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Pupils' Design Decisions in Design and Technology Education

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Abstract

This paper presents some initial results of a pilot study carried out as part of a PhD degree for Loughborough University. The aim of the study is to improve our understanding of how pupils from Cyprus take their decisions while working with design and technology activities. An action research methodology was developed in order to understand how existing practice influences pupils design decisions. Pupils' sources of information and their ability to set appropriate criteria were also investigated through this study. Data were collected from observations (N=59), semi- structured interviews with pupils (N=15) and through pre-tests and post-tests (N=59) with decision-making tasks. Pupils' responses were categorised according to phenomenology and a coding system was developed based on pupils' responses. The initial results of the study show that the majority of pupils rarely search for information outside the class before taking their design decisions. The main source of information for Cypriot pupils is their teacher and this is more obvious at younger ages (age 11-12) than later on (age 14-15). A difficulty that pupils face during decision-making is their inability to set appropriate evaluation criteria for their design decisions. Another weakness identified from the research is the lack of motivation that pupils might have during decision-making. The paper also indicates future research plans.

Key words

decision-making, sources of information, design decisions

Introduction

Despite the significance of decision-making as a vital activity in human behavior there is little research available that explains that phenomenon. The development of pupils' decision-making skills is an important objective that general education seeks to enhance. Developing pupils' decision-making capability would make a significant link between the work of pupils in design and technology classrooms and their everyday decisions outside school.

In the field of educational research, pupils' decision-making strategies have only recently gained significant attention. There are very few research studies that look at various aspects of decision-making in the area of design and technology education (Barlex, & Rutland, 2004; Davies, 2004; Barlex, 2007; Coles & Norman, 2005; Mettas, Thorsteinsson & Norman, 2007; Mettas & Constantinou, 2008). Some research outcomes coming from the area of cognitive development are directly related to the teaching and learning of pupils' decision-making skills.

The different strategies that pupils spontaneously use when they have to make a design decision will be the focus of the study, and associated learning difficulties will also be identified. The research will also attempt to explore whether the decision-making skills that are learnt through design and technology could be transferred to other issues like environmental, genetic engineering, personal purchasing etc. In addition the research aims to explore whether pupils' age influences their behaviour when engaged with decision-making in the area of design and technology education. Pupils between 11-14 years old participated in the study in order to examine possible age differences in their decision-making strategies.

Literature Review

Although many research studies have examined how adults make decisions (Byrnes, 1998; Payne, Bettman, and Johnson, 1993; Tversky, 1972; Klayman, 1985; Howse, Best and Stone, 2003; Busemeyer & Myung, 1992; Hogarth, Gibbs, McKenzie & Marquis, 1991), relatively little work has explored decision-making in young children and how decision-making skills develop (Davidson & Hudson, 1988). Recently, however, researchers have begun to investigate the development of pupils' decision-making (Davidson, 1991a, 1991b; Davidson & Hudson, 1988; Klaczynski, Byrnes, & Jacobs, 2001) and how the process changes with age.

Studies that have included younger pupils (Davidson, 1991a, 1991b; Klayman, 1985) have generally found that the

strategies employed by younger pupils (ages 8-10) are different from those employed by older pupils (ages 13-15) and adults. Davidson (1991a, 1991b) found that compared with younger children, older children searched considerably fewer alternatives as well as less dimensions of those alternatives. Older children searched information more efficiently and systematically, and as a result, they made better decisions than did younger children.

Recent research on children's decision-making (Howse et al., 2003) has found that, unlike older children and adults, young children are frequently unable to eliminate an alternative as soon as it is obvious that it is unsuitable. In particular, young children have difficulty ignoring irrelevant information and attending to relevant information when examining alternatives.

In the field of education Venville, Rennie and Wallace (2004) investigated the sources of information that pupils employ while working with design activities. The trials performed during class were frequently used as a source of knowledge by pupils and gave them critical information to make decisions about their designs. Designs that pupils had used in previous years were used as an important source of knowledge by some new pupils. The teacher was also an important source of information used by pupils at one time or another in the design project. Venville et al (2004) concludes that the extent to which the pupils relied on various sources of information seemed to be directly linked with the degree of open-endedness of the problem that the pupils were attempting to address.

In design and technology pupils are usually dealing with a range of decisions. When pupils are designing they are facing different options, choices about construction materials and processes to use (Middleton, 2005). According to Barlex and Rutland (2004) and Barlex (2007) an important step is to audit a variety of design decisions that are likely to be made by pupils tackling a design and make activity. They identified five key areas of design decisions: conceptual, technical, aesthetic, constructional and marketing.

Decision-making processes involve many cognitive and meta-cognitive procedures. The existing literature review suggests that values, knowledge and skills have a significant role in decision-making (Hicks et al., 1982; Norman, 1998; Coles and Norman, 2005; Aikenhead, 1994; Aikenhead, 1989). Values are a core element of effective decision-making because they describe our objectives: what we as decision makers want to accomplish. We care about making the best choice because of the different alternatives we face that can lead to different consequences and some of these consequences will provide

more satisfaction than others. The use of appropriate knowledge is also important in order to make comparisons between positive and negative features of all available choices. Skills are required as well in decision-making when values and knowledge need to be combined together in order to work out the different processes and strategies that could be used (Baron and Brawn, 1991).

In design and technology education the combination of knowledge, skills, and values in various design tasks allow pupils to maximize their problem solving and decision-making skills, their flexibility and adaptability to other aspects of life as well. Hicks et al. (1982) points out the importance of knowledge, skills and values in the domain of design and technology in general and in design decision-making in particular:

"It is when the three components of this framework (skills, knowledge and values) come together in one activity that it can be termed 'technological'. However, whereas all types of design activity share the three components it is when the knowledge component is analysed in detail that the activity assumes a greater or lesser technological significance"

(p.7)

By the same token Norman (1998) explores the relationship between knowledge, skills and values in design activities and indicates how one factor influences the existence of other factors:

"Individual designers operate within a particular design area and it is possible, from the design activities in that area and its products, to identify knowledge, skills and values which it might prove helpful for the individual designer to acquire. This is not a causal relationship i.e. the acquisition of these knowledge, skills and values will not guarantee the designer success; neither is it an exact relationship i.e. there is no guarantee that for a particular project the designer might not need to acquire further knowledge, skills or values."

(Norman, 1998, p.76).

Gilbert (1991) argues that when pupils face design decision-making problems they usually solve the problem by empirical knowledge, which exists apart from scientific knowledge and this sometimes does not produce the best consequences. He goes on and discusses mental 'belief' systems and argues that the acceptance of an idea is part of the comprehension process. In other words, pupils employing a knowledge-building activity, which involves treating new information as something

problematic that needs to be explained, are able to avoid premature assimilation of new information, to bracket their beliefs, and to create a temporary context to make sense of the new information (Gilbert, 1991). This means that interpreted knowledge by self-regulation is more useful than directly assimilated knowledge in problem solving (Chan, Burtis, & Bereiter, 1997).

Although decision-making is an important issue for design and technology education Kimbell, Stables, Wheeler, Wosniak and Kelly (1991) assert that in technology education programs, little attention has been given to the discursive practices of justifying trade-offs, arguing for selection among alternative acceptable solutions, or persuading collaborators to contribute to a specific line of work. We have been limited by suggestions that the language of technology is dominantly a "concrete one; of graphics, symbols and models" (Kimbell et al. 1991, p. 25).

Purpose of the research and research questions

The aim of the research is to identify the factors that are involved in the design decision-making of pupils aged 11 to 14 in the area of design and technology education. This is a small scale pilot study which will formulate the background for a larger research programme. Specifically, the research questions that will guide this study are the following:

- (i) What strategies do secondary education pupils' follow in order to make their design choices?
- (ii) What types of sources of information do secondary education pupils' prefer when making a technological decision? Do the sources change as the pupils grow older?
- (iii) What is the ability of pupils' to develop criteria for evaluating options?

The Design of the Research

The study explores how pupils' use their previous experiences in order to take their design decisions. Therefore, data collection procedures aim at capturing pupils' specific decision-making strategies for a given project.

For the purpose of the current research various data collection methods were employed. The main data collection methods that were used in this study include interviews and direct observations. An additional source of information was the pupils' logbooks. The design of the pilot study is presented in figure 1.

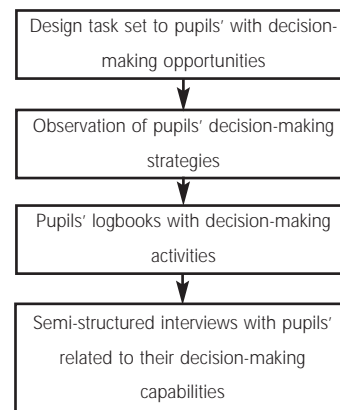


Figure 1: The Design of the Pilot Study

Initially, a specific decision-making task was given to pupils, during that stage pupils recorded and justified their design decisions in their log books. The task was different for each age group and required pupils to design a simple product. During that period observation of pupils while designing was taken place. The last section of the pilot study consists of a semi-structured interview which took place after the pupils finished their decision-making tasks. The rationale for that step was to shed further light on some specific areas of practice during their decision-making tasks.

Decision-Making Tasks

A task was designed for each class level (Year 7 to Year 9), with different content but always with the same viewpoint and requirements. Pupils' in Year 7 were asked to design and make a simple key ring, in Year 8 pupils were asked to design a moving picture and in Year 9 pupils were asked to design electronic alarm system. All the tasks lay within the Cypriot national curriculum guidelines. The task was originally in Greek and has been translated to English for the purpose of the report. Decision-making tasks were developed on the basis that they had no 'right' answer; were linked with some particular technological knowledge from the key area chosen; and contained some information helpful to the decision-making process. During the completion of the task pupils kept detailed logbooks in which they justified all their major design decision. The following are examples of types of questions that were asked for the purpose of the logbooks:

1. What are the most important reasons that made you decide to construct this project?
 - From where did you get your ideas?
 - What are your next steps?

2. What are the most important reasons that made you decide to use this mechanism?

- Did you use any information that helped you to make your decision?

3. What are the most important reasons that made you decide to use this decoration?

- If you had the chance to change something in your moving picture what would you change?

Such questions are meant to raise the pupils' consciousness concerning values involved, technological (and other) knowledge involved, evaluation criteria, and transferability of skills to other domains.

Observations

An observation protocol provided the framework for the observations. The protocol looked at three elements of pupils' decision-making selected from factors identified in the literature review: sources of information, evaluation criteria and decision-making strategies. Three classes were observed with approximately 20 pupils each, and the observations were carried out within a period of six weeks. The aim of the observation was to gather as much information as possible about the pupils' design decision strategies in praxis. The participants were not asked to plan or conduct any special preparation or to make any alterations to normal routines for the study. The duration of each class period is normally forty-five minutes. The observation schedule that was followed considered both the participants' convenience and the limitations of this study.

Interviews

The interview schedule design drew upon the research questions and the literature review. This schedule provided a general framework for obtaining the needed information (Cohen, Manion & Morrison, 2007). The interview included eight questions, which involved three aspects: pupils' sources of information (e.g. Did you search for further information that helped you take that decision?), the ability to set multiple criteria (e.g. When you took that decision did you think of any factors (criteria) that the decision should satisfy?), pupils' ability to transfer decision-making skills to other activities (e.g. Do you think that the decision-making skills you learned during the design and technology lessons can be used (transferred) to other daily activities?). Each interview lasted 20-25 minutes.

A digital voice recorder was used to record the pupils' interviews. The pupils were informed that they were being recorded and their consent was obtained. When interviews

were finished, a full transcript was made. The language of the pupils' interviews was Greek and some selected parts were translated to English for the analysis.

Sample and Data Collected

Table 1. Presents the number of participants and the duration of the data collected in the pilot study.

	Pupils' Interviews	Observations	Pupils' Logbooks
Number of Participants	N=15	N=59	N=59
Duration (min)	15-20	(3X6X45)* 810 (12h)	-

*(3x6x45) = 3 classes x 6 observations x 45 minutes

Table 1: Pilot Study Data Collected

Analysis of Results

The research was conducted through a phenomenographic approach because of its appropriateness to the investigation of a phenomenon such as decision-making. Phenomenography aims to describe the ways in which people understand features of the world around them. Phenomenography aims to investigate the relation between the phenomenon and the people who experience the phenomenon (Marton & Booth, 1997). The results of the study are showing all possible conceptions that pupils' decision-making capabilities have within design and technology classes.

During the interviews, pupils' expressed their beliefs about their experiences with design decisions in design and technology classes. They also responded to decision-making tasks in relation to their technology projects. The main outcomes from the interviews are presented below:

Pupils' base their design decisions mainly using their prior experiences from the subject. They tend to choose materials and processes that they used in their previous projects using their empirical knowledge as developed through the subject. For example, a child said during the interview: "I usually make use of materials that I applied in my previous projects and turned out to be good choices".

Peers seem to play an important role in pupils' decisions, both in their technology projects and in their personal decisions as well (e.g. purchase of mobile phones). They ask their peers to guide them about their decisions or they imitate their peers' choices on similar decisions. From interviews it emerged that teachers are very important sources of information for pupils. When pupils are not certain about their next steps they tend to ask their teacher to suggest the best possible solution. For example a pupil said: "when I am not sure about the best choice for my project I ask my teacher to help me". From the results it seems that the importance of teachers as a source of information is more evident in Year 7 (age 12) and less important in Year 9 (age 14).

Pupils' of all ages consider the internet as an important source of information for their design decisions. However, interviews indicated that pupils at Year 7 and Year 8 (ages 12 and 13 respectively) usually rely on the first relevant webpage they face on the internet. On the contrary, pupils at Year 9 (ages 14) search for alternative web-pages in order to double check the validity of the information.

In addition the interviews revealed that when dealing with design decisions, pupils have difficulties setting appropriate criteria to evaluate their possible options. For example a pupil said: "because of the time limitation I took the design decisions without thinking of any possible criteria that should be accomplished. I have in my mind some guidelines and I use my past experience to take the decision". On the contrary pupils have a very clear understanding of possible criteria and their relative importance when they have to take a personal decision. For example when they have to buy a mobile phone for themselves, they take into account technical features, aesthetic factors and cost. They also weight those criteria and make complex decisions.

Pupils expressed the belief that they don't feel that they can transfer their abilities from school to other areas of life, such as personal purchasing. For example, a pupil said: "I think that school is something different from personal life. What we are taught in school cannot be applied in our personal decisions". Only some pupils in Year 9 (age 14) believe that school teaching can help them take personal decisions as well.

Pupils' logbooks

Pupils kept logbooks during the project, where they justified their design decisions. When they had to decide about a design project the majority of pupils chose topics related to their everyday activities or hobbies, for example sports logos (mainly boys) and love hearts (mainly girls).

In logbooks pupils were asked to think if their design decisions could affect their forthcoming decisions on their project. For instance, pupils were asked to decide if the desirable type of movement might affect the type of mechanism that they would use. Younger pupils' (age 12) believed that one decision would not affect the decisions that would follow. Older pupils' (Year 14) believed that one design decision could possibly affect other decisions that follow. Table 2 shows the degree to which pupils of different ages believed that one decision would affect other decisions or not.

	Year 7 (age 12)	Year 8 (age 13)	Year 9 (age 14)
Will affect	5% (N=1)	37% (N=7)	90% (N=18)
Will not affect	95% (N=19)	63% (N=12)	10% (N=2)

Table 2: Pupils' beliefs about how one design decision might affect next decisions in the same project.

During the design task pupils mentioned in their logbooks a number of sources of information that they used in order to acquire the relevant knowledge for their design decisions. Age seems to be an important factor that affects the sources of information that pupils use. Table 3 shows the main sources of information that pupils used during their design project.

Source of Information	Year 7 (age 12)	Year 8 (age 13)	Year 9 (age 14)
Teacher	55% (N=11)	37% (N=7)	25% (N=5)
Peers	10% (N=2)	10.5% (N=2)	15% (N=3)
Existing Projects	15% (N=3)	15.75%(N=3)	15% (N=3)
Internet	10% (N=2)	15.75%(N=3)	25% (N=5)
Books	10% (N=2)	10.5% (N=2)	15% (N=3)
Trials	–	10.5% (N=2)	5% (N=1)

Table 3: Pupils sources of information

Observations

The observations showed that many pupils rarely search for relevant information outside the class before taking their design decisions. The main source of information seems to be their

teacher and this is more obvious at younger ages (Year 7) than later on (Year 9). Some difficulties that pupils face during decision-making include their inability to set appropriate evaluation criteria for their design decisions. This difficulty was identified from previous research as well (Mettas and Constantinou, 2006a) with slightly older pupils (age 18). Another difficulty identified from the research is the lack of motivation that pupils might have during decision-making. Pupils do not acknowledge the importance of spending time on designing their project and they like to move to the making part.

During the observations many pupils were influenced by their peers. Several times pupils took similar or the same decisions as their classmates did during their technology projects. When pupils have a doubt about their possible choices their first action is to look around and see what other pupils do in similar decisions. Peer influence seems to be equally important for all age groups (ages 12-14) included in the current study.

Discussions

The different strategies that pupils' spontaneously use when they have to make a design decision were the focus of the study, while learning issues were also identified. Three different sources of data, interviews, observations and logbooks were collected and analysed during the study.

From the analysis of data collected it emerge that most pupils rarely search for relevant information that will helped them develop the necessary theoretical background in order to strengthen their design decisions. This outcome was obtained both from interviews, observations and logbooks. Pupils usually use their empirical knowledge when facing design decision-making problems in order to judge and take design decisions. A similar outcome was reported by Gilbert (1991) with slightly younger pupils.

From the results obtained from observations and pupils' logbooks, some difficulties that pupils faced during design decision-making were identified. Pupils showed a number of difficulties when trying to evaluate alternative ideas. The main difficulty identified from the analysis of the data is the pupils' weakness in thinking about appropriate criteria that will assess possible alternative solutions. This outcome is more frequent in younger pupils' (age 12-13) than in older pupils' (age 14-15). Similar results were obtained from Mettas and Constantinou (2008) with older students (ages 18-20). In addition Birnbaum (1998) argued that even adults often have difficulties setting suitable evaluation criteria in order to assess alternatives.

Another important issue that emerges from the study is the problematic use of the internet as a source of information from young pupils (age 12-13). Pupils trust the first information that appears to them from their search without trying to confirm or double check the information with other alternative online resources. However older pupils (age 14-15) are more critical and they tend to search for alternative sources in order to verify the information.

Teachers and peers play an important role as pupils' sources of information. Teachers seem to be less important for aged between 14-15 and much more important for younger pupils' (aged 12-13). On the other hand peer influence is evident both from observations and interviews and is almost the same for all age groups included to the study.

Conclusions

The analysis of the results indicates that pupils' decision-making is a complex process that involves many pitfalls. Teachers, researchers and educational authorities should explore the development of decision-making skills as part of school teaching in a more systematic way. Despite the small number of pupils that were involved in this pilot study some useful results were obtained.

The research identified some difficulties faced by pupils in relation to decision-making. The most frequent is their inability to set appropriate evaluation criteria for their design decisions. Another difficulty identified from the research is the lack of motivation that pupils might have during decision-making. Pupils do not acknowledge the importance of spending time on designing their project and they like to move on to the making part.

The degree to which pupils trust or do not trust information from the internet is another issue that needs to be addressed. Many pupils use the available information from the internet without trying to check the accuracy of the information. This could lead to wrong judgments and as a result bad decision-making, not only in technology projects but in everyday activities as well.

This is the pilot study for a larger scale research programme that aims to improve our understanding on how pupils develop decision-making skills and how teaching in design and technology could help them improve those skills. Further research will include a larger sample, more detailed interviews and observations of pupils while designing.

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