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# Argumentation in science education as an evolving concept: Following the object of activity

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ABSTRACT

The paper argues that the way we realise or define argumentation in a research project aiming at promoting the practice in primary science education should not be considered as something static and pre-given but may change during the various phases of the project, based on stakeholders' motives and needs. This claim is supported through the findings of a two-year empirical study that took place in Cyprus, which illustrate in detail the transformations that the definition and meaning of argumentation in primary science education went through. Activity theory is used as a theoretical, methodological and analytical framework. Specifically, the paper mainly draws on the notion of the object of the activity, used as a conceptual heuristic, and on the notions of the springboard and the microcosm from expansive learning theory, used as methodological and analytical tools, in order to trace the various definitions and meanings attributed to argumentation by stakeholders. Implications for research and the assessment of teachers are also presented.

## 1. Introduction and research aim

Argumentation in science education is considered to be a core practice that can empower students develop their reasoning skills, criteria for knowledge evaluation, attain scientific literacy and other subsidiary skills (e.g., Berland & Reiser, 2009; Erduran, Ozdem, & Park, 2015; Jiménez-Aleixandre & Erduran, 2008; Kelly, Druker, & Chen, 1998). Many researchers suggest that argumentation is a skill that can be developed (e.g., Kuhn, 1991; Mason, 1996), either by explicitly teaching argumentation (e.g., Osborne, Erduran, & Simon, 2004; Zohar & Nemet, 2002) or by creating the conditions through which students engage with argumentative discourse through appropriate activities (e.g., Duschl & Osborne, 2002; Kuhn, Kenyon, & Reiser, 2006; Martin & Hand, 2009).

Various definitions of argumentation exist in science education research. van Eemeren and Grootendorst define it as the "*verbal, social and rational activity aimed at convincing a reasonable critic of the acceptability of a standpoint by putting forward a constellation of propositions justifying or refuting the proposition expressed in the standpoint*" (van Eemeren & Grootendorst, 2004, p.1), emphasising thus argumentation as a social and rational activity. Kuhn and Udell (2003) suggest a similar definition, proposing that argumentation is "*the dialogic process in which two or more people engage in debate of opposite claims*" through which an evaluation and justification of claims to scientific knowledge takes place (p. 1245). Moreover, according to Naylor, Keogh, and Downing (2007), argumentation is regarded as the process of evaluating and justifying claims. Osborne et al. (2004) propose that argumentation may be seen "*as a*

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*referent to the process of arguing*" (p. 998), while Jiménez-Aleixandre, Agraso and Eirexas (2004, p. 2) understand argumentation as "*the capacity of relating data and evidence to theoretical claims, the capacity of choosing among several alternatives using reasoned criteria*". Furthermore, on a more structural account of the argument, used by various researchers in their projects (e.g., Clark, Sampson, Weinberger, & Erkens, 2007; Erduran, Simon, & Osborne, 2004; Kelly & Takao, 2002), Toulmin (2003) suggests that an argument is a pattern of five constituent components; the claim, the data, the warrant, the backing and the rebuttal. A claim is regarded as the initial assertion in which we commit ourselves, data as the facts that seem to support this initial assertion, and the warrant as the supplementary and explanatory statement that may help us validate and authorise the step we take to present certain data as the basis of a certain claim. As the warrant is hypothetical, we may also present a backing which is an assurance to establish the authority of the warrant. Finally, we may also put forward rebuttals to express any conditions of exceptions which reduce the warrant's strength and authority.

The main aim of our paper though, is to illustrate that, regardless of the initial definition or meaning given to argumentation at the beginning of a research project, what argumentation means for stakeholders may change during the various phases of the project, acquiring different identities and definitions. Argumentation's definition and meaning that is, seems as an evolving concept and as a trajectory rather than a static, pre-defined and pre-given entity in science education practice. Put in the form of a research question, our research tries to respond to the following question:

- how is the initial definition of argumentation in primary science education being re-adapted and re-formulated by stakeholders (e.g., teachers, the science inspector) during the various phases of a research project, based on their own needs and motives?

Our research project managed to do this by following "argumentation" as the object of the activity of argumentation instruction in primary science education and by tracing and portraying its evolution and the various transformations that it went through, during a two-year research process. In order to achieve this, activity theory (e.g., Engeström, 1987; Leont'ev, 1978; Vygotsky, 1978) was used as a theoretical, methodological and analytical framework. Specifically, the paper mainly draws on the notion of the object of the activity used as a conceptual and methodological heuristic and on the notions of the springboard and the microcosm from expansive learning theory, used as methodological and analytical tools.

The paper begins with a brief presentation of the concept of the object-driven activity in respect to argumentation and continues with an overview of the concept of the object, introduced through the work of Marx (1973), who laid, amongst others, the philosophical foundation of activity theory, Leont'ev (1978, 1981) and Engeström (1987) (Section 2). A following section (Section 3) presents the methodology of the research, presenting a rationale for following the object of the activity as a methodological and analytical tool and the specific research and analytical processes of the study. The Findings section (Section 4) reports on the various transformations that argumentation as the object of activity seemed to go through during the two years the research was running. The importance of the findings and the practical implications deriving from them are being discussed in the Discussion section (Section 5).

## 2. The object-driven activity

### *2.1. Argumentation as an object-driven systemic activity*

According to activity theory, human praxis is realised in the form of activities, as individual actions are insufficient to explain human behaviour and may appear meaningless outside the collective activities in which they occur (Leont'ev, 1978, 1981). The important aspect that should be bear in mind though, as Leont'ev (1978) emphasised, is that behind every activity there is a need that the activity aims to satisfy. Activities comprise of actions which are directed towards a specific goal, even though they are still stimulated by the activity's motive (Leont'ev, 1978, 1981). Actions comprise of operations which relate to the conditions that enable their materialisation and may be considered as automatized or routinised actions. Engeström (1987) expanded this initial approach of the concept of the activity by realising activities as historically accumulated, multi-voiced, object-driven systemic wholes that can be portrayed by using the activity system model (Fig. 1).

In a paper that was published recently (Lazarou, Sutherland, & Erduran, 2016), we have portrayed that the practice of argumentation instruction may exist not only as an action but also as a discrete systemic activity within the broader activity of science education, following the definition of the activity as it was given by Engeström (1987). "Argumentation", as the main motive of this activity system, was considered as being the object of the activity and was defined by participants as the skill that students should

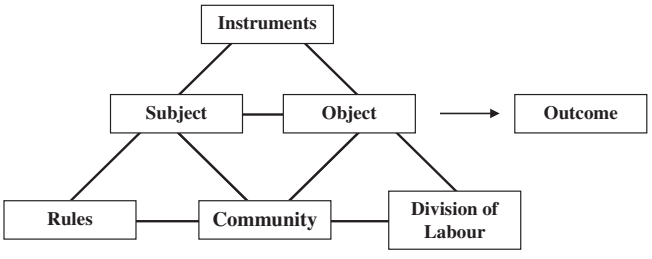


**Fig. 1.** The expanded activity system model (Engeström, 1987).