Abstract. It is argued that conflating two graphical forms (diagrams and pictures) is poor educational practice, which might be implicated in the development of the graph-as-picture misconception. We describe an interactive educational diagram system that facilitates diagram comprehension and exploits new paradigms of teaching and research methodology.

1. Aims

:: Developing methods for assessing primary school students (aged 8 to 11 years old) in terms of whether they possess the misconception and characterize its degree.
:: Remediate or prevent the development of the graph-as-picture misconception and providing a carefully designed interactive graphical learning environment.

2. What is the Graph-as-Picture Misconception?

It is one of numerous difficulties faced when a person attempting to comprehend an abstract representation (line graph) interprets it in terms of its pictorial resemblance.

3. Evidence of Diagrams Use by Young Children

:: In the UK National Curriculum there are examples where primary school students are first introduced to diagrams via examples that are mixtures of abstract representations and pictures [2].

:: It seems young children’s abilities might be underestimated since, for example, students between 7 and 11 years old have shown to understand line graphs [3].
:: Several kinds of graph-as-picture misconceptions probably exist - student’s responses [4] show that graphs are sometimes interpreted as pictures and as maps. Hence, a more accurate term might be graph-as-another-representation misconception.

4. Method

Improving Janvier’s [5] paper-and-pencil tasks, we developed an interactive, dynalinked diagram learning environment, embodying the child’s actions by providing a large interactive touch screen as display and interface.

We designed the learning system to also function as a technology enhanced resource tool and we triangulated different data sources (data logging, video recording, and dynamic video screen capture using Camtasia Studio 6).

(a) Assessment

:: We prefer information-processing approaches to assessment rather than traditional psychometric methods.
:: We used a semantic differential judgment task to get an insight into the mental organization of student’s graphical knowledge.
:: In order to elucidate the range of graph-as-X misconceptions, the cards used display a wide range of representational forms (tables, bar graphs, line graphs, networks and hierarchies, and set diagrams).
:: We encouraged students to think aloud during the session.

(b) Identifying

:: A modified version of the graph questionnaire in [6] was used to identify the misconception.
:: Multiple-choice questions require the student to: to read both axes, perform operations, and read-off question answers.
:: The read-off (interpretation) question contains items that make reference to the graph as a picture of the situation, e.g. “He walked the hill and then went down the other side”

(c) Overcoming

:: Based on the original paper-and-pencil task of [5] an interactive touchscreen-based “Racing Car Activity” was developed. Students move an image of a car around a track and the velocity graph is plotted concurrently alongside.
:: In order to use the system as scaffolding to help students to connect an abstract representation to a concrete representation, several dynalinking [7] features were added. Dynalinking is bi-directional – car/track movement-to-graph, graph-to-car/track movement.
:: Concurrent verbal and retrospective debriefing protocols were also recorded - the experimenter discussed the car’s behaviour and the graph’s form with the student during post-task screen replays of the child’s “races”.

(e) Overcoming through an interactive dynalinked racing car activity. While the child moves with his/her finger the car along the track, the speed/distance graph is plotted concurrently.

5. Selected Results

:: Results from 3 participants (8, 9 and 11 years old) showed that graphical knowledge increases with age, as expected.
:: Young participants tended to mis-categorise representations such as the (very prevalent) tables [2] when the cell content was pictorial rather than alphanumeric.
:: Triangulating multiple data sources (screen recording, data logging and video recording) allowed to observe, participant’s conceptions, actions, strategies, and problems (e.g. problems for integrating two variables).
:: There were some methodological drawbacks were the protocols applied (concurrent-verbal and retrospective debriefing) were sometimes too short due to the speed which the activity was (originally) performed.

References