Student Engagement with Resources as Observable Signifiers of Success in Practice Based Learning

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Abstract. Practice-based learning activities with a focus on Science, Technology, Art, Math and Engineering (STEAM) are providing new opportunities for teaching these subjects. However, we lack widely accepted ways of assessing and monitoring these practices to inform educators and learners, and enable the provision of effective support. Here, we report the results from a study with 15 teenage students taking part in a 2-day Hack. We present the results from analysis of video data recording collaborative working between groups of students. The analysis of the video data is completed using the ERICAP analytical framework (Luckin *et al.*, 2017) based on ecology of resources and interactive, constructive, active and passive concepts. The results illustrate the differences between students' engagement with resources which might be utilized as signifiers of student success in similar learning environments. **Keywords:** STEAM Education, Ecology of Resources, Collaboration.

Introduction

This paper reports the use of Learning Sciences constructs (Ecology of Resources and ICAP Framework) to support the potential analysis of collaborative problem-solving (CPS) in practice based learning (Cukurova *et al.*, 2016). We report an empirical study of teenagers who are using physical computing and design materials in to learn about STEAM subjects. Our goal in this study is to explore the ways students interact with the resources available to them to support their activities. The key question that drives the research we report here is: *How can we assess the effectiveness of a particular instance of students' group work to inform the future design of technology scaffolding for STEAM activities?*

Methodology

The participatory design-based study was conducted with 15 secondary school students aged 14-15 years. A range of data sources were collected during the hack event. In this paper, we only focus on the video data and in particular upon the interactions of individual learners within their CPS group. Two researchers coded the video of each group according to the ERICAP framework to identify the resources available and in use by the learners (see Luckin *et al.*, 2017 for the details of the framework). Resource use was recorded at 30 second intervals. To verify the validity of the video analysis we sought independent verification. An expert from another university who had not previously been involved in our study data collection or analysis provided this verification. We asked her to watch our video data of the 3 groups who took part in the Hack Event as illustrated in Tables 2 and 3 there was evidence that the group ERICAP framework overlaps with expert evaluation of students' CPS.

Results

Figure 1 illustrates a comparison between two learners from the coin sorter project group. It illustrates the chronology of the resources used by each learner over an hour period in the middle of the first day of the Hack event. The white areas indicate that a resource is not present, the striped areas indicate that a resource is present, but not in use, and the black areas indicate that a resource is being actively used by the learner in focus.

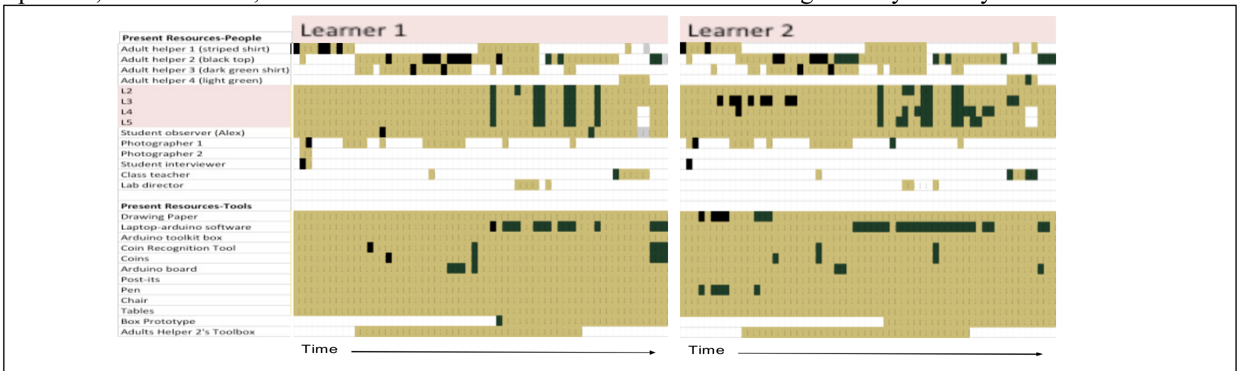

Fig. 1 Comparison of resource use by individual students in a group.

Looking more closely at this data, in particular at the black areas in Figure 1, we can see the resources that were actively in use by each learner at the same time, indicating a relationship between these resources with respect to that learner. These periods of active engagement are markedly different between L1 and L2 who were working as part of the same group: L1 starts their active engagement with multiple resources 15 minutes into the session and engages actively with multiple resources for a total of 30% of the session. By contrast, L2 started actively interacting with multiple resources, much earlier in the fifth minute, and L2 interacted in this way for 50% of the session. In order to probe learners' activity with resources in greater depth, we focus our attention on the interactions between learners and resources. The ERICAP analysis for L1 and L2 reveals that there is only 1 minute, which is less than 2% of the hour-long session in which L1 interacts at levels 4 or 5 (interactive and constructive engagement), both socially with other learners and physically with the tools required for the problem-solving activity. This suggests that L1 engages in little CPS activity in this particular hour-long session of the Hack Event. By contrast, L2, interacts at levels 4 or 5 both socially with other learners, and physically with the tools required for the problem-solving activity for 23 minutes (38%) of the session.

Table 1. The % of the session that each learner spent interacting with Constructive or Interactive engagement.

	Robot Group	Coin Group	Glove Group
L1	62.5	65.83	95
L2	72.5	72.5	96.67
L3	45	56.67	91.67
L4	31.67	72.5	96.67
L5	43.33	70.83	88.33

Table 2 shows the variance across all learners in the observable evidence of CPS, which ranges from 31.67% of the session for L4 in the Robot group to 96.67% for L2 in the Glove group. To verify the validity of the ERICAP video analysis we sought independent verification. An expert from another university who had not previously been involved in our study data collection or analysis provided this verification. We asked her to watch our video data of the 3 groups who took part in the Hack Event as illustrated in Tables 2 and 3 and identify the times during the learners' interactions when in her judgement there was evidence that the group was engaged in CPS.

Group Name	%
Robot Group	51
Coin Group	67.67
Glove Group	93.67

Table 2. Average % of the session when learners were Constructively or Interactively engaged with a resource.

Group Name	%
Robot Group	18
Coin Group	47
Glove Group	95

Table 3. The % of the session that an independent expert rated as consistent with CPS.

The ERICAP framework analysis ranks the groups in the same order as the independent expert. However, the data concerning the Robot group is at particular variance between the ERICAP analysis and the human expert. The possible explanation for this may lie in the fact the coders using the framework did not code the students' interactions with this ready-made robot as interactions with the prototype, the independent expert did accept students' interactions with this ready-made robot as interactions with a prototype. It is however important to recognize the significance of such a disagreement, because technology interventions for such evaluations of CPS would need to be able to cope with such differences.

Conclusions

The ERICAP framework has been informed by theories from the Learning Sciences and used for the analysis of data collected from practice-based learning activities involving groups of teenage learners solving problems collaboratively as parts of a Hack event. Our analysis enabled us to identify that whilst all groups of learners were provided with a similar set of resources, the resources that they chose to use in their collaborative problem-solving activity were quite different. There is often a motivation to provide similar types of resources to all learners taking part in these sorts of collaborative activities. Our findings suggest that these resources are not accessed in a consistent manner. We illustrated that there were particularly substantial differences between learners in the extent to which their engagement with resources can be categorized as interactive or constructive.

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