clear expectations of the project and this is well communicated to the students.

Learning experience

Most interviewees report that they learned how the theory from the books is put to use in order to solve everyday research questions ("theory into practice"). They acquire experience on how the software (SPSS) works, how to work with (regional) clients, how to create a questionnaire and draw a sample, and how a time-plan can help in getting the project done on time. As one student states "you really get what it is". Students also report to have learned special general skills (emphasizing everybody's strong points), such as working with SPSS or searching for literature. The extent to which a group would appreciate these special (and sometimes complementary) skills partly determines the success of the group project.

All interviewees report added value of statistics group projects, especially because the learning is contextualized ("compared to just learning from the book, it added to my learning"). Students who work with regional clients also report added value of the town-gown relationship, i.e. the experience with community research and the interesting topic. The idea of being able to contribute to the regional community really appeals to the interviewees although they face many challenges when working with a real client. A research project is hands on, less abstract (than theory) and interesting. It creates an independent learning environment and it enables critical thinking.

Trial and error seems to be the most prominent way of learning, as most interviewees report it: learning from mistakes. Some even mention that the learning only starts with the onset of the project ("I learned basically everything during the project"), and they recommend that the project starts parallel to the lectures. The book is put to good use as most students use it as a reference. The learning in groups is a hard lesson for most students, as they need to get used to dividing tasks, learn how to compromise, learn how to work with group members at a different pace - and skills level, making each group member feel equally responsible for the output. The workload however is reported as 'doable'. One student reports to get 'lucky' as one of his group members takes charge of the group, divides the work, keeps an eye on the deadlines and manages the project to come to a good end. One student mentions that a good way of learning is to "complement on each other's knowledge and skills".

Self-regulated learning

Group dynamics led to unexpected results in regard with the learning process: students started peer assessment procedures to evaluate each other's work. This self-regulated learning process evolved outside the supervisors' interference and it proved to be successful in writing the paper. The reason students started this form of assessment may have resulted from the grading system that is used, where students - besides getting a group grade each - are made responsible for a particular part of the writing process and as a result, groups may want to monitor each other's work to make sure it is consistent and free of mistakes.

Assessment

Students find it difficult to reflect on whether their grade is 'well deserved' or not and who's responsible. The spread assessment is mostly favored (eight out of ten) but students report that part of

the grading does not reflect on the actual work that someone does, especially with the research log. Besides being easy to manipulate, in some cases the grade is perceived as unfair because if students are efficient and knowledgeable workers they tend to use up fewer hours.

In three (out of ten) cases one or a few (smaller) exam(s) are preferred, in one case an individual paper is preferred. The majority of the interviewees (8 : 10) see the added value of this spread assessment over the 'one exam' procedure at standard universities: the perception of control over their grade, and the idea that 'all's not lost' if you fail one of the smaller exam's. Spread grading is perceived as fairer if the group is coherent. In groups with free riders fairness of the grading is sometimes considered a problem but as one student said: "It is hard for a professor to assess how a student really is".

Strengths and weaknesses

Most students specify the 'learning by doing' as the added value of statistics projects, the fun you have with other students, the emphasis on everybody's strong points, the spread assessment, and the usefulness for other courses. Without this project, some students would have failed or dropped out. There is a downside to working in groups but that does not have much baring on statistics but on group work in general: possible free riding or joining a group with 'left-overs'. Additionally, disappointment with supervision, possible unfairness of grades and unclarity of the end terms play a role. Almost half of the students address the problem of being overwhelmed during the first semester of their lives away from home. Two students would rather have one big exam because 'that's how I learn' and one student would like the project to start earlier during the semester parallel to the theoretical part.

All students have their learning moments, such as: starting studying earlier and harder for the exams, choosing to join a specific (as in 'better') group, dividing the work better, addressing problems in the group more directly, making sure you know what a client expects from the study, and disappointment in group supervision. They recommend more guidance on research question, an earlier start of the project, better guidance of the group dynamics, no grade for the research log, practice parallel to theory instead of afterwards, literature on project management, help with picking groups. One student would like an individual paper, but she guessed she would be the only one.

Course evaluation results

The qualitative evaluation during the last 7 years seems to confirm the aforementioned results. From the total number of student-evaluations (n=180), only a few students give a negative comment on the statistics project, such as bad choice of group, free riding, too strict deadlines and unclear expectations. Seventy-nine students (43.8%) point out that they liked the statistics project most compared to the other course elements. Key words are: real life learning experience, interesting topics, application of the learned theory, acquiring of skills, group collaboration, and time spent.

4. Discussion & Conclusion

In answer to the question 'how first year students at a Liberal Arts & Sciences college experience the statistics projects', it is noticeable that the interviewed students see the added value of statistics group projects in comparison with more traditional ways of learning statistics. Students learn because they can put theory into practice and they experience 'how it really works'. This is in line with notions by Lave & Wenger (1991) on situated learning. Although learning takes place the hard way, by trial and error, students prefer the statistics projects over standard teaching methods. This was confirmed by Keeler & Steinhorst (1995) who stated that students are more engaged in the course material when involved in collaborative groups, because they have to process the information rather than passively listen to lectures. Going through this learning curve, students also develop critical thinking that helps them in other courses and projects. The development of self-regulated learning tools, such as peer review, helps students to create a research paper that is supported by the whole group. Besides, students appreciate the hands-on and interesting topics, and the spread assessment. Lastly, by assessing both team- and individual effort, students tend to come to meetings better prepared (St. Clair & Chihara, 2012).

Students also learn a thing or two about group collaboration and negotiation, the development of a feasible timeframe, and how to deal with free riding behavior and conflict. It is assumed that if the

in-group cohesion is great, the group work is appreciated (irrelevant of the question whether the group works hard or not, so a group that only 'celebrates' also has good cohesion). If, on the other hand, there is a lot of diversity with regard to level and work ethic, the group work is not appreciated. As one student put it: "If you like each other the group gets less diverse but also less creative". This was confirmed by St. Clair & Chihara (2012).

This study has its limitations. The small, non-random set-up undoubtedly yields low external validity (and reliability). Although generalizability is not the objective of this explorative study, these results should be treated with care. On the other hand the scope of the content seems to expand as previous studies have shown similar findings (Keeler & Steinhorst, 1995; St. Clair & Chihara, 2012;Verhoeven, 2011, 2009).

Recommendations

As Hydorn mentions (2007) it is a challenge to teach statistics and the introduction of student projects helps and inspires students to enhance their learning and to contextualize the learned. A few recommendations can be made on the students' side. First of all, students would like to start their project as early as possible in the semester, parallel to the theoretical lectures so they can put the theory to action immediately. Furthermore, they would like to have access to written information on how to set up a research project (Verhoeven, 2011) and have a clear insight in the expectations on the end terms and the grading (Svanum & Bigatti, 2006). It is recommended to hold on to the spread assessment, but at the same time closely monitor the individual responsibility of students (St. Clair & Chihaha, 2012). Answers to questions on the effect of situated learning on study achievement in statistics education, should be sought by means of larg(er) randomized designs. Ideally, a comparison between standard teaching methods and a collaborative learning approach is made.

On a final note, group projects can enhance the learning of statistics, provided much attention is paid to the organization of the projects, the end-terms and to group dynamics.

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