Former Students' Views on the Usefulness of Conceptual Modeling Education

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Abstract. A big challenge for education and research in Requirements Engineering and Conceptual Modeling (RE/CM) is the need for much more empirical research about the use in practice of RE/CM, including the practical impact of CM education. Former students of RE/CM are potential prescriptors of the RE/CM concepts, methodologies and tools that they have learnt, but they are also conditioned by the current use of those same issues in practice. In this paper we focus on the views that former students of a RE/CM course have, now as young professionals, on the usefulness of the received CM education. We have surveyed over 70 former students to know their opinions on the usefulness of the education on a representative set of CM artifacts. Our results show that our former students find quite useful in general their received CM education, with different usefulness degrees for the various learned artifacts.

Keywords: Conceptual modeling, Education, Practice, Survey

1 Introduction

It is widely recognized that there is a need for much more empirical investigation about the use of Requirements Engineering/Conceptual Modeling (RE/CM) in practice and the practical impact of its education [1,2,3]. In this paper, we focus on CM education and we try to provide some empirical data on its usefulness.

In the context of the well-known Kirpatrick's pedagogical framework for evaluating educational programs [4], the work reported here corresponds to the third evaluation level, which deals with evaluating student behavior. This aims at understanding what happens when students leave the classroom and enter jobs where they could apply what they learnt. In this paper we focus on the views that former students have, now as young practitioners, on the usefulness of the CM education that they received. To this end, we have surveyed over 70 former students in order to know their opinions and recommendations on the received education on a representative set of CM artifacts.

We have found in the literature some reports of surveys on former students' perceptions of the impact of the education they received on their professional activities [5,6], but they are set up at a general and wide educational range, dealing with the education they received during their whole studies. As far as we

know, there has been no prior attempt to evaluate the perceptions and behavior of former students of RE/CM, and this is the first time in which students of an informatics engineering university program are surveyed on their views of CM education and practice.

The structure of the paper is as follows. Section 2 briefly describes the RE/CM course taken by the students that later participated in the survey. Section 3 describes how we designed and conducted the survey. Section 4 presents the general results of the survey, with an emphasis on the former students' opinions of the CM education usefulness as well as their recommendations of learning. Section 5 presents the detailed results for each of the four artifacts surveyed. Finally, section 6 summarizes the conclusions.

2 The RE/CM Course

In this section we briefly describe the RE/CM course taken by the former students that participated in the survey.

The course started in 2005 as an elective course of the speciality in Software and Information Systems of the five-year program of *Informatics Engineering* taught at the *Barcelona School of Informatics* of the *Universitat Politècnica de Catalunya (UPC) – BarcelonaTech*. Typically, students take the course during their fourth year in the program, after (among others) an introductory course to software engineering.

The course is taught using a variant of the PBL (*Project-Based Learning*) approach. The main activity of the course is the requirements specification of a software system, including its conceptual schema. The structure of the requirements specification is an adaptation of the *Volere* template [7], which includes the definition of use cases and the glossary. The structure of the conceptual schema (specified in UML/OCL [8,9]) is the classical one: structural schema (including integrity constraints) and behavioral schema [10]. At the beginning of the course, the teachers establish a vision [11], which varies each course. The students -working in groups of 5-7 people- study the relevant methods, languages and techniques and apply them to the determination and specification of the requirements of a system that realizes the vision.

Students have available deliverables from previous editions of the course, which can be used as (good) examples. The conceptual schema must be defined using the USE tool [12], and be validated by means of example instantiations.

3 Survey Design and Conduct

We created a web-based survey [13] in order to collect the perceptions of the respondents about the current use of well-known conceptual modeling artifacts, and the usefulness for practice of the education received on these artifacts. The survey included two initial questions aiming at characterizing the number of years of professional experience, and the number of projects with a significant RE/CM activity in which the participant has been involved. The other parts of

the survey focused on specific RE/CM artifacts. In this paper we focus only on the four artifacts more closely related to conceptual modeling, which are: (1) Use cases (scenarios); (2) Glossary; (3) Structural schema (UML class diagram, ER schema); and (4) Integrity constraints (UML invariants).

The names of the artifacts in the survey were as indicated above, but it was made clear that in practice they may be called with different names (examples are shown above within parentheses). It was also made clear that the questions referred to explicit artifacts written in any language and at any level of formality, not necessarily the same as those learnt in the RE/CM course.

We targeted the survey to past students of the indicated RE/CM course. The potential number of survey participants was 369, but we were able to know the current email address of 182 people (49.3%). We sent them an email invitation (and reminders) to visit the survey website. We collected survey responses during October-December 2012. The survey was implemented using the web-based SurveyMonkey tool. The survey was initially tested through personal interviews with two former students with wide experience as practitioners.

In this study, we focus, for each artifact $\mathcal{A}$, on the following three questions:

- The *Education usefulness* question ($\mathcal{E}$), aimed at collecting the current perception on the usefulness for practice of the received education:
  $\mathcal{E}$: *"In general, do you think the education received on the definition of the artifact $\mathcal{A}$ has been helpful in your professional practice?"*
- The *Learning recommendation* question ($\mathcal{L}$), aimed at collecting the recommendation of in-depth learning for each artifact:
  $\mathcal{L}$: *"In general, do you agree that conceptual modeling students should learn in depth the importance of defining the artifact $\mathcal{A}$ and how to do it?"*
- The *Usage* question ($\mathcal{U}$), aimed at collecting the current use of each artifact in professional practice.
  $\mathcal{U}$: *"In general, in the projects in which you have participated, the artifact $\mathcal{A}$ was created ... ?"*

If the answer of the participant to $\mathcal{U}$ indicates low usage, then the participant was also asked to answer the *Recommendation of use* question ($\mathcal{R}$):

$\mathcal{R}$: *"In the projects in which the artifact was not created, would you have recommended its creation, taking into account the situation and the resources available at that time?"*

The respondents were asked to answer questions $\mathcal{E}$ and $\mathcal{L}$ using a five-point Likert scale with the values: 1 (*strongly disagree*), 2 (*disagree*), 3 (*neither agree nor disagree*), 4 (*agree*) and 5 (*strongly agree*). Similarly, questions $\mathcal{U}$ and $\mathcal{R}$ were asked to be answered using a frequency Likert scale, with the values: 1 (*never*), 2 (*rarely*), 3 (*sometimes*), 4 (*often*) and 5 (*always*).

The survey participants were asked whether they were willing to participate in a post-survey meeting. A few of the most-experienced respondents were invited to a 90-minutes meeting aimed at validating the survey results.

Table 1. Participants by number of years and projects (%)

	Projects					
Years	0	1	2	3	>3	
≤ 2	1.39	2.78	5.56	0.00	1.39	**11.11**
3	0.00	4.17	6.94	5.56	2.78	**19.44**
4	1.39	0.00	0.00	4.17	8.33	**13.89**
5	2.78	4.17	2.78	1.39	16.67	**27.78**
≥ 6	1.39	2.78	2.78	2.78	18.06	**27.78**
	6.94	**13.89**	**18.06**	**13.89**	**47.22**	

4 Survey Results and Discussion

In this section, we describe the general results of the survey. Our aim is to provide an analysis about the relevance of the received education for practice, from the point of view of our former students with professional experience. In subsection 4.1 we summarize the number of participants in the survey by the number of years since they took the course, and the number of projects with a significant CM activity in which the participants have been involved. Subsections 4.2-4.5 define the analysis indicators and present the main general assessments.

4.1 Participant Characteristics

We received 72 complete responses to our survey, which represents a response rate of 39.6%. Table 1 shows the percentage of participants by the number of years since the course was taken, and the number of projects with a significant RE/CM activity in which the participant has been involved. It can be seen that 55% of the participants took the course five or more years ago, and that 61% have participated in three or more relevant projects.

These results indicate that a large fraction of the respondents have a considerable experience in RE/CM. The table also shows that 6,94% of the respondents have not participated in any project with a significant RE/CM activity. These responses have been ignored in the results reported in this paper.

4.2 Education Usefulness ($\mathcal{EU}$)

The first objective of our work was to obtain an assessment of the perceived *Education Usefulness* ($\mathcal{EU}$) for the professional practice, regarding each CM artifact. A first assessment can be obtained from the answers to the $\mathcal{E}$ question.

Table 2 gives the mean (M) and the standard deviation (SD) of $\mathcal{EU}$ for each artifact. It can be observed that there are differences depending on the artifact. Some general trends (in average) can be observed: the structural schema and the use cases are the artifacts with the highest $\mathcal{EU}$ mean (4.31 and 4.02), and also with the lowest SD. (2) The $\mathcal{EU}$ mean for integrity constraints (3.47) shows that

Table 2. $\mathcal{EU}$, $\mathcal{LR}$ and $\mathcal{CP}$ for each artifact (*Likert scale*)

	$\mathcal{EU}$		$\mathcal{LR}$		$\mathcal{CP}$	
	M	SD	M	SD	M	SD
Use Cases	**4.02**	0.83	**4.42**	0.80	**3.10**	1.13
Glossary	**2.94**	0.96	**3.68**	0.91	**2.62**	1.24
Structural Schema	**4.31**	0.74	**4.58**	0.69	**3.56**	1.20
Integrity Constraints	**3.47**	1.07	**4.07**	0.91	**2.64**	1.30

education on this artifact is quite useful. (3) The glossary has the lowest mean (2.94), which is below the answer *neither agree nor disagree* in the *Likert scale*.

Table 2 also shows M and SD for the answers to question $\mathcal{U}$, which indicate the perception on the current practice of each artifact, denoted by *Current Practice* ($\mathcal{CP}$). These values suggest that the higher $\mathcal{CP}$ is observed for an artifact, the higher $\mathcal{EU}$ is perceived. It is also important to note that, for all artifacts, the mean of $\mathcal{EU}$ is higher than the mean of $\mathcal{CP}$, so that other factors than the current direct application of the artifacts contribute to positive perceptions on the education usefulness.

4.3 Learning Recommendation ($\mathcal{LR}$)

The second objective of our work was to obtain an assessment of the *Learning Recommendation* ($\mathcal{LR}$) for each CM artifact, from the perspective of the former students that participated in the study. A first assessment is provided by the answers to the question $\mathcal{L}$.

Table 2 shows the mean (M) and the standard deviation (SD) of $\mathcal{LR}$ for each artifact. We can observe that $\mathcal{LR}$ and $\mathcal{EU}$ follow similar trends, although there is more emphasis on the learning recommendation for each artifact. These results suggest that the learning recommendation is mainly influenced by the perception on the usefulness for practice of the received education. It is also important to note that for all artifacts the mean of $\mathcal{LR}$ is greater than the neutral value (3) in the Likert scale. However, learning about the structural schema and the use cases clearly have a higher recommendation, in comparison with integrity constraints and glossaries.

4.4 High/Low Education Usefulness and Learning Recommendation

In order to go in depth in the relationship between the perception on the education usefulness for practice ($\mathcal{EU}$) and the learning recommendation ($\mathcal{LR}$), we classified the answers to questions $\mathcal{E}$ and $\mathcal{L}$ into two groups:

- *High agreement* answers: Those that correspond to the values *agree* (4) or *strongly agree* (5) in the Likert scale.
- *Low agreement* answers: Those that correspond to the values *neither agree nor disagree* (3) or *disagree* (2) or *strongly disagree* (1).

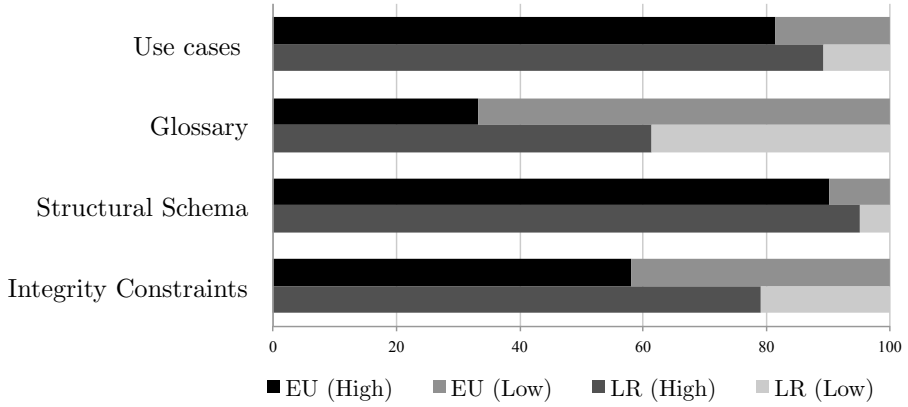

Fig. 1. High and Low indicators for $\mathcal{EU}$ and $\mathcal{LR}$

This classification allows to formally define the *high* ($_{\mathcal{H}}$) and *low* ($_{\mathcal{L}}$) indicators for $\mathcal{EU}$ and $\mathcal{LR}$ as follows for each $\mathcal{A}$ artifact:

$$\mathcal{EU}_{\mathcal{H}}(\mathcal{A}) = \frac{\mathcal{E}_4(\mathcal{A}) + \mathcal{E}_5(\mathcal{A})}{\mathcal{E}(\mathcal{A})} * 100 \qquad \mathcal{EU}_{\mathcal{L}}(\mathcal{A}) = \frac{\mathcal{E}_1(\mathcal{A}) + \mathcal{E}_2(\mathcal{A}) + \mathcal{E}_3(\mathcal{A})}{\mathcal{E}(\mathcal{A})} * 100$$

$$\mathcal{LR}_{\mathcal{H}}(\mathcal{A}) = \frac{\mathcal{L}_4(\mathcal{A}) + \mathcal{L}_5(\mathcal{A})}{\mathcal{L}(\mathcal{A})} * 100 \qquad \mathcal{LR}_{\mathcal{L}}(\mathcal{A}) = \frac{\mathcal{L}_1(\mathcal{A}) + \mathcal{L}_2(\mathcal{A}) + \mathcal{L}_3(\mathcal{A})}{\mathcal{L}(\mathcal{A})} * 100$$

where $\mathcal{E}_i(\mathcal{A})$, $i = 1..5$, is the number of respondents that answered i in the Likert scale of the $\mathcal{E}$ question of artifact $\mathcal{A}$. Similarly, $\mathcal{L}_i(\mathcal{A})$, $i = 1..5$, is the number of respondents that answered i in the Likert scale of the $\mathcal{L}$ question of artifact $\mathcal{A}$. $\mathcal{E}(\mathcal{A})$ and $\mathcal{L}(\mathcal{A})$ are the total number of respondents to each question. Note that $\mathcal{EU}_{\mathcal{H}}(\mathcal{A}) + \mathcal{EU}_{\mathcal{L}}(\mathcal{A}) = 100$ and $\mathcal{LR}_{\mathcal{H}}(\mathcal{A}) + \mathcal{LR}_{\mathcal{L}}(\mathcal{A}) = 100$.

Fig. 1 shows the relationship between $\mathcal{EU}$ and $\mathcal{LR}$ by means of two bars for each artifact. The first bar classifies the percentage of responses between those that are in the *High Education Usefulness* ($\mathcal{EU}_{\mathcal{H}}$) situation, and those that are in the *Low Education Usefulness* ($\mathcal{EU}_{\mathcal{L}}$) situation. Similarly, the second bar classifies the percentage of respondents in two groups: those that are in the *High Learning Recommendation* ($\mathcal{LR}_{\mathcal{H}}$) situation, and those that are in the *Low Learning Recommendation* ($\mathcal{LR}_{\mathcal{L}}$) situation.

The bar chart in Fig. 1 reinforces the idea that the usefulness of the received education for practice is an important influence factor on the positive learning recommendation, since first and second bars for each artifact follow a similar trend.

4.5 Current Practice Influence on Education

In this section we analyze in depth the influence of the current practice on the *Education Usefulness* ($\mathcal{EU}$) perception and the *Learning Recommendation* ($\mathcal{LR}$) according to the view of the participants in the survey.

Table 3. $\mathcal{EU}_{\mathcal{H}}$ and $\mathcal{EU}_{\mathcal{L}}$ responses (%) classified into $\mathcal{CP}$ situations

	$\mathcal{EU}_{\mathcal{H}}$				$\mathcal{EU}_{\mathcal{L}}$			
	$\mathcal{CHP}$	$\mathcal{IP}$	$\mathcal{ALP}$	Total	$\mathcal{CHP}$	$\mathcal{IP}$	$\mathcal{ALP}$	Total
Use Cases	81.5	0.0	0.0	**81.5**	0.0	10.8	7.7	**18.5**
Glossary	33.3	0.0	0.0	**33.3**	0.0	34.9	31.7	**66.7**
Structural Schema	90.2	0.0	0.0	**90.2**	0.0	6.6	3.3	**9.8**
Integrity Constraints	58.1	0.0	0.0	**58.1**	0.0	22.6	19.4	**41.9**

Tables 3 and 4 classify the answers of $\mathcal{EU}_{\mathcal{H}}/\mathcal{EU}_{\mathcal{L}}$ and $\mathcal{LR}_{\mathcal{H}}/\mathcal{LR}_{\mathcal{L}}$ in three *Current Practice* ($\mathcal{CP}$) situations, according to the analysis in conjunction of questions $\mathcal{U}$ and $\mathcal{R}$ [14]:

- *Current High Practice* ($\mathcal{CHP}$). These are the situations in which, according to the answer to question $\mathcal{U}$, the artifact is *often* (4) or *always* (5) used.
- For *Current Low Practice* ($\mathcal{CLP}$) situations (in which the artifact is *never* (1) or *rarely* (2) or *sometimes* (3) used according to the answer to question $\mathcal{U}$), the answer to the *recommendation of use* $\mathcal{R}$ question, allows us to distinguish the following situations:
  - *Improvement Potential* ($\mathcal{IP}$) if the answer was *often* (4) or *always* (5).
  - *Accepted Low Practice* ($\mathcal{ALP}$) if the answer was *never* (1), *rarely* (2) or *sometimes* (3).

Our rationale for the definition of $\mathcal{IP}(\mathcal{A})$ is that we consider that situations have potential for improvement if they are in $\mathcal{CLP}$ but the respondents would have recommended *often* or *always* the creation of the corresponding artifact. That is, if the recommendation had been followed in the given situation, then it would have been in the $\mathcal{CHP}$ situation.

Similarly, $\mathcal{ALP}$ situations are defined as those that are in $\mathcal{CLP}$ and the respondents would have not recommended *often* or *always* the creation of the artifact.

Table 3 points out that there is a strong relationship between high education usefulness perception ($\mathcal{EU}_{\mathcal{H}}$) and current high practice ($\mathcal{CHP}$), since all respondents that perceive an artifact as highly applied in practice also consider the received education useful. In contrast, those that perceive a low current use also perceive a low usefulness of the education for current practice ($\mathcal{EU}_{\mathcal{L}}$), regardless they expect an improvement potential on the use ($\mathcal{IP}$ situation) or not ($\mathcal{ALP}$).

In Table 4, it can be observed that most of the respondents in the low recommendation of learning ($\mathcal{LR}_{\mathcal{L}}$) situation are those that accept a low current practice of the artifact ($\mathcal{ALP}$). There are also very few respondents for each artifact who, although they consider that the education on the artifact may be useful, they would not recommend to learn it in depth. On the other hand, respondents who highly recommend to learn an artifact ($\mathcal{LR}_{\mathcal{H}}$) are those that consider either that (1) the artifact has a current high practice ($\mathcal{CHP}$), or (2) there is an improvement potential ($\mathcal{IP}$) situation, in which they would recommend the use of the artifact if they would lead the project.

Table 4. $\mathcal{LR}_{\mathcal{H}}$ and $\mathcal{LR}_{\mathcal{L}}$ responses (%) classified into $\mathcal{CP}$ situations

	$\mathcal{LR}_{\mathcal{H}}$				$\mathcal{LR}_{\mathcal{L}}$			
	$\mathcal{CHP}$	$\mathcal{IP}$	$\mathcal{ALP}$	Total	$\mathcal{CHP}$	$\mathcal{IP}$	$\mathcal{ALP}$	Total
Use Cases	78.5	10.8	0.0	**89.2**	3.1	0.0	7.7	**10.8**
Glossary	25.8	35.5	0.0	**61.3**	6.5	0.0	32.3	**38.7**
Structural Schema	88.5	6.6	0.0	**95.1**	1.6	0.0	3.3	**4.9**
Integrity Constraints	56.5	22.6	0.0	**79.0**	1.6	0.0	19.4	**21.0**

5 Results per Artifact

In this section we focus on each of the four artifacts and we briefly describe the analysis about its education relevance for practice, based on the indicators presented in Section 4.

5.1 Use Cases

Table 2 shows that, for the use cases artifact, $\mathcal{EU}$ (4.02) and $\mathcal{LR}$ (4.42) have a value in the Likert scale greater than 4. In Fig. 1, it is also clear that $\mathcal{EU}_{\mathcal{H}}$ and $\mathcal{LR}_{\mathcal{H}}$ are significantly greater than $\mathcal{EU}_{\mathcal{L}}$ and $\mathcal{LR}_{\mathcal{L}}$. These results indicate that use cases are relevant artifacts for the professional practice and that learning them in-depth may be useful for practitioners.

According to Table 3, 81.5% of the respondents consider that use cases have a current high usage in practice ($\mathcal{CHP}$), and that the education on this artifact is useful ($\mathcal{EU}_{\mathcal{H}}$). Table 4 also shows that the 89.2% of respondents recommend to learn the artifact ($\mathcal{LR}_{\mathcal{H}}$). These respondents correspond to those that either perceive use cases as currently highly used ($\mathcal{CHP}$) in practice (78.5%) or would recommend ($\mathcal{IP}$) its use (10.8%).

5.2 Glossary

As illustrated in Table 2, $\mathcal{EU}(\textit{glossary})$ is lower than the neutral value in the Likert Scale (2.94) and, consequently, its relevance for practice is quite low. However, its $\mathcal{LR}$ mean is 3.68, so that several respondents recommend to learn about the glossary. Fig. 1 shows that this is the only artifact for which $\mathcal{EU}_{\mathcal{L}}$ is greater than $\mathcal{EU}_{\mathcal{H}}$. The analysis suggests that the education on the specification of glossaries has the lowest relevance perception for practice.

In Table 3, it can be observed that 66.7% of the respondents consider that glossaries have a current low usage in practice and that the education on this artifact has a low usefulness perception. Only 33.3% of the respondents consider that the glossary is highly used and that the education is useful for current practice. Nevertheless, according to Table 4, an important percentage of the respondents (35.5%) are in the $\mathcal{IP}$ situation and recommend to learn about the glossary, together with those that perceived them as already highly used (25.8%).

5.3 Structural Schema

Table 2 shows that, for this artifact, the mean of $\mathcal{EU}$ is 4.31 and the mean of $\mathcal{LR}$ is 4.42. These are the highest values in comparison with the rest of artifacts considered in the study. This results are also confirmed in Fig. 1, where it is clear that $\mathcal{EU}_{\mathcal{H}}$ and $\mathcal{LR}_{\mathcal{H}}$ are greater than 90%, while $\mathcal{EU}_{\mathcal{L}}$ and $\mathcal{LR}_{\mathcal{L}}$ are very low. These results indicate that the education on the elicitation and specification of the structural schema of an information system is considered very relevant for practice and its learning is highly recommended.

Tables 3 and 4 clearly show that the dominant situation is that of respondents in the $\mathcal{CHP}$ situation (those that perceive a high usage of conceptual schemas in practice) who also consider the education on structural schemas very useful (90.2%) while they recommend its learning (95.1%).

5.4 Integrity Constraints

As illustrated in Table 2, $\mathcal{EU}$(*integrity constraints*) is 3.47 and $\mathcal{LR}$(*integrity constraints*) is 4.07. Fig. 1 also shows that, although $\mathcal{EU}_{\mathcal{H}}$ is lower than the same value for the structural schema and the use cases, near 60% of the respondents recommend that students learn about integrity constraints.

Table 3 confirms that the highest education usefulness on integrity constraints ($\mathcal{EU}_{\mathcal{H}}$) is perceived for those that are in the $\mathcal{CHP}$ situation (58.1%). However, Table 4 shows that there is an important percentage of respondents (22.6%) in the $\mathcal{IP}$ situation that highly recommend to learn about the integrity constraints, together with those (56.6%) that already consider that their use is high ($\mathcal{CHP}$). Only 19.4% of the respondents accept the low practice ($\mathcal{ALP}$) of integrity constraints and do not recommend their learning ($\mathcal{LR}_{\mathcal{L}}$).

6 Conclusions

In this paper, we have analyzed the perceptions on the usefulness for the professional practice of CM education, based on a survey answered by over 70 former students of a RE/CM course within an informatics engineering university program. The survey was aimed at knowing their opinions and recommendations, as practitioners, on the received education on a representative set of CM artifacts. As far as we know, this is the first attempt to evaluate the perceptions of RE/CM former students about the received education for their current practice.

In general, the survey results indicate that our former students consider their received CM education as useful for their professional work. The analysis of the results also points out that there are differences on theses perceptions depending on the artifact. In particular, they consider very useful the structural schema and the use cases, both with very high levels of perceived usefulness. Consistently, they highly recommend in-depth education on these artifacts. For integrity constraints, the perceptions on their education usefulness are lower, although many

participants recommend to learn them in-depth. In contrast, the education received on the specification of glossaries has the lowest perception of usefulness for practice.

The results reported in this paper are subject to some threats to their validity beyond our local context. The main threat is the geographic and domain bias of the survey, created by drawing the respondents from the former students of an RE/CM course offered by a particular university.

We consider that the analysis reported in this paper can be useful for improving the effectiveness of our RE/CM course, taking into account the views and recommendations of our former students with professional experience in software development. Hopefully, these results could be of interest to other similar courses on conceptual modeling.

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