The role of social interaction in software effort estimation: Unpacking the "magic step" between reasoning and decision-making

Kristin Børte [a,b,*], Sten R. Ludvigsen [c], Anders I. Mørch [c]

[a] Simula Research Laboratory, P.O. Box 134, NO-1325 Lysaker, Norway
[b] Department of Educational Research, University of Oslo, P.O. Box 1092, Blindern, NO-0317 Oslo, Norway
[c] InterMedia, University of Oslo, P.O. Box 1161, Blindern, NO-0318 Oslo, Norway

ARTICLE INFO

ABSTRACT

Context: Software effort estimation is a core task regarding planning, budgeting and controlling software development projects. However, providing accurate effort estimates is challenging. Estimation work is increasingly group based, and to support it, there is a need to reveal how work practices are carried out as collaborative efforts.
Objective: This paper examines the use of concepts in software effort estimation by analysing group work as communicative practice. The objective is to improve our understanding of how software professionals invoke different types of knowledge when talking, reasoning and reaching a decision on a software effort estimate.
Method: Estimation meetings in the industry where planning poker was used as the estimation method have been video recorded and analysed by means of the interaction analysis technique, focusing on the communicative and collaborative aspects of the group work.
Results: The user story mediates the types of resources and knowledge needed to solve the task. Concepts from the knowledge domain are used to frame the task and allow the participants to reach consensus, sufficient to take the next step in the problem-solving activity. Individual knowledge seems to be the dominating orientation when it comes to specifying the work needed for solving the tasks.
Conclusion: The step from reasoning to decision-making has been called the "magic step" in software effort estimation. We argue that the magic step is found in the analysis of the social interaction in which the concepts used are anchored in the knowledge domain of software engineering and in the historical experiences of the participants and subsequently become activated. We propose that by taking a socio-cultural perspective on concepts in activities, the ways in which software professionals reach a decision can be unpacked. The paper contributes to an understanding of the role of concepts in group work and of software effort estimation as a specific work practice.

1. Introduction

Developing a software system is a complex task that comprises software processes such as specification, design, implementation, validation and evolution. However, creating predictable software processes so that the software project can meet the delivery on time, on budget and in a cost-effective manner is challenging [1]. Planning is thereby essential to control and monitor these processes. Software effort estimation is one core task in this respect because it is used for purposes such as planning, budgeting and controlling [1–3]. However, providing accurate effort estimates is difficult. A review of studies of software development projects shows that 70–80% of such projects overrun their estimates and spend on average 30–40% more effort than estimated [4]. Moreover, the consequences of providing inaccurate or over-optimistic effort estimates can be severe. For example it may result in lost contracts and business opportunities because of financial trouble, delays in implementation, or the quality of the software might be compromised for the companies involved to meet the demand for delivery on time. Software effort estimation should therefore be perceived as an organizational, social and technical problem, and a better understanding of the work practice of software effort estimation is therefore important for professionals and project management in software development if aiming at supporting and improving this practice. In this paper we investigate the estimation practice through a detailed qualitative analysis.

Software effort estimation is a challenging task because of the future-oriented aspect of dealing with a system that is yet to be

* Corresponding author at: Simula Research Laboratory, P.O. Box 134, NO-1325 Lysaker, Norway. Tel.: +47 91197219.
  E-mail address: kristin.borte@simula.no (K. Børte).

developed. In addition, activating knowledge and making it relevant to solve specific problems is not straightforward [5]. Each problem setting has its own set of complex issues, which need to be weighted, prioritized and attended to in locally specific ways. As software effort estimation is a challenging task, project managers seldom carry out the estimation work alone. They depend on input from, for example, programmers, technical architects and database specialists to provide an effort estimate. Moreover, it is an increasing trend in the industry to organize estimation work as collaborative processes in groups and teams [6]. Estimating in groups has also shown promising results with regards to estimation accuracy [7–9]. This means that to understand how estimation work is carried out, we need to focus on the collaborative work process, and on how problem solving activities are carried out. The present paper is a contribution towards this and focuses on the work of software professionals, with specific attention given to the collaborative problem solving.

The aspect of professional work that we address is how concepts are used and handled in software effort estimation work. We take as a point of departure that when engaged in problem solving, professionals draw on resources that originate from research and developmental work in a particular knowledge domain as well as on experience-based knowledge. The empirical focus is on how a group of professionals with backgrounds in software development creates estimates of the work effort needed for developing new components of a software system.

Understanding how software professionals reach a decision on a software effort estimate is difficult, and the step from reasoning to quantification has in previous research been described as the "magic step" of software effort estimation [10]. This has been based on the difficulties software professionals have regarding describing how they quantified the effort. Jørgensen [10] reports that what software professionals typically do is provide a detailed description of the different steps that come before the actual quantification. Instead of relying on interviews and experimental data, which have been predominant in the previous work, this paper aims to investigate the magic step by focusing on the social interactions and collaborative work of a group of software professionals when estimating one release of a software system.

Focusing on social interaction and collaboration allows for a focus on how language is used. Language consists of concepts that do not, in general, have any set of fixed meanings, but rather need to be understood in relation to what people are trying to achieve in collaborative activities [11]. Hence, meaning potentials need to be realized, and meanings need to be created for concepts to have meaning in situ for the participants. Concepts have two primary layers: the first layer is that a concept incorporates information that could be relevant to the here and now, while the second layer is the historically accepted use of the concept [11]. Concepts in the workplace are often loaded with history as a result of being part of the long-term historical and institutional development. The actual meaning–making with concepts is contingent in an activity. One function of concepts is that they provide opportunities to classify phenomena and through this cope with a high degree of complexity.

This paper looks into one particular aspect of complexity, namely how software professionals in groups reason and reach consensus of an effort estimate through their use of concepts. The study adopts a socio-genetic perspective, which implies that knowledge is associated with the concepts that are invoked in talk. To understand what counts as knowledge in estimation practices, we study the work of software professionals in the field to see what concepts they invoke in talk. Raising the question of what counts as knowledge makes us aware of how and what kind of knowledge is seen as valuable and visible in the practice.

The research questions raised in this paper are:

- How do the participants arrive at an estimate when using planning poker as a technique?
- What kinds of knowledge are invoked in the work of achieving an effort estimate, and where does this knowledge come from?

The questions are examined in the context of a group of software professionals who employ a specific estimation technique, known as planning poker. Planning poker is a group estimation technique, which facilitates social interaction in the construction of an estimate. Moreover, all group members present participate in the estimation work by showing a card that represents their individual opinion about the estimate of the task. If the estimates that are shown on the different cards are not the same, the group discusses and provides justification of particularly outlying values. Hence, the participation in the discussion is unequal and not based on the need for all group members to articulate. Rather, the present group members' participation is ensured through the showing of their cards. The planning poker technique is used in this study for estimating the effort of one release of a large software system that handles public pensions and loans.

The structure of the paper is as follows. We begin by describing software effort estimation as a type of work as it is revealed in research literature. In Section 3, we present the theoretical perspective that forms the premises for the empirical analysis. Then in Section 4, we present our methods and analytical strategies before we conduct an empirical analysis in Section 5. In Section 6, we compare our results with the results reported in the literature using our theoretical perspective, and in Section 7, we summarize our findings.

2. Software effort estimation as a specialized work practice

A specialized work practice such as software effort estimation provides a good case for examining professional work because both a specialized technical knowledge of software development and the capability of envisioning a software system that is yet to be developed are needed.

The large number of overruns in the IT industry has been a known problem for years and thus software effort estimation has been addressed in research literature since at least the 1970s. The dominating focus in the previous research has been on developing and improving formal estimation models in which software cost estimation has been investigated from a technical point of view [12]. Since 1990, there has been an increase in research papers addressing expert judgment-based estimation, which is the most common estimation approach used in the industry today [13–15]. The focus of attention has then turned from the technical details to the professionals performing the estimation work. A large part of this research identified different factors that influence the decisions that software professionals make when estimating the effort of a software development project. For instance, a review paper by Halkjelsvik and Jørgensen [16] on studies of judgment-based predictions of performance time point to the issue that in software development, factors such as anchor information, wishful thinking, request format and irrelevant information influence the judgments software professionals make on an effort estimate. The magic steps in the decision-making process in such studies can be understood as located within the individuals and their cognitive efforts, as these studies aim at revealing what idiosyncrasies influence individuals' decisions on an estimate, and thus they seek to understand the quantification step. It is this quantification step that has been termed the "magic step" in software effort estimation [10].

Many studies of expert judgment-based estimation use the individual as the unit of analysis, but the social aspects (e.g. group