Building an Orchestrable Tool to Help Teachers Design and Conduct Collaborative ER Diagramming Activities

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Abstract. The design of educational tools tends to focus on students' learning, giving less importance to the role of the teacher. The design of these tools often does not allow teachers to adapt the technology according to their learning designs. This means that the designer may impose pedagogical approaches to teachers. This is a problem as it does not offer teachers the flexibility they need to make an effective use of the technology for their courses. A promising approach to address this problem is the metaphor of *orchestrable technology*, which poses that teachers should be allowed to tune the tool so it can be adapted to their activity designs. This paper describes our work in progress in the context of small group Entity-Relationship (ER) diagramming. We present Hecoder, a learning tool that allows the teacher to design tasks, organise groups, monitor student's work, provide feedback and assess the final outcomes. The paper examines the design implications of our system; presents preliminary results of using Hecoder in an authentic classroom; and provides insights about our future strands of research using Hecoder and other collaboration tools.

Keywords: ER diagramming, visualisations, CSCL, orchestration.

1 Introduction and Approach

The advances in learning technologies have led teachers to consider emerging learning contexts, tools and mechanisms to design and conduct their courses. Particularly, in higher education, teachers often have an important role because they have to take design decisions around the learning activity [3]. This includes the definition of the physical setting (remote setting or the classroom), the social rules (e.g. the definition of roles or group formation mechanisms), the learning tasks and the tools to be used [4]. However, the design of educational tools has mostly focused on the students' activity without giving much importance to the role that the teacher can play as designer and orchestrator of such activities [6]. The design of the learning tools often does not allow teachers to configure or adapt some aspects of the tool according to their learning designs. This means that the designer may be imposing pre-defined pedagogical approaches to teachers. This is a problem, as it does not offer teachers the flexibility they need to make an effective use of the technology for their courses. Moreover, the design of more 'intelligent' learning systems tends to amplify this issue [8]. Much more attention has been paid on providing automatic support to students directly without or with little teacher's intervention [5].

A promising approach to bridge the design of support technology and the teacher's pedagogical intentions is the metaphor of *orchestrable technology*. This perspective poses that for a learning tool to be orchestrable it should allow the teacher to tune or configure at least some aspects of the technology so it can be adapted to the learning and pedagogical goals of a learning activity [7]. Our work builds on this principle to design tools that can provide support to teachers in the classroom, or for remote settings, according to their particular pedagogical goals. This paper presents our work in progress in the context of orchestration of small group Entity-Relationship (ER) diagramming. We present Hecoder, a learning tool that allows the teacher to design tasks, organise groups, monitor student's work in real-time, provide feedback and assess the final outcomes. The rest of the paper examines the design implications of Hecoder; presents preliminary observations from using our system in an authentic university classroom deployment; and describes our future strands of research using Hecoder.

2 Hecoder: Helping Teachers Design and Conduct ER Diagramming Collaborative Tasks

Entity-Relationship (ER) diagramming is a common task in database design. Understanding the concepts behind ER diagramming are very important, not only in software engineering education, but also in the workplace [2]. There are many available tools that can be used to perform this task. These also include educational tools that offer different functionalities to coordinate learning activities. In this section, we present three representative ER diagramming tools to illustrate the aim of our approach to support teacher's orchestration. These include the web-based tools Cacoo[1] and Gliffy[2]. The third tool is Creately[3], which provides both a web and desktop interfaces.

Table 1 presents the comparison of a set of key features that will help us illustrate how our work aims to go beyond previous work towards building an orchestrable tool. First, most of currently available online collaborative tools afford the creation of groups that can work in real-time on the same learning artefact. As shown in Table 1- rows 1 and 2, these are basic functionalities that all previous tools have; however, this does not necessarily make it easy for a teacher to create small teams for their classes (as it may be done with regular Learning Management Systems). The first design principle for Hecoder to facilitate the orchestration of activities is that *teachers can configure teams within groups of students*, so the same teacher can have multiple groups and form small-groups within them (Table 1- Row 3). This function makes it

[1] https://www.cacoo.com/

[2] http://www.gliffy.com/

[3] http://www.creately.com/

feasibile to use the tool to conduct classroom activities, being the main driver that motivated the development of Hecoder. The above additionally allows students to *collaborate through a private chat* that is not shared with the whole class, creating the conditions for small group collaboration (Table 1- rows 4 and 5).

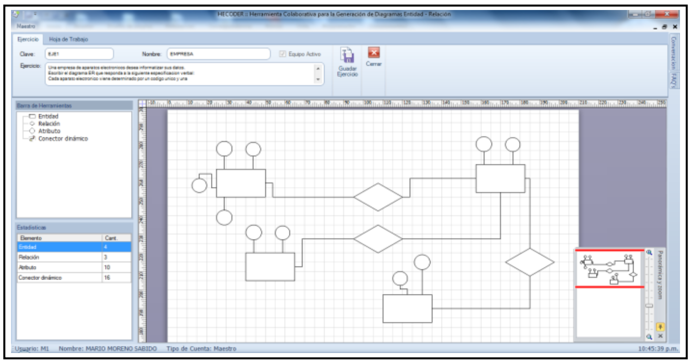
Additionally, current ER diagramming tools provide *authoring functions* so that teachers can create exercises for students (Table 1- row 7). Our approach aims to go beyond this functionality by allowing the teacher to pre-load a teacher's solution. Similarly to Cimolino et al.'s approach [1], this ideal solution can be used by the system to *automatically compare student's solutions* and provide feedback to both the teacher and the students (Table 1- Row 8). Hecoder also allows the teacher to control the assignment of different tasks to teams rather than simply creating files with starting diagrams (Table 1- Row 9). Hecoder also provides the option to be installed in a local network, reducing the possible problems of internet access that many schools may face (Table 1- Row 10 and 11).

	System Features	**G**	**CR**	**CA**	**HE**
1.	Creating groups with system users	✓	✓	✓	✓
2.	Collaborative interaction with the diagrams in real-time	✓	✓	✓	✓
3.	Creating teams (sub-groups) within groups	✗	✗	✗	✓
4.	Providing interaction via chat	✓	✓	✓	✓
5.	Providing private small-group interaction (chat)	✗	✗	✗	✓
6.	Providing class level frequent answers/questions board FAQ's	✓	✓	✓	✓
7.	Allowing teachers to create tasks	✓	✓	✓	✓
8.	Comparing automatically student's artefacts with a teacher's ideal solution	✗	✗	✗	✓
9.	Allowing the assignment of tasks to teams	✗	✗	✗	✓
10.	Providing student's access though internet	✓	✓	✓	✓
11.	Providing student's access in a local network (without internet)	✗	✗	✗	✓

Tabla 1. Key features to be offered to teachers compared with present ER diagramming learning tools (G= Gliffy CR= Creately CA= Cacoo HE= Hecoder).

Overall, Hecoder is being designed taking into account the authentic use of the tool by a classroom teacher. Instead of providing a wide range of features, we aim to understand how the technology will be used by the teacher in an authentic scenario. Our system allows the teacher to manage the tasks, form teams, monitoring student's tasks in real-time, provide feedback directly to student's artefacts during the collaborative process, and interact with students through chat or through a FAQ section.

Figure 1 presents the interface that the teacher can use to design a task. The task includes the instruction for the activity (see Figure 1, top) and a teacher's solution in the form of an *ideal* ER diagram. Figure 2 shows the student's interface. Each student can open the task that the teacher assigned to their group. Student's can create the diagram that solves the problem collaboratively. They can either use the chat to communicate online (see Figure 2, top right) or discuss face-to-face if the tool is being used in the classroom. Students can also have quick access to a FAQ section (see Figure 2, bottom right) that can be used to communicate with students of other groups for questions that may rise at a classroom level.



Clave: EJE1

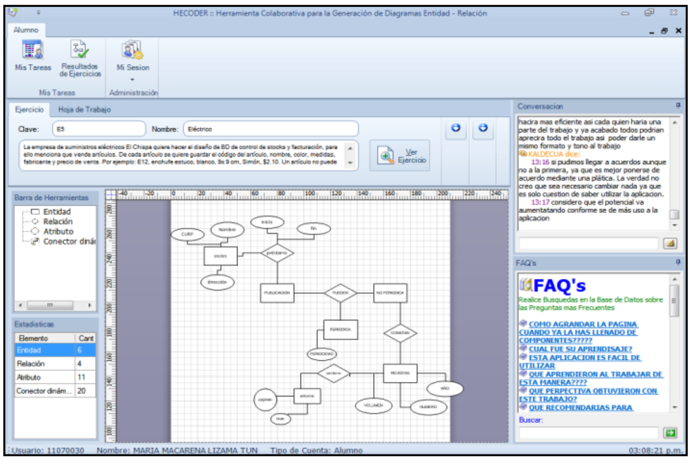
Nombre: EMPRESA

Ejercicio: Una empresa de aparatos electronicos desea informatizar sus datos.
Escribir el diagrama ER que responda a la siguiente especificacion verbal:
Cada aparato electronico viene determinado por un codigo unico y una

Elemento	Cant.
Entidad	4
Relación	3
Atributo	10
Conector dinámico	16

Usuario: M1 Nombre: MARIO MORENO SABIDO Tipo de Cuenta: Maestro 10:45:39 p.m.

Fig 1. Teacher's authoring tool: creating a ER task.



Clave: E5

Nombre: Eléctrico

La empresa de suministros eléctricos El Chispa quiere hacer el diseño de BD de control de stocks y facturación, para ello menciona que vende artículos. De cada artículo se quiere guardar el código del artículo, nombre, color, medidas, fabricante y precio de venta. Por ejemplo: E12, enchufe estuco, blanco, 9x 9 cm, Simón, $2.10. Un artículo no puede

Elemento	Cant
Entidad	6
Relación	4
Atributo	11
Conector dinám...	20

hacira mas eficiente asi cada quien haria una parte del trabajo y ya acabado todos podrian aprecira todo el trabajo asi poder darle un mismo formato y tono al trabajo

KALDECUA dice:

13:16 si pudimos llegar a acuerdos aunque no a la primera, ya que es mejor ponerse de acuerdo mediante una plática. La verdad no creo que sea necesario cambiar nada ya que es solo cuestion de saber utilizar la aplicacion.

13:17 considero que el potencial va aumentatando conforme se de más uso a la aplicacion

FAQ's

Realice Busquedas en la Base de Datos sobre las Preguntas mas Frecuentes

- COMO AGRANDAR LA PAGINA CUANDO YA LA HAS LLENADO DE COMPONENTES?????
- CUAL FUE SU APRENDISAJE?
- ESTA APLICACION ES FACIL DE UTILIZAR
- QUE APRENDIERON AL TRABAJAR DE ESTA MANERA????
- QUE PERPECTIVA OBTUVIERON CON ESTE TRABAJO?
- QUE RECOMENDARIAS PARA

Usuario: 11070030 Nombre: MARIA MACARENA LIZAMA TUN Tipo de Cuenta: Alumno 03:08:21 p.m.

Fig 2. Student's perspective: solving a task.

3 In-the-wild Preliminary Studies

A field study was conducted to explore how the functionalities of our tool can be used in a real classroom. The study was conducted during an undergraduate course on *Database Design* at the Superior Technology Institute of Motul. The learning activities linked with ER diagramming were conducted for 2 weeks with two groups of 18 (A) and 22 (B) students. The same teacher conducted the activity in both groups. A total of five 1-hour sessions were dedicated to the discussion of the theoretical elements to understand how to build ER diagrams and to create practice diagrams based on cases posed by the teacher. Hecoder was used in one of the sessions in each group. Students were organised in groups of 4 or 5 members. Observations were carried out during the sessions to understand how the features of Hecoder should be enhanced to facilitate classroom orchestration. Figure 3 shows the computer lab environment where the classes were held. This learning setting poses numerous challenges for a teacher to monitor collaborative work. It is not evident how the group formation matches the physical disposition of students and the teacher cannot easily move around to monitor each student's individual work.

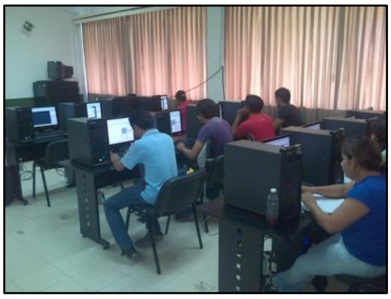


Fig 3. Hecoder system being used to orchestrate an ER diagramming task in the classroom.

The main observations of this field study that will drive future development of Hencore include:

i) Students need a personal space to work on their own. During the field studies, many students decided to start the tasks by working on their own, building a personal diagram on a piece of paper. Then, they found it difficult to incorporate their personal perspectives into the group diagram (using Hecoder), but at least they had time to think about a possible solution and alternatives before sharing them with the rest of the group. A further version of Hecoder should allow the teacher to design the way in which the activity will be deployed, for example, including stages for individual work, small group diagramming, and whole class sharing.

ii) In the classroom, students found difficult to communicate via chat. So most of them had to organise and discuss face-to-face. Even though this behaviour is out of the boundaries of the system, the learning setting still affects the mechanisms for students to collaborate. For example, the physical disposition of the space, as shown in Figure 3, affected not only the way students interacted with each other but also how the teacher coordinated and monitored what each group was doing. This suggests that we need to take into account a higher level perspective to consider not only the tool usage but also the space and the way in which students establish their social rules [4].

iii) Teacher's awareness can be enhanced with monitoring tools. Given the challenges posed by the setting for a teacher to see what student's are doing, a teacher's dashboard can help them quickly see if groups have included the key elements of the diagram at some point and compare the overall progress of the class. Additionally, similar information can be shown to the teacher after the class to reflect about the design and possibly adjust the design for future learning activities. For example, Table 2 shows the results of comparing student's perspective with the teacher's for two diagrams build in an 1-hour session using Hecoder in the two different classes (groups A and B). The teacher could see that there was not much difference between groups, but between tasks. Overall, student's included around 70% of the key elements defined in the teacher's diagram for the first task, while they only included 30% of them in the second task. This may help the teacher identify the issues with the class design and re-design in further classes (for example, reducing the complexity of the tasks to fit two of them into a single session or just focusing on a single task per session). The indicators can also be used by the teacher to assess in real-time student's progress towards the ideal solution.

	Task 1			**Task 2**		
	Entities	Relationships	Attributes	Entities	Relationships	Attributes
A	75%	59%	78%	20%	29%	14%
B	81%	75%	64%	41%	38%	20%
Total	78%	67%	71%	31%	33%	17%

Table 2. Proportion of entities, relationships and attributes included by groups compared with the teacher's solutions.

4 Conclusions and Future Work

As a result of our initial exploration we can envisage the future functions that Hecoder should provide to enhance classroom orchestration and to make the tool an orchestrable technology. Although Hecoder allows the teacher to compare each team's diagram with an ideal diagram, this needs to be provided to the teacher in real time so s/he can provide immediate feedback as required. This would be helpful also for a remote setting. Hecoder should allow the teacher easily see the progress of all groups at once. The automated analysis of student's solutions may help the teacher quickly identify which teams may need closer attention or a revision of the whole diagram which requires more time. Future work should also consider management functions so the teacher can have more control over the multiple instances of Hecoder for classroom sessions.

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