Have We Missed Something? Identifying Missing Types of Research in Computing Education

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ABSTRACT
In this paper, we introduce a new way to categorise existing educational research making it possible to find new previously overlooked research topics. This novel categorisation system is based on the didactic foci of the research papers. Our categorisation scheme is not data driven as in previously published categorisation systems but is derived from the didactic triangle, which is a theoretical model describing the elements of a teaching-studying-learning processes.

The didactic-focus-based categorisation system can be used to promote discussion about missing types of research foci within the computing education research (CER) community. In addition, the new categorisation system supports meta-level analysis of published research papers and thus contributes to the discussion of the goals and the present state of CER. We analyse previously existing categorisation systems and describe how our system differs. Finally, we give two examples how to apply the new theoretical categorisation system. First, we use research papers published in ICER conferences 2005-2009 as our source material to illustrate how to apply the new theoretical categorisation system for revealing a number of areas for novel research such that seem to have received little attention from the CER community. The second example highlights how the categorisation system can be used to find overlooked research topics on some specific research area (in our example students’ success in CS1).

Categories & Subject Descriptors: K.3.2 [Computers and Education]: Computer and Information Science Education

General Terms: Theory

Keywords: didactic triangle, didactic focus, computing education research, classification criteria, literature

1. INTRODUCTION
As a research field matures and the number of publications grows, motivation arises to define past and current trends in the field.

Computing education research (CER) has reached a point where there already exists a vast number of publications. Several actions have been taken to define the contents and the state of current CER by developing different kinds of categorisation systems. The desire to define the state of CER reflects its similarity with other fields (see, for example, papers concerning mathematics education [1], the goals of educational research [2], and higher education research [3]).

This paper contributes to the latest discussion of the state of CER by providing a wholly novel point of view to categorising research. Not only does this new viewpoint emphasise what has been studied but it also highlights aspects of the instructional process that have been overlooked and thus it provides a pool for new research questions. Therefore, we hope to add an important viewpoint to existing literature relating to categorisation systems. However, before we introduce the new categorisation system, we review the existing ones. Then we explain how our new categorisation system was developed and finally we show two examples how the system works in practice by categorising all research papers published in ICER over the years and how the categorisation system can be used to find overlooked research topics on some specific research area (here CS1). The contributions of this paper lay in findings, which point out some areas where new research is needed.

2. PREVIOUS CATEGORISATION SYSTEMS IN CER
Clancy et al. [4] presented one of the first categorisations for CER. Their four categories included: a) small-scale investigations and the scope of study, b) tool motivated investigations, c) mental and conceptual related investigations, and finally d) the research paradigm. This categorisation seems to have been influential when subsequent categories have been created.

Fincher and Petre [5] identified ten research area categories in computer science education research. The main categorisation base was the topic of the paper even though the nature and the scope of the paper were also discussed. In the study by Pears, et al. [6] the authors used categories that were introduced in the paper of Fincher and Petre as a starting point for their analysis.

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Created by Pears et al. to identify important measures limiting the teaching of introductory programming. Valentine [8] introduced the character and the content of the paper as bases for categorisation. The studies by Simon [9] and Simon, Carbone et
al. [10] as well as Sheard et al. [11], on the other hand, applied a classifying system that had four dimensions: nature of the paper, topic, context, and the breath of paper’s context. The study by Glass et al. [12] based the analysis of publications in the computing disciplines on the topic, the research approach, the research method, the reference discipline, and the level of analysis. The analysis by Randolf et al. [13] of methodological properties of publications in the field of computer science education drew the attention, for instance, to research methodology, research design, and the variables examined. Finally, the extensive study by [14] reported on a categorisation system based on the topic of the paper.

The above variety of categorisation systems illustrates the researchers’ interest in defining the content, context, and standards for quality of the new research area. As a summary, the existing categorisation systems have used four different kinds of aspects to shed light on what has been studied so far.

1) Methodology
   - Nature of approach: e.g., research – practice [12]
   - Methodological properties: e.g., used methodology, design, variables, level of analysis [12], [13]
   - Research paradigm [4]

2) Reference discipline
   - E.g., educational tradition [12]

3) Content
   - Nature of research: e.g., theoretical – empirical [5], [6], [7], [9], [10], [11]
   - Theme, topic, context of the paper [4], [5], [6], [7], [8], [9], [10], [11], [12], [14]
   - Scope [4], [5], [6], [7], [9], [10], [11]

4) Significance
   - How influential the paper has been [6], [7]

The common feature to all presented systems is that the used categories have been derived from the data (the CER literature). As the summary list conveys, previous categorisation systems cover a large set of different aspects of research papers. In our paper, however, we present as an alternative categorisation system that highlights yet a new aspect, didactic focus, which is based on theory and not on aspects listed above.

3. THE NEW CATEGORISATION SYSTEM BASED ON DIDACTIC FOCUS

The didactic focus, which is used as the categorisation base, is derived from the didactic triangle (Figure 1), which goes back in its origin to the beginning of the 19th century, to the works of Johann Friedrich Herbart [see e.g. 15]. He introduced the triad of learner-teacher-content and emphasised that the relation between teacher and learner is not direct but that content stands between them. The didactic triangle describes these three main elements of a didactic system and the interrelations between them. The arrows in the triangle stand for relations between the elements as they appear in an institutional instructional process. Arrow A stands for the relation between the content and the teacher. Arrow B stands for the teacher’s relation to or conceptions of the student and vice versa. Arrow C stands for the relation between the student and the content, which expresses itself, for example, as studying [16].

![Figure 1 The didactic triangle [see e.g. 15]](image1)

The didactic triangle is a schematic representation on a high abstraction level, which enables several variants of interpretation concerning the meaning of the arrows and thus the model serves as a tool for analysing several aspects of instruction. Künzli [17] argued that, depending on the emphasis, each strand (or arrow) in the triangle can have more than one meaning. Furthermore, the relationships in the didactic triangle stand not only for concrete practice but also for theoretical cognitions. Friesen [18, p. 50] summarised the relationships between the elements: “all of the relationships in the Didaktik triangle should also be understood ... in terms of a “comprehensive intertwining of action and reflection, practice and theory” – an understanding of theory and practice in which the relationship between the two is an object of explicit concern and reflection.”

Even though the origin of the didactic triangle goes back over hundred years, as a theoretical tool it is still “alive” in the sense that it is found useful and is being developed further. The study by Bergamin [19] developed the triangle by adding community to the triangle, creating a tetrahedron. In addition, it analysed the elements of teaching and learning situations in the context of blended learning and stated that community is one essential, fundamental characteristic of co-operative learning. In Bergamin’s model, the community is an equal node in the tetrahedron along with teacher, student and content. Kansanen and Meri [20] and Kansanen [16] have also developed the triangle further by adding another arrow (D), as shown in Figure 2. This arrow stands for the didactic relation between the teacher and the students’ studying and learning processes, which can be seen as scaffolding. This didactic relation can be externalised, for example, by giving lectures or providing a learning environment.

![Figure 2 The didactic triangle as presented by Kansanen [16]](image2)

3.1 Development of the three-layered structure from where categories are derived

The categories of the new categorisation system are derived from the three-layered structure that is based on the didactic triangle. The development of the three-layered structure is reported in more detail elsewhere [21]. Therefore, in this paper we describe the development only briefly and focus on the outcome and the emerging categories.
We took the elements of the didactic triangle as presented by Kansanen [16] as the starting point for further development of the triangle. The first development was to add a relation between the student node and arrow D to represent the students’ relation to the teachers’ pedagogical actions, such as giving a lecture. We added this relation to emphasise the importance of students’ perceptions of the teacher’s pedagogical actions. Students’ perceptions may influence, for instance, their motivation and the types of chosen study strategies. The added relation thus emphasises students’ role in the instructional process.

The second development related to setting the triangle in a larger context. Figures 1 and 2 represent the learner-teacher-content relations in the context of a single course. In order to set the triangle in a larger context, each of the three main elements of the didactic triangle can be understood as an instance of some larger entity. Hence, the number of possible viewpoints from which the instructional process can be seen grows significantly. For example, the teacher could be replaced by a team of teachers, the organisation in charge of a degree programme, or even the society at large. Likewise, the student could be replaced by a community of students or even by the citizens of a society. The content node of the triangle can also be seen as a part of a larger entity: the goals for the instruction. Here the goals are understood as a more comprehensive concept than just the taught content. For example, the goals of a course may include the knowledge, skills and attitudes that the student is expected to acquire. Goals can refer to the goals of a study module, a single course, a degree program, or even to the general goals of education that the society provides to its citizens. In general, one can view the instructional process on the course level, the organisation level, and the society level. Figure 3 presents these three layers side by side. Note that on the course level the readers have a choice whether they want to concentrate on an individual student or teacher’s experiences or on the experiences of a larger set of students (such as all students in the course) and teachers (such as a team of teachers and assistant teachers in a course). On the organisation level, the community of students refers to a large group of students, such as all computer science majors or even all students at the university.

![Figure 3 The three levels of the didactic triangle: course level, organisation level and society level](image)

The three viewpoints presented in Figure 3 increase the applicability of the didactic triangle as a base for categorisation of research since it does not confine us to the individual or course level. However, Figure 3 gives the impression that the three levels exist in isolation from each other, even though the different levels actually coexist and interact with each other. If we look at all three levels at the same time, the result could look like Figure 4. This figure emphasises the interrelated nature of the three levels of the instructional process.

![Figure 4 Coexistence of different levels of the three-layered didactic structure](image)

The nodes of the triangles are inclusive so that each student is a part of a larger community of students and hence has a relation to this learning community and also to the society. Thereby this three-layered structure includes also the aspect of community that was introduced in Bergamin’s model [19] as one essential characteristic of the instructional process. Correspondingly, the teacher as a staff member has a relation to the university (as an organisation) and to society, too. A teaching organisation (such as a university) can be seen as a part of an executive system that fulfils the society’s educational goals. Therefore, the organisation stands in relation to the society. In the same manner, the content of a course or a larger entity of studies is in relation, for example, to the goals of a degree program and finally to the general goals of education.

### 3.2 Three-layered structure as a base for categorisation of research

The following eight main categories are derived from the three-layered didactic structure (Figure 4). The first three categories are derived from the three main elements of the instructional process, visually expressed as the three nodes of the triangle. The first category addresses the goals and the content of the instructional process. The second and the third category address the actors of the process. The categories four to eight are derived from the relations between the nodes or the node and another relation (the arrows in Figure 4). Note that each category contains three levels (the individual or course level, the organisation level, and the society level). The resulting eight categories are:

1. **Goals and content**: The focus of research is on the goals and/or content of the instructional process. This category includes research that analyses, for example, the characteristics of the goals or content of a specific course or a larger entity of studies, such as a degree programme/curriculum. Another example of research that would fall into this category is research that analyses the relationship between the goals and the content in one level (course, degree, general goals of education) or between different levels. Study by [22] is an example of a paper in Category 1. The study evaluates characteristics of learning environments (algorithm visualizations) and how they can support the instructional process. Since the study does not relate to some particular course but has a wider focus, this paper is placed on Organisation level.
2. **Student(s)/community of students/citizens:** The focus of research is on one student or the students of one course or the students of some degree program. In the widest context, this category would also discuss citizens of a society. In this context, citizens are discussed as actors and objects of the general education system, which the society provides. The category includes research that addresses the characteristics, knowledge, or prior learned skills of students, community of students, or citizens. The study by [23] is a good example of research that has a clear focus on students’ specific ability (abstraction ability) in a context of success in the curriculum level. Thus this paper would be categorised as belonging to Category 2, level Organisation.

3. **Teacher(s)/organisation/society:** The focus of research is on one teacher or the teachers of a course, teachers as a part of an organisation, or on a teaching organisation itself. Furthermore, teaching organisations as a whole arrange the education the society has decided to provide to its citizens. The different foci within this category include aspects, such as the interactions between actors on one level (e.g. between teachers) or between levels (e.g. the ways a teacher can affect organisation level decisions). For instance, [24] focuses on the computer science teachers and the ways in which they change their teaching practice. Even though the main focus of the paper is on teachers’ pedagogical actions (Category 7.3), the paper could also be interpreted as focusing on characteristics of the teachers (Category 3).

4. **Student(s)/community of students/citizen – teacher(s)/organisation/society:** The focus of research is on relationships between actors, for example, the relation between a community of students and the teaching organisation (Arrow B in Figure 2 represents the course level relation between these actors). The relationship does not contain the pedagogical aspect (e.g. teaching, which is discussed later) but the way the actors perceive each other. For instance, Crenshaw et al. [25] analysed the CS students’ conceptions of the members of the department.

5. **Student(s)/community of students/citizens – goals/content:** The focus of the research is on a student’s or a community of students’ relation to the goals and/or content of the instructional process (Arrow C in Figure 2 represents the course-level relation). This category can further be split into three subcategories:

   5.1. **The understanding of and attitude about goals and content** that the student(s)/community of students/citizens have. The study by [26] examined students’ understanding of object-oriented program execution and thus it belongs to Category 5.1. Since the data were collected from a CS1 course the paper is placed on a course level.

   5.2. **The actions (e.g. studying)** the student(s)/community of students/citizens do to achieve the goals or learn the content. Naturally, there are several different types of actions a student can choose from to achieve goals and thus the content of this subcategory is diverse. For example, one focus of the study by [27] is on what learning strategies end-user programmers use when learning programming related knowledge. This study does not discuss course level or curriculum level issues but focuses on learners who are outside the teaching organization. Thus, the study is placed on society level.

   5.3. **The results of the action** (subcategory 5.2 above) of the student(s)/community of students/citizens, for instance, a course’s passing rate, a department’s graduate rates and the acquired skills and knowledge. The study by [28] focuses on the skills students have learned and is therefore a good example of a study falling in this category.

6. **Teacher(s)/organisation/society – goals/content:** The focus is on the teachers’ or organisation’s relation to the goals and/or content of the instructional process (Arrow A in Figure 2 represents the course-level relation). This relationship may be externalised in several ways. On the course level it could mean the way in which the teachers understand the goals and the content of the course or the attitudes the teachers have towards the goals and the content. On the degree level, the relationship could manifest as the degree requirements that the teaching organisation sets for Bachelor’s or Master’s degrees. The study by [29] has several foci and one of them relates to CS teachers’ opinions about what should be taught in introductory programming courses. This study is placed on the course level.

7. **Teacher(s)/organisation/society – studying:** The focus of the research is on the teacher’s or the organisation’s/society’s relation to the way the students understand the goals/content of the studying, and to how the students study (cf. subcategories 5.1, 5.2, 5.3) (Arrow D in Figure 2 represents the course-level relation). This category also includes the pedagogical actions that the teacher/organisation/society does to further students’ studying processes. The category can be divided into three subcategories:

   7.1. **The conceptions of teacher(s)/organisation/society of students’ understanding/attitude on goals/content.** This category could include studies on teachers’ conceptions of how useful students find the course or how they understand some particular concepts. For instance, the study by [30] emphasises the teachers’ awareness of students’ conceptual understanding and can thus be placed in this category.

   7.2. **The conceptions of teacher(s)/organisation/society of students’ actions towards achieving goals (e.g., studying).** Studies of teachers’ conceptions of which course topics are difficult for students to learn belong to this category. For instance, [29] discusses what students find most difficult in a CS1 course according to CS teachers and therefore this study belongs to category 7.2, the course level.

   7.3. **Pedagogical activities of teacher(s)/organisation/society.** The range of studies that belong to this category is wide. On one hand, studies focusing on designing a course or a course design belong to this category (e.g. [31]). On the other hand, the studies on the ways in which teachers change their teaching practice [24] belong to this category, too.

8. **Student(s)/community of students/citizens – teacher(s)/organisation/society’s pedagogical means to enhance learning:** The focus of the research is on the
students’/community of students’/citizens’ relation to the teachers’, teaching organisations’ or society’s actions to enhance studying and learning (dashed line arrow in Figure 2 represents the course-level relation). One of the foci of the study by [32] relates to how students experienced a challenging pedagogical intervention, which challenged them to become in-depth researcher-learners. This study is placed on a course level.

As some of the examples given in the previous paragraphs convey, some research papers may have several foci. However, usually it is possible to define which is the main focus of the paper and which are side foci that are given less emphasis in the paper.

4. TWO EXAMPLES HOW TO USE THE ABOVE CATEGORISATION SYSTEM

In this section we give two examples of how the didactic-focus-based categorisation system can be used. First, we categorise instructional-process-related research papers published in ICER conferences to show which new aspects this categorisation system is able to bring out. The second example shows how the system may be used to identify overlooked research topics on some specific research area.

4.1 Categorised ICER papers

The data pool consisted of all research papers published in ICER during the years 2005-2009. Altogether 72 papers were published of which we included 67 in our analysis. The five excluded papers1 did not discuss the instructional process but the state of the research area and therefore they were out of the scope of this categorisation system.

The categorisation process started by all authors of this paper reading and individually categorising all the papers published in 2008. After this first round we discussed the differences and refined the categorisation rules. One of the first clarifications we made concerned the papers’ main foci. It became soon obvious that many papers had several foci and that often one of them was emphasised more than the others. Therefore, we decided to make a distinction between paper’s main focus and less emphasised side foci. However, in few cases we agreed that that a paper had two or more equally weighted main foci.

After the first round of categorising all the papers published in 2008, the rest of the papers were categorised by at least two authors. If their categorisations differed from each other, the third author categorised the paper independently and the final decision to which category the paper belongs was made based by negotiating and majority vote. During this process we also discussed the reasoning behind our categorisation to clarify the rules of categorisation and to find an agreement. Our emphasis during this process was on finding an agreement on where is the paper’s main focus.

The results of the categorisation are summarised in two tables. Table 1 shows only the distribution of the main foci of the ICER papers. Table 2 presents the distribution of all didactic foci that we found in the ICER papers. Therefore, the first table highlights what

<table>
<thead>
<tr>
<th>Category</th>
<th>Course level</th>
<th>Organisation level</th>
<th>Society level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Goals and content</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>2 Student(s)/community of students/citizens</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>3 Teacher(s)/organisation/society</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4 Student(s)/community of students/citizen – teacher(s)/organisation/society</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5.1 The understanding of and attitude about goals and content</td>
<td>10</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>5.2 The actions of students</td>
<td>14</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5.3 The results of students’ action</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6 Teacher(s)/organisation/society – goals/content</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7.1 The conceptions of teacher(s)/organisation/society of students’ understanding/attitude on goals/content</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7.2 The conceptions of teacher(s)/organisation/society of students’ actions towards achieving goals</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>7.3 Pedagogical activities</td>
<td>12</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>8 Student(s)/community of students/citizens – teacher(s)/organisation/society’s pedagogical means to enhance learning</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The main focus of the research papers published in ICER workshops is clearly on students (shaded area in Table 1): students’ actions (Category 5.2 studying), students’ understanding on course topics and/or goals, and students’ features (Category 5.1, e.g., previous programming experience). There are also many papers that focus also on teachers’ pedagogical actions (Category 7.3, e.g., using some specific pedagogical approach in class).

Table 1 also clearly highlights the aspects of the instructional process that are overlooked. For instance, there are no studies that would have focused mainly on CS teachers (Category 3, e.g., the level of CS teachers’ pedagogical training and interest towards teaching, or CS teachers’ conceptions of how students understand the goals and the content of the course). There were also no studies on teachers’ conceptions of students’ understanding of the goals and content of the course (Category 7.1). We also found only two studies that focused on how CS teachers perceive the goals and the content of the course they teach (Category 6). How students perceive the pedagogical interventions (Category 8) has seldom been on the main focus of the research papers. Overall, Table 1 clearly brings forward the fact that the most of the studies focus on the course level issues. Organisation/curriculum or society level studies are more infrequent.

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4.2 Analysis on papers on specific topic

The second example highlights how the didactic-focus-based categorisation system can be used to find overlooked research topics on some specific research area. As an example, we categorise some papers aiming at predicting or explaining students’ success in a CS1 course (Table 3). For this example, we had to expand our data set outside ICER papers since otherwise the number of papers would have been too low to convey the benefits of using this categorisation system. We used the pool of 13 papers, which were all relevant we could find with reasonable effort in CER-related conference proceedings (ACE, ICER, SIGCSE, PPIG, ITiCSE), working group reports (ITiCSE), and journals (Computer Science Education, Comput. Small Coll.). The selection criterion was that the paper clearly aimed at studying factors, which predict or explain students’ success in a CS1 course. In addition, we delimited the pool of papers to the ones published within the last decade to capture the foci of the recently published papers. We note that this focuses the research on the course level.

Table 3 An example of the categorised studies on factors that predicted or explained students’ success in a CS1 course

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Didactic foci of the paper (all studies were done at the course level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>2 - - 5.3</td>
</tr>
<tr>
<td>II.</td>
<td>2 - - 5.3</td>
</tr>
<tr>
<td>III.</td>
<td>2 - - 5.3</td>
</tr>
<tr>
<td>IV.</td>
<td>2 - - 5.3</td>
</tr>
<tr>
<td>V.</td>
<td>2 - - 5.3</td>
</tr>
<tr>
<td>VI.</td>
<td>2 5.1 (self-efficacy) - 5.3</td>
</tr>
<tr>
<td>VII.</td>
<td>2 5.1 (perceptions of difficulty, work load) - 5.3</td>
</tr>
<tr>
<td>VIII.</td>
<td>2 5.1 (self-efficacy) - 5.3</td>
</tr>
<tr>
<td>IX.</td>
<td>2 5.1 (self-efficacy) 5.2 (game playing) 5.3</td>
</tr>
<tr>
<td>X.</td>
<td>2 5.1 (task value) 5.2 (self-reg. learning) 5.3</td>
</tr>
<tr>
<td>XI.</td>
<td>2 5.1 (comfort level) 5.2 (work style) 5.3</td>
</tr>
<tr>
<td>XII.</td>
<td>2 5.1 (attitudes to studying) 5.2 (deep and surface approach to learning) 5.3</td>
</tr>
<tr>
<td>XIII.</td>
<td>2 5.1 (comfort level) 5.2 (hours of work) 5.3</td>
</tr>
</tbody>
</table>

Note. References are listed in Appendix.

All studies included in this analysis focused on students’ success at the course level. All studies focused on the students’ characteristics (Category 2) and the results of the studying process (Category 5.3). Five studies focused on these two categories only. Three studies had an additional focus on the students’ conceptions of the course goals and content (Category 5.1). Finally, five studies focused also on the actions students undertook to achieve the goals (Category 5.2). A closer examination of the actions that were analysed reveals that many studies emphasised general studying preferences such as the deep and surface approaches to learning or aspects of self-regulated learning. The actual actions observed were limited to the number of working hours and game playing during the course. The focus of these studies was on the student and the studied factors were often quantitative by nature.

The summary of the findings indicates that there are overlooked aspects of the instructional process that would need closer investigation. Extending the focus, for instance, to students’ actual studying-related actions (e.g., lecture attendance and usage of learning material/environment) or teachers’ pedagogical actions would deepen the knowledge of the factors that affect students’ success and failure. Our study serves as an example how the categorisation system based on didactic focus may help researchers to analyse the research relating to some particular topic. As a result of this analysis, researchers may find relevant and previously overlooked research questions.
5. DISCUSSION AND CONCLUSION
In this paper we have introduced a categorisation system that is based on the didactic focus of educational research. The introduced novel categorisation system differs from the previously published systems by having a theoretical origin. The benefit of taking the didactic triangle as a starting point for development of the categorisation system is that this system helps researchers to discern the various aspects of the instructional process and to analyse which aspects are less studied.

We have demonstrated the usefulness of the new categorisation system by analysing all papers published in ICER 2005-2009, as well as a sample of papers in a narrow scope. The previous analysis reveals several interesting observations, which the CER community should consider. First, most research has been carried out on a course level only. Though we agree that there is a strong need to solve problems on course level, we maintain that giving too much attention to this level has its dangers, as well. Key issues in students’ success and problems are often more complicated and have connections to higher levels, such as scheduling of studies, curriculum level goals, teachers’ pedagogical training and support, and their resources. Current research, at least in ICER, seems to give too little attention to this complexity. Possibly, researchers take institutional rules and practices, as well curriculum level issues as something which either is too institution specific to be of general interest, or something which we cannot change. Therefore, they may be more motivated to study course level actions.

Second, it is noteworthy that very little attention in research has been given to contents and goals, i.e., what students are studying, while the vast majority of research investigates how studying and learning takes place. Considering the fact that all pedagogical planning should begin from a critical analysis of the goals, and proceed then to planning teaching and learning methods, this is somewhat surprising. Does research have so little to say, what would be appropriate goals, for example, for an introductory programming course?

Third, teachers are central actors in the instructional process. Still rather few research papers address their conceptions, attitudes, and skills. Moreover, we did not find any research that would have addressed the relation between teachers and students, though it does not seem evident that this relation would be irrelevant and uninteresting from the research point of view. These observations are just examples about the possibilities that this novel type of literature analysis can identify for the CER community. We ourselves have learned that creating a categorisation system that would be unambiguous is not a simple task. Achieving a common understanding between researchers who categorise research papers requires many discussions and clarifications of the rules. For instance, it is important to agree that teaching does not mean teacher-student interaction face-to-face only, but includes also virtual interactions and all phases of the teaching-learning process from setting of goals and planning activities to evaluation and giving feedback. It is obvious that the classifiers have to be experienced researchers and reasonably well trained in this specific task of categorisation. However, even when these measures are taken, there may still remain some differences in how people perceive research papers. Thus, we recognise that some of our categorisation in this paper may be criticised. However, we emphasise that the whole goal of this kind of work is building the big picture of the field. From this point of view, a few possible ambiguous classifications do not clutter the results.

The presented examples of applying the new categorisation demonstrate how it can help researchers to analyse what has been studied so far, and more importantly, which areas or topics are overlooked. We have identified several research areas for future research. However, we recognize that the analysed data pool, the ICER papers, is far too small to provide an overview of the whole CER field. We need to extend this analysis to cover other important journals and conferences in the field.

6. REFERENCES

APPENDIX
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