A Teaching Process Oriented Model for Quality Assurance in Education - Usability and Acceptability

Elisa Reçi and Andreas Bollin

Alpen-Adria-Universität Klagenfurt, Department of Informatics-Didactics,
Universitätsstraße 65-67, Klagenfurt, Austria,
{Elisa.Reci | Andreas.Bollin} @aau.at

Abstract. The lack of standards to objectively assess the quality of teaching opened a new path of research. Teaching involves a lot of different tasks and activities that should be looked at, so, consequently, when talking about the quality of teaching, it makes sense to look at teaching as a process and to assess its maturity. This contribution briefly looks at existing approaches, and also introduces the idea of a teaching maturity model (TeaM) for school and university teachers. As such a framework, even though it is helpful from a measurement perspective, might not be acceptable by teachers. In this paper, a study for testing the TeaM model in respect to its usability and acceptability with informatics lecturers at the Alpen-Adria-Universität Klagenfurt is presented. The results show the interest of our teachers in the model, but also some of the impediments that have to be dealt with when applying the model on a larger scale.

Keywords. CMMI, teaching quality, maturity model, higher education

1 Introduction

Quality assurance in relation to the educational system is a path of research with the aim of providing standards to assess that quality. Researchers have already presented models within this scope. These models assess the quality by covering only one or two factors of teaching (like teachers, curricula, etc.). Further studies emphasize the fact that a better quality of teaching is achieved when managing the whole teaching process [1]. Their work is based on the concept of a maturity model from the Software Engineering Institute (SEI) of Carnegie Mellon University. The SEI addresses the quality for software development by assessing and managing the process for producing that software. The process is defined in a framework called Capability Maturity Model Integration (CMMI) [3]. In this model, levels of maturity are assigned to processes based on their performance. The model of Chen et al. [1] is based on CMMI, and like Chen et al. we also believe that quality is related to the management of the teaching process. Spurred by their results and the concept behind CMMI [3], a Teaching Maturity Model (TeaM) covering all educational levels was created. The TeaM model differs from the work of Chen et al., as it considers not only university teachers but primary and secondary teachers as well.

The basic components of the TeaM model were constructed by following the strategy of SEI. The TeaM model's practices and the other specific elements were created by observing experts in teaching, and by collecting best practices. The TeaM

model was also assessed by a CMMI expert. All our evaluations so far showed that the TeaM Model seems to be consistent and contains all the aspects of the teaching process [17].

On the other side, the introduction of the model in the educational domain raised up the question of how to integrate it in daily life. The future target is to integrate the TeaM model in educational institutions so that teachers can use it to assess the quality of the teaching in their lectures. But, this means also to test the model and to improve it based on the feedback that we get, and with it also to look at its usability and acceptability. In other words, the objective of this paper is to check the applicability of the TeaM model in respect to university teachers at Alpen-Adria-Universität Klagenfurt.

Within the scope of the paper, now a closer look at the opinion of teachers was taken when using the model. The results of a study asking informatics lecturer at the Alpen-Adria-Universität Klagenfurt are presented. The study was looking at the aspects of usability and acceptability when working with the TeaM model.

The rest of the paper is organized as follows: Section 2 describes related work by giving an overview of how models like CMMI-Services and others are related to the educational system in respect to their usability and acceptability. A detailed description of how the TeaM Model is tested and the feedback from the lecturers is presented in Section 3. In Section 4, the results of the study in respect to our model are discussed. Future work and summary is described in Section 5.

2 Background

This section gives a short description of related models. It introduces briefly how CMMI is structured and discusses, also for related models, their applicability and usability in practice.

2.1 Related Work

The traditional forms for addressing the quality of teaching, such as students' evaluation, feedback, peer evaluation and inspectors are seen as quite subjective. This has opened a path for research for some assessment models which relies on standards. Here, a lot of authors address the quality of teaching by mainly focusing either on teachers (preparation, communication, engagement), or pupils/students, or course content or the environment. Taking a closer look at the existing work, these models can be divided in several groups.

There are models that, for addressing the quality of teaching, focus only on teachers. The AQRT model which address the quality of teaching by assessing the teacher teaching practices [8]. There, Chen at al. applied the model in thirty physical education lessons with nine elementary physical teachers. The results emphasize the applicability of the model. The competence based model is another model which assesses the teaching quality through teacher-licensure tests [9]. Mehrens' study is more an investigation and analysis of licensure and teachers competency tests. A similar model

is the Competence based model for teachers how to teach [5] and based on this it assesses the quality.

There are other approaches that consider the pupils/students and the teachers' interactions for addressing the quality. The CEM model is one of them. It assesses teacher quality based on students' outcomes [7]. Azam and Kingdon applied their model to compare the students' results of the exams from the tenth-grade to the twelfth-grade. Based on the results (improved or not) the teacher contribution was estimated. The National Education Association uses a standard-based learning and assessment system to show how student learning standards can be connected with teacher education and assessment [10]. Although there is no concrete implementation in practices, this is how they suggest to measure the quality of teaching. The assessment of teacher competences and students learning and feelings is another model presented by Snook et al. [11]. In their article, they do an investigation in New Zealand schools system. The Angebots-Nutzungs Model is used to address quality based on teacher-student interaction (results, feelings, and environment) [4]. TEQAS is another model where quality is addressed by assessing the teaching education [6]. Dilshad showed the applicability of the model by covering five quality variables through interviews (questionnaire) with 350 students and M.Ed. programmes.

Furthermore, there is the TALIS model which assesses the quality based on working condition of teachers and the learning environment [12]. The OESD article was a technical report where they applied the model in a pilot test with five volunteered countries: Brazil, Malaysia, Norway, Portugal and Slovenia. The test was successful.

Beyond the traditional forms and the assessment methods mentioned above, some maturity models based on the CMMI's principles were created. Researchers in the field of computer science education adapted and created maturity models to assess and to improve the curricula or the institution itself [13], [14], [19]. The validation of the models is referred to a later stage and so far no results are published yet. While Ling et al. applied their model through a case study in a private institution of Higher Learning (IHL) in Malaysia and mentioned that a larger participation of IHLs will be used in future for a better validation of the model [19].

The adaption of CMMI in educational domain is seen also for courses design either in a classroom environment [15] or online [20], [16]. The model of Petri is not validated yet [15]. Neuhauser did the validation of the model in relation to usability, and the answers from the questionnaires revealed that 88% of the responders find themselves in a cell within each PAs [20]. Similarly, Marshall and Mitchell validated the processes and the model in the analysis of an e-learning module at New Zealand University [16].

Likewise, in primary and secondary schools, some CMMI-like implementation models with the focus on the institutional level or on the syllabus [2], [21], [22] were created as well. Montgomery applied her model in six schools for defining the level of using computers and technologies in schools. The models provides goals and practices for making improvements [2]. Solar et al. conducted a pilot study to test the validity of the model and its associated web-support tool [21]. They tested the applicability of the model in different schools and obtained positive feedback from them.

Only Chen et al. established a maturity model for observing the teaching process. The model is limited to a subset of possible Process Areas and focusses on tertiary teachers [1] only. In their paper, Chen et al. address the implementation of a model for

primary and secondary schools, but to the best of our knowledge, such a model has not been implemented and/or published yet.

We believe that the quality of teaching is more than just focusing on the teacher or on the students, and it is more than just looking at the institution or the course content. It is rather a process that includes all of above and more. So, unlike the aforementioned models but like Chen et al., we address the quality by looking at the teaching process as a whole. In contrast to Chen et al. our model considers not only tertiary teachers but primary and secondary teachers as well. First, the model was established [17] and now, in a second stage, interviews are conducted in form of questionnaires in order to define the usability and acceptability of the model. Section 3 provides a detailed explanation of the settings and the results.

2.2 Maturity Model in Practice

The application of maturity models is straight forward to engineers, but for teachers such an assessment might be new. Thus, this section describes the application of a maturity model in practice and briefly discusses usability and acceptability concerns.

Capability Maturity Model Integration (CMMI) came from the need to assess and improve the quality of products. After many years of research, the SEI collected and grouped together some relevant tasks and activities (by naming them Process Areas (PAs)). These tasks were further split in basic ones (named Specific Goals (SGs)) and their related activities (named Specific Practices (SPs)). The specific tasks and activities are unique to a Process Area. When talking about the generalization and standardization of processes, then some general tasks (named Generic Goals (GGs)) and related general activities (named Generic Practices (GPs)) were also defined. The latter tasks and actives are common for all Process Areas [3]. The assessment of the process for producing a product (Software/Service, etc.) with this model, has a twofold meaning. It can focus on different PAs and defines at which level (Capability Level (CL)) the correlated specific tasks and activities are fulfilled, or it controls the fulfillment of tasks and activities on a predefined group of PAs that correspond to a Maturity Level (ML). Such outputs reveals at which maturity level a process for producing a product stays. Further improvement for the process means fulfillment of the group of PAs corresponding to a higher ML [3].

Naturally, the question of how an assessment with maturity models looks like, might pop up. For conducting the assessment, CMMI has specific models which consists of steps of implementations. The assessment is conducted by a CMMI institute certified Assessor. The steps of the assessment start with the analysis of the requirements which determine what processes (sectors) a company wants to assess. This is followed by an appraisal plan development and a selection and preparation of a team for doing the assessment. The PAs are selected and a catalog with questions is prepared. CMMI-Services contains a total of 24 PAs and each of them has the corresponding goals and practices. This means that a catalog with several questions needs to be answered by the interviewees. Herewith, considerable time is required, and the quality and quantity of questions is important as it might influence the results for ranking the company in the

appropriate maturity level. In the last steps of the implementation artifacts are obtained and the appraisal is conducted [3].

One major problem when addressing the quality of maturity models is strictly related to the time consumption for planning, answering and conducting the appraisal. It is also related to the quality and quantity of the questions, and considerations that a rating to a maturity model might influences the company (in money, success, etc.). However, the published "appraisal results directory" from the CMMI institute manifests the usability and applicability of the CMMI model [18].

Software Engineering Institution put too much effort to come up with a consistent version of CMMI. It was a long process of studies and improvements within this last 30 years. Now days, although that the model is applied in practice, there are still parts of it being improved. It is a continuous process of improvements. The same problem holds for the TeaM model. Several studies are requisite for producing a better version of the model.

3 Validating the TeaM Model

The TeaM model is built up from the necessity of some standards to address the quality of teaching. The particularity of the model is on addressing quality by considering the teaching process as a whole with regard to teachers at university, primary and secondary schools. Making use of the model then either helps the educational institution in evaluating and improving its quality of teaching (by, when required, producing a ranking), or it helps teachers to evaluate and improve their teaching process by their own. Within the TeaM model, the teaching process is composed of four phases:

- *Initialization* - where administrative issues are managed;
- *Preparation* - where the course is planned and prepared by teachers;
- *Enactment* - where the implementation of the teaching unit takes place;
- *Quality and Incident Control* - where possible incidents and the teaching process itself are observed, analyzed and refined.

For each of these phases, factors related to the quality of teaching are determined, and in the TeaM terminology they are called Process Areas (PAs). Each PA contains a collections of goals and activities (practices). The implementation of these goals and practices indicates which PA is satisfied. In TeaM this is called reaching a Capability Level. When a predefined group of PAs are satisfied until the maximum Capability Level, then a Maturity Level is reached. The latter expresses how mature the teaching process is. Achieving a higher Maturity Level (so improving the teaching process) means satisfying all the PAs associated to that Maturity Level. A detailed description of the TeaM model can be found in the paper of Reci and Bollin [17].

In a second stage of our research, a validation of the TeaM model was necessary. For such a validation a survey (with questionnaires and interviews) was provided. The practices of the TeaM model were mapped to questions in a questionnaire (comparable to the CMMI appraisals). The interviews helped to check the consistency of the model. When checking its applicability in practice, then an additional questionnaire with 7 questions (related to applicability) was given to the teachers.

3.1 Study Objectives

Having the TeaM model in mind and the time-problems of applying maturity models in practice, the objective of the study is to test the TeaM model in terms of usability and acceptability with some teachers at the University of Klagenfurt. In the context of this paper the following question needs to be answered:

How is the applicability of the TeaM model perceived by lecturers at the Alpen-Adria-Universität Klagenfurt?

To deal with the objective and for answering the question, a survey (interviews within a 7 questions questionnaire) is performed where the TeaM model was applied in practice and feedback from its applicability were collected by the participants.

3.2 Research Settings

The survey (including questionnaire and interviews) was used as a research instrument to assess the applicability of the TeaM model in practice. The assessment was planned similar to CMMI appraisals, and in a first round were looked at lectures at our University. For that, 30 informatics courses from bachelor and master programs at Alpen-Adria-Universität were selected. The main target were the lecturers of these courses who were then interviewed. From 30 informatics courses that were selected for the study, only 13 lecturers participated and answered the questionnaire. There were a mix of lectures from many years to few years of experiences. Only one of them was female. All were specialized in the field of informatics and teach in bachelor and master program of this field.

In contrary to CMMI, the TeaM Model has a total of 12 PAs with their related goals (31) and practices (76). The practices of each PA were taken and a catalog with questions was provided. The catalog contained 76 "yes/no" questions representing the 76 practices of the TeaM model. For instance the practice "SP1.2.1.2 Arrange the Classroom Atmosphere" is presented in the questionnaire like "7. Do you attempt to provide an adequate atmosphere in the classroom?". The same structure is applied to all the other practices. For supporting the appraisal process, the 76 questions were provided in an electronic format using Google forms. This makes the questions public and accessible by those who are interested to use such a model. Moreover the participation remains anonymous as no personal data is collected. The link for our questionnaire is allocated at the website of our institute, in the project section with the name "TeaM model"[1]. Interested readers can join and give their personal experience. Such an online questionnaire helped us to apply the TeaM model in practice.

For performing the appraisal, two non-expert assessors (members from the informatics didactic department of the Alpen-Adria-Universität Klagenfurt) were involved to do the interviews.

During the interviews, the teachers were given two questionnaires. The first questionnaire contained 76 questions related to 76 practices of the TeaM model. The

[1] In the project website you find both the link for the questionnaire and the file containing the detailed description of the TeaM Model Version 1.6 (including the 76 practices) [23].

scope was to introduce the model to the teachers by applying it in practice. Beyond applying the TeaM model in practice, this paper's aim was to know what the teachers think about the usability and acceptability of the model. For this reason, a second questionnaire (with 7 questions) concerning these two dimensions (usability and acceptability) was given additionally to teachers during the interviews. The questions were:

- (Q1) Time to fill the TeaM questionnaire
- (Q2) The understandability of the questions
- (Q3) A ranking of the process to fill the questionnaire
- (Q4) The benefit of this model in future
- (Q5) The relevance of the model to assess the quality of teaching
- (Q6) The model could blame the teachers' way of teaching
- (Q7) Other observations or ideas to share

The results are presented in details in section 3.3. While, the presentation of the results from the first questionnaire is not the scope of this paper.

In the last step of the appraisal, the assessors conducted the interviews and documented the outcomes. For this paper, we use these results with the scope to improve the model and to see its effect while applying in practice. In the future step, the results from applying TeaM model in practice will be further analyzed to see if there is a correlation between the generated TeaM's maturity levels for each course with the feedback provided in the ZEUS system at university of Klagenfurt.

3.3 Study Results

The 13 lecturers participated in the questionnaire worked through all the "yes/no" questions about the practices of the TeaM model, and at the end they provided their opinion about missing/plentiful practices of the model. Additionally a questionnaire with 7 questions was given to them to better understand their perception about usability and acceptability of the model.

(Q1) The first question was related to the time required to fill out the questionnaire. The average time was 30 minutes to answer the 76 questions. Only one interview lasted longer (56min) because the assessor read the questions and the interviewee read the questions himself one more time.

(Q2) The second question dealt with the understandability of the questions from the first questionnaire. We were looking for any ambiguity. Five questions needed the explanation of the assessor because their structure was misleading for the interviewees. Basically, these questions were connected with "and/or" conjunctions and this confused the interviewees. Examples of such questions are: "Do you consider other requirements that might come from students/pupils (like explanation of a new term, repetition of an exercise, etc.), OR administration (like substituting a colleague in one teaching hour because she/he is sick?)"; "Do you consider AND document problems during units' delivery?".

Another problem was a set of questions related to existing curricula. As there are courses which are not based on only one curriculum, a correct answer was impeded as well.

(Q3) The third question produced a ranking from unpleasant (1) to wonderful (10) of the process for filling out the questionnaire. The interviewees and the assessor had the feeling to rate it with 6. This was related to the unclear structure of the sentences and to the fact that they had to think about their teaching process for the first time. This created a little tension on them and they were trying to explain the reason why their answers were no or why "bad" things happened in their course. The assessor think that this questionnaire might work better without the presence of an assessor. However the interviewees expressed interest on the model.

(Q4) The benefit in using this model for the future was the fourth question. The interviewees liked the idea to think about the questions that help to improve their teaching, so they think is good to apply the model. The only problem was related to the documentation practices required by the model.

(Q5) The fifth question revealed if the TeaM model is relevant or appropriate to be used in order to assess the quality of teaching. None of interviewees raised a concern that any of the questions was not related to the quality of teaching. They see it as good collection of standards to follow for addressing the quality.

(Q6) The six question looked closer at the fear of the interviewees if such an assessment could blame their way of teaching. In a way, yes. They express it somehow even in question 3. They expressed worries about some questions that they could only answer with "no", and this was in a major part related to the documentation practices.

(Q7) Last but not least, they were ask about other observations or ideas to share. They think that providing more information on the questions in such a way that no assessor has to participate during the assessment would made them answer in less tension. Most questions were well understandable and also interesting to think about. Already the process of trying to answer the questions and thinking of their own process is worth the questionnaire.

4 Discussion

By analyzing the collected feedback, it is noticeable that the model somehow surprised the interviewees. It made them think (maybe for the first time) about teaching as a process. If we go back to the questionnaire, it is obvious that in contrary to the CMMI questions catalog, answering the questions concerning the TeaM model takes not so much time (referring to Q1). This is worth it when thinking about the model as a part of assessing and improving your work.

Based on the results (Q2), we see that the TeaM model needs to be improved regarding the structure of its "and/or" sentences, even though splitting them will yield to a bigger number of questions and consequently to a more time consuming.

When answering the main question related to the objective of this paper, the TeaM model is perceived as interesting from the general point of view of the lecturers at Alpen-Adria-Universität. Providing an improved version of the model with clearer questions and with no assessor, will further motivate the teachers to use it in practice. Clearly, at least within the scope of the study, the model is applicable by the teachers at Alpen-Adria-Universität Klagenfurt. Another benefit in it is to be considered: by just introducing the TeaM model, the idea of seeing the own teaching process in more detail

was planted into the heads of the participants. When perceiving TeaM more as a self-assessment framework rather than as a raking generator, then its integration in practice in the educational domain could be larger.

5 Summary and Future Work

The TeaM model is an ongoing project running at the Alpen-Adria-Universität Klagenfurt. At first, it can be seen as a model for ranking. This might create doubt with teachers whether to use it or not. However, the main aim of the TeaM model is not to create a ranking between teachers or educational institutions (even though one might do so). TeaM aims at providing a framework that helps teachers to assess the quality of teaching and to tell them how to improve.

In so far, after a lot of theoretical research, the TeaM model is now consistent and its applicability in practice was tested for the first time. Based on the results presented in this paper, it seems that it can be used by teacher to assess their teaching process.

As a future work, we plan to test the model in other courses at university and schools and to produce stable maturity levels based on the results. Another future work will be the extension of the TeaM by an advisory framework. The practices of the models will then be presented in a form of the check list, clearly defined and annotated, and future users will not need the presence of an assessor to apply the appraisal.

References

1. Chen, C.Y., Chen, P.C., Chen. P.Y.:Teaching Quality in Higher Education: An Introductory Review on a Process-Oriented Teaching-Quality Model. Total Quality Management and Business Excellence, 25, 36-56 (2014).
2. Montgomery, B.: Developing a Technology Integration Capability Maturity Model for K-12 Schools. Published Diploma thesis. Concordia University, Montreal, Canada (2003).
3. Forrester, E.C., Buteau, B.L, Shrum, S.: CMMI for Services. Guidelines for Process Integration and Product Improvement. Second Edition. Pearson Education, Inc.USA. (2011).
4. Helmke, A., Helmke, T., Lenske, L., Pham, GH., Praetorius, A., Schrader, F., and Ade-Thurow, M., Studienbrief Unterrichtsdiagnostik. Projekt EMU (Evidenzbasierte Methoden der Unterrichtsdiagnostik) der Kultusministerkonferenz. Landau: Universität Koblenz-Landau (2011).
5. Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland. Standards für die Lehrerbildung: Bildungswissenschaften. Beschluss der Kultusministerkonferenz (2004).
6. Dilshad, R.M. Assessing Quality of Teacher Education: A Student Perspective. Pakistan Journal of Social Sciences, pp. 85-97 (2010).
7. Azam, M. and Kingdon, G. Assessing the Teaching Quality in India. IZA Discussion Paper (2014).
8. Chen, W., Mason, S., Stainszewski, Ch., Upton, A., Valley, M. Assessing the Quality of Teachers' Teaching Practices. Educ Asse Eval Acc Springer (2012).
9. Mehrens, W.A. Assessing the Quality of Teacher Assessment Test. Assessment of Teaching: purposes, Practices and Implications for the Profession (1990).

10. National Education Association. Teacher Assessment and Evaluation. The National Education Association's Framework for Transforming Education Systems to Support Effective Teaching and Improve Student Learning.
11. Snook, I., Neill, J., Birks, S., Church, J., Rawlins, P. The Assessment of Teacher Quality. An investigation into current issues in the evaluating and rewarding teachers. Institute of Education Massey University (2013).
12. OESD. TALIS Technical Reports. Teaching and Learning International Survey (2008).
13. Lutteroth Ch., Reilly A., Dobbie G., and Hamer J. A maturity model for computing education. In Proceedings of the ninth Australasian conference on computing education-Volume 66. Australian Computer Society, Inc., 107–114 (2007).
14. Duarte D and Martins P. A maturity model for higher education institution. In Proceedings of the 23rd International Conference on Advanced Information Systems Engineering Doctoral Consortium (CAISE). 25–45 (2011).
15. Petrie ML. A Model for Assessment and Incremental Improvement of Engineering and Technology Education in the Americas. In Proceedings of Second LACCEI International Latin American and Caribbean Conference for Engineering and Technology (LACCEI'2004).
16. Marshall S. and Mitchell G. Applying SPICE to e-learning: an e-learning maturity model? In Proceedings of the Sixth Australasian Conference on Computing Education-Volume 30. Australian Computer Society, Inc., 185–191 (2004).
17. Reçi E. and Bollin A. Managing the Quality of Teaching in Computer Science Education. In CSERC '17: The 6th Computer Science Education Research Conference, Helsinki, Finland (2017).
18. CMMI Institute Published Appraisal Results "https://sas.cmmiinstitute.com/pars/pars.aspx", accessed on 02.03.2018
19. Ling, T., Jusoh, Y., Abdullah, R., and Hayati Alwi, N., A Review Study: Applying Capability Maturity Model in Curriculum Design Process for Higher Education. Journal For The Advancement Of Science & Arts 3, 1, 46–55 (2012).
20. Neuhauser, Ch., A maturity model: Does it provide a path for online course design. The Journal of Interactive Online Learning 3, 1, 1–17 (2004).
21. Solar, M., Sabattin, J., and Parada, V., A maturity model for assessing the use of ICT in school education. Journal of Educational Technology & Society 16, 1, 206 (2013).
22. White, B., Longenecker, H., Leidig, P., and Yarbrough, D., Applicability of CMMI to the IS curriculum: a panel discussion. In Information Systems Education Conference, 1–5 ISECON (2003).
23. Institute of Informatic didactic, A.A.U.K.: http://iid.aau.at/bin/view/Main/Projects, accessed on 03.07.2018