A grounded theory approach to the development of a framework for researching children's decision-making skills within design and technology education

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Abstract

This paper discusses the establishment of a framework for researching children's decision-making skills in design and technology education through taking a grounded theory approach. Three data sources were used:

(1) analysis of available literature;
(2) curriculum analysis and interviews with teachers concerning their practice in relation to their respective national curricula; and
(3) a study of classroom activity in order to gather children's' perspectives.

These three data sources provided triangulation, as well as supporting the validation of the data obtained. The main areas of interest for the literature search were children's decision-making strategies, the implementation of decision-making in educational contexts and the roles of teachers and curriculum materials in the development of children's decision-making skills. In this paper the key outcomes of this literature search are presented. Teachers in Cyprus, England and Iceland, were interviewed concerning their practice and the results of these interviews are presented. The exploratory study was conducted in a Cypriot classroom and the results found in this context are noted and compared with the literature sources and interview outcomes. The resulting framework illustrates the possible factors that affect children's decision-making skills within design and technology education and is designed to be used in a subsequent research investigation using these possible factors as preset codes.

Key words

decision-making, design decisions, grounded theory, research framework.

1. Introduction

Decision-making is one of the fundamental processes that humans continuously go though in their everyday life. From a very young age people make various decisions or select from available or created options (Zoller, 1982). Every decision is made within a decision environment, which includes the collection of information, alternative options, values, and preferences available at the time of the decision. An ideal decision-making environment would include all possible information, all of it accurate, and every possible alternative. However, in practice both information and alternatives are constrained because the time and the effort to gain information or to identify alternatives are limited (Clemen, 1991). Since decisions must be made within this constrained environment decision-making is considered to be a complicated cognitive process which involves many factors (Kahneman and Tversky, 2000).

Despite the significance of decision-making as a vital activity in human behaviour providing holistic accounts of the phenomenon has not attracted the attention of many researchers in the education field. In the area of design education, children's decision-making strategies have only recently gained significant attention, perhaps because of the increasing acknowledgement of the importance of understanding the drivers behind decisions relating to creativity, sustainability and innovation. There are a few research studies that explore various aspects of decision-making in the area of design and technology education (Barlex and Rutland, 2004; Davies, 2001; Barlex, 2007; Coles and Norman, 2005; Mettas, Thorsteinsson and Norman, 2007; Mettas and Constantinou, 2008). Some research outcomes that come from the area of cognitive development (Davidson, 1991a, 1991b; Klaczynski, Byrnes and Jacobs, 2001) or operational management (Bazerman, 2005; Hammond, Keeney and Raiffa, 1999) can also be related to the teaching and learning of children's decision-making skills.

There has been significant research relating to particular factors that have significant influence on design decision-making. Designing is enabled through modelling (Baynes, 2009), which involves interaction through all the senses between imaging in the 'mind's eye' and the external world. Consequently, design decision-making is related to that interaction, and the decisions reached become evident within the outcomes of designing. The curriculum, and in particular the design tasks undertaken and the pedagogy used, have been shown to have significant impacts on designing and design outcomes. The intention of this paper is to note, but not revisit, such factors in order to establish a framework for an empirical study of design decision-making as it is observed to occur in classrooms.

The key factors that are involved in children's design decision-making processes have been derived from three sources. Firstly, a literature search relating to children's and adults' decision-making strategies and the implementation

of decision-making in educational contexts in general and in design and technology education,in particular, was undertaken. Secondly, a further study reviewed curriculum materials and analysed interviews with teachers from Cyprus, England and Iceland (Mettas, Thorsteinsson and Norman, 2007). The third study analysed observations carried out in a Cypriot classroom (Mettas and Norman, 2008). Together these three research studies have contributed to the development of a theoretical framework, which will be used to structure the analysis of a research study of children's design decision-making in design and technology education. This theoretical framework has arisen from a grounded theory approach, and will be used in the research in order to provide preset codes for the analysis of data. It is presented here as a tool that could have value for other researchers.

2. Analysis of literature concerning children's decision-making skills

2.1 Decision-making as a human activity

In everyday activities humans take various decisions. Their decision-making process is not always following logical or rational thinking. Most of the time, humans do not take decisions rationally, but on the basis of heuristics (Gigerenzer, 2001). Heuristics have been identified from many research studies and are a number of simplifying strategies or rules of thumb used in making decisions (Tversky, 1972; Gigerenzer, 2001).

Heuristics can provide an alternative perspective on observed behaviours. Heuristics act as a mechanism for coping with the complex environment surrounding our decisions. Individuals may use simple rules for decision-making when faced with complex decisions. Kahneman, Slovic and Tversky (1982) argue that such heuristics reduce cognitive requirements by focusing the decision-maker on the most promising strategies.

In some cases more detailed decision-making processes are needed and researchers often place emphasis on describing a sequence of steps that could guide rational decision-making (Bazerman, 2005; Hammond, Keeney and Raiffa, 1999). The steps or strategies that have been suggested have many similarities. Hammond, Keeney, and Raiffa (1999) suggest eight steps:
(1) work on the right problem;
(2) specify your objectives;
(3) create imaginative alternatives;
(4) understand the consequences;
(5) grapple with your tradeoffs;
(6) clarify your uncertainties;
(7) think hard about your risk tolerance; and
(8) consider linked decisions.

Those steps provide a useful order for thinking about what an optimal decision-making process might look like, but are not likely to describe the realities of human decision-making.

2.2 Children's decision-making

Several studies with young children (aged 6-8) (Davidson, 1991a, 1991b; Klayman, 1985) have generally found that the strategies employed by younger children are different than those employed by older children (aged 10). Davidson (1991a) examined the decision-making strategies of 6, 8 and 10 year old students using a decision board, a method used previously with adults (Ford, Schmitt, Schectman, Hults, & Doherty, 1989). A decision board allows participants to open doors to examine information about different alternatives before making decisions. Davidson (1991a, 1991b) found that when compared with younger children, older children searched considerably less alternatives as well as less dimensions of those alternatives. Davidson supports that older children searched information more efficiently and systematically, and as a result, they made better decisions than did younger children.

Klaczynski, Byrnes and Jacobs (2001) argue that an explanation for why children may have difficulty ignoring irrelevant information is that they may not be motivated to do so. They suggested that this lack of motivation could occur mainly for two reasons. Firstly, it takes effort to consider options carefully, so it may not be worth the effort if one does not care about the decision. Secondly, it is possible that children may not realise that ignoring irrelevant information will lead them to make a better choice. Thus, children may be unmotivated to expend the resources to ignore irrelevant information when they do not realise that it will help them to make better decisions (Klaczynski et al., 2001).

2.3 Decision-making in design and technology education

In design and technology education children are usually dealing with "ill-defined" or "wicked problems'" (Rittel and Webber, 1973) and they ''contain a complex of missing information, inexplicit requirements and conflicting demands'' (Pedgley 1999, p.33). Greenwald (2000) characterised an ill-defined problem as being: "unclear and raises questions about what is known, what needs to be known, and how the answer can be found. Because the problem is unclear, there are many ways to solve it, and the solutions are influenced by one's vantage point and experience" (p. 28).

Barlex (2007) and Barlex and Rutland (2004) describe four types of criteria of design decision-making in design and technology education. Barlex (2007) argues that a change of decision within one of the factors will affect some, if not all of the other design decisions. Barlex and Rutland (2004) categorised the types of criteria as follows:

- a concept: that considers originality; novelty; feasibility, usefulness and function;
- aesthetic criteria: requiring the pupil to consider 'ways in which the product will appeal to the senses' – sight, hearing, touch, taste and smell;
- technical criteria: requiring the pupil to consider 'how the product will work' and the nature of the components and materials required to achieve this;
- constructional criteria: requiring the pupil to consider 'how the product will be made' and the tools and processes needed to achieve this

(Barlex and Rutland, 2004).

Nicholl and McLellan (2007a and 2007b) presented the idea that lack of creativity in children's design and technology projects affected children's decision-making judgement and is partly the result of fixation. They define fixation as the "difficulty in generating novel ideas due to imagination being 'structured' by pre-existing knowledge" (p.71).

Nicholl and McLellan (2007a) argue that the stereotypical design ideas based on popular culture typically seen in secondary D&T classrooms in the UK are the outcome of fixated thinking. Because imagination is structured and operates along the path-of-least resistance, students will draw on sources of knowledge that are most accessible to them. Nicholl and McLellan (2007b) point out that teachers gave attention to existing products in guiding children's designs and as a result influence their design decisions.

2.4 Knowledge, skills and values in design decision-making

In 1982 Hicks led a Working Party for the UK's Assessment of Performance Unit (APU), which was set the task of exploring the nature of design and technology. Amongst the important ideas which emerged from that group was the categorisation of the key factors influencing design decision-making into knowledge, skills and values. This was extended in a 1998 paper by Norman, which argued that the technology which is used for the purposes of designing could similarly be usefully described in terms of these same three categories (technology for design). Hicks et al., categorised knowledge as comprising control, energy and materials; skills as comprising investigation, invention, implementation and evaluation; and values as being technical, economic, aesthetic and moral. (ibid, 1982)

The knowledge, skills and values model has also been adopted by other researchers such as Pedgley (1999) and Trimingham (2008). Norman (1998) suggested that effective design is 'bounded' by the designers' knowledge, skills and values, and that education or professional development should seek to address these as key issues. In the school environment knowledge, skills and values are also likely to have an influence on children's decision-making activities in design and technology education.

2.4.1 The role of values in design decision-making

Despite the obvious role of values in decision-making only in recent years has research explored their in-depth involvement in decision-making (Coles and Norman, 2005; Trimingham, 2008). Trimingham (2008) investigated the role of values in design decision-making. She reviewed the existing literature (e.g. Hicks et al., 1982; Coles and Norman, 2005, Layton, 1992) and categorised the types of values that are involved in design decision-making. Subsequently she investigated those values and developed categories for a taxonomy of the values influencing design decision-making.

Trimingham (2008) argued that the use of values in design decision-making needs to be included in course curricula and presented within a framework of knowledge, skills and values. She points out that: "It is clear that values influence design decision-making in many ways, for instance they are used to reduce avenues of enquiry, to direct activity, to analyse ideas, to inform about sizes, properties, functions and manufacture, among many other areas. Values are used to drive all sorts of decisions from manufacturing to aesthetics" (p.50)

2.4.2 The role of knowledge in design decision-making

Reasoned choices and evaluation are often based on values but, although values are an important basis for making a judgment, the use of relevant conceptual knowledge is needed in order to weigh the advantages and disadvantages of the available options (Sadler, 2004; Perkins and Salomon, 1989). Piaget (1972) theorised that individuals tend to reason at more sophisticated levels in areas in which they have more knowledge.

Several teaching models for thoughtful decision-making for use in education have been proposed (Aikenhead, 1985; Kolstø, 2000; Ratcliffe, 1996). Ideally such teaching models should build on knowledge of the strengths and weaknesses in students' decision-making. However, only a few studies have explored the kinds of knowledge students draw upon, and how they actually apply this knowledge, when confronted with technologically controversial social issues (i.e. Fleming, 1986; Ratcliffe, 1996).

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Hicks et al., (1982) stated that designers often require information from other disciplines when making decisions. The information used by designers could be obtained from various sources but only when information is processed in designers' minds does it becomes knowledge (Norman, 1998). When designing, designers and pupils apply information taken from a wide range of areas and hence acquire knowledge of the significance of such information when applied in particular contexts.

2.4.3 The role of skills in design decision-making

Good decision-making involves the integration of personal and social values with sources of information and knowledge. In order to integrate values and knowledge, thinking skills need to be applied. In design and technology education skills are fundamental almost in every step of designing. According to Baynes (2009) "Design activity is the exercise of the set of skills useful in planning, making and evaluating." (p.45)

Polanyi (1962) in his description of the notion of skills argued that ''...you cannot acquire a skill merely by learning to perform its fragments, but must also discover the ability of co-ordinating them effectively''. Hicks et al., (1982, p.6) identified four core categories in design and technology in which skills could be developed: investigation, invention, implementation, and evaluation, or validation (1982, 4–5). All these categories are essential elements of design and technology education and could enhance decision-making skills.

2.5 Transfer of design decision-making skills

Singley and Anderson (1989) defined transfer at the individual level as "how knowledge acquired in one situation applies (or fails to apply) to another" (p.1). Butterfield and Nelson (1989) suggested that promoting transfer is the fundamental goal of teaching, because contexts and purposes change, and people are severely handicapped if they do not adapt their past learning to new circumstances and intentions.

However, despite the importance of transfer of knowledge and skills research studies suggest that there is little evidence to support its existence (Carraher and Schliemann, 2002; Welch, 2007). Components of thinking such as skills and strategies, may be specific to the content, and tied to the context in which they were learned (French and Rhoder, 1992). Carraher and Schliemann (2002) identified that, 'there is little evidence for some monolithic skill or piece of knowledge being carried over intact from a unique prior situation to the present one' (p19).

It might be anticipated that a context in which transfer might thrive is the relationship between science and design and technology in secondary schools. Barlex and Pitt (2000) investigated this area and the study concluded that there is very little linking between the two subjects, but made recommendations 'for improving the situation by identifying measures which might help to bring school science and school design and technology into a relationship that is more fruitful and also reflects 'real world' practice' (p9).

2.6 Teachers' roles

Teachers have an important role in children's learning through the activities that they employ in their school class. Their teaching methods, the autonomy that they give to children and their own ideas about the national curriculum are only some examples of factors that will affect children's learning. Especially in design and technology where there are so many diverse issues (design tasks, content knowledge, health and safety etc.) that the teachers need to manage, their decisions about approaches are very likely to have an influence on children's design decisions, both through the opportunities they provide and the strategies employed.

Research studies (McCormick, Murphy, and Hennessy, 1994; McCormick, 1990; Banks, Leach and Moon, 1999) have shown that teaching can be influenced by factors such as prioritising management and accountability (McCormick et al., 1994); teacher beliefs (McCormick, 1990; Neisser 1976); teachers' pedagogic knowledge (Banks et al., 1999, p. 94); problems of curricular choice and coverage (Anning et al., 1996, p. 6) and classroom and school administration expectations (Banks et al., 1999, p. 90). McCormick (2004) also identified that teachers were considered to be an important source of information for children's design work. From the available literature, it is clearly to be expected that the pedagogical approach taken by teachers will prove to be an important element in understanding decision-making in classrooms.

2.7 The role of the curriculum

According to Prideaux (2003) the curriculum represents the expression of educational ideas in practice and includes all the planned learning experiences of a school or educational institution. Although the largest part of school teaching is based on the content of the curriculum, in practice there will be some 'unplanned' learning activities as well; those that derive from outside the curriculum.

Prideaux (2003) points out that "the curriculum must be in a form that can be communicated to those associated

with the learning institution, should be open to critique, and should be able to be readily transformed into practice" (p.268). Davis and Krajcik (2005) point out that curriculum designers "must ensure that the curriculum materials are accurate, complete, and coherent in terms of content and effective in terms of pedagogy, with good representations of the content, a clear purpose for learning it, and multiple opportunities for students to explain their ideas" (p.3). Therefore curriculum content will have an effect on the nature and the frequency of decision-making opportunities given to pupils.

3. Findings from practice: Curriculum analysis and teacher interviews

The national curricula in Cyprus, England and Iceland and teaching resources (books, software, etc.) were reviewed and interviews were conducted in order to investigate teachers' views on how children acquire decision-making capabilities in design and technology education. More specifically four teachers from each country were interviewed. The aim was to understand how cultural differences may affect teachers' ideas about decision-making. A more detailed description of the methodology used can be found in Mettas et al., (2007).

From the review of the curricula materials in Cyprus, England and Iceland it could be observed that the English and Icelandic curricula are framed more in process terms when compared to the Cypriot curriculum. The current approach of the Cypriot curriculum is more content oriented and the subject is usually conceived in terms of major sub-divisions, such as communications, mechanisms, electronics, structures, and energy. Design decisions have to be taken within a specific domain (for example electronics). The curriculum guidelines for England and Iceland both require decision-making opportunities to be provided in technological contexts. For example: "Make and justify decisions regarding the choice of materials and manufacturing processes and use them to draw up a manufacturing specification" (English NC (2007), age 15), or "Choose the appropriate components for the input, process, and output of an electronic system" (Cypriot NC (2000), age 15). The Icelandic curriculum specifies less design decision requirements and relies more on a general form of a design process with the emphasis on innovation.

In the research interviews teachers from the three countries expressed the opinion, that some children expect everything to be done for them (teacher) and that they are not used to thinking for themselves and therefore find decision-making difficult. They use their past experiences from previous years and their textbooks to decide mainly about the appropriate materials.

The majority of children rarely search for information outside the class before taking their design decisions. The main source of information for Cypriot and English children is their teacher and this is more obvious at younger ages (age 11-12) than later on (age 14-15). However, teachers from Iceland said that their students use the internet as the main source of information for their design decisions.

It was reported that a further difficulty that children face during decision-making was their failure to set appropriate evaluation criteria for their design decisions. This difficulty had been identified in previous research (Mettas and Constantinou, 2006a) with older students (age 18-19). Another issue identified from the research was the lack of motivation that children might have during decision-making. Children did not acknowledge the importance of spending time on designing their project and they like to move to the making part.

4. Findings from children's perspectives

The third research study sought to capture the children's points of view and included a specific design task. The task was directly related with the Cypriot curriculum of design and technology education. The task required children to design and make a simple mechanical game using levers and linkages. During the task children recorded and justified their design decisions in their log-books. At the same time the children were observed while designing was taking place. After the task was completed a post-test was administered to the children, which comprised decision-making opportunities not directly relevant to design and technology activities. The purpose of that procedure was to gather information about children's ability to transfer their skills learned in design and technology classes to other activities. The last section of the study consisted of a semi-structured interview after the children had finished with the decision-making tasks set to them. More details of the methodologies used can be found in Mettas and Norman (2008).

The aim of this study was to understand how pupils from Cyprus make their decisions while working with design and technology activities, and from their perspectives. Fifty-nine children from a Cypriot secondary school participated in the research study, 30 from the first class (aged 12-13) and 29 from the second class (age 13-14). Table 1 gives an overview of the number of participants and the data collected in the research study.

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. Mainly grounded theory techniques were used to analyse the data collected from the research study (Glaser & Strauss, 1967). Grounded theory refers to theory that is developed inductively from a corpus of data. This means that the resulting theory is based on the responses of the research participants and not on any pre-set ideas.

From the analysis of data collected it emerged that most pupils rarely search for relevant information that will help them develop the necessary theoretical background in order to strengthen their design decisions. This outcome was obtained from all of the data sources; interviews, observations and log-books.

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).

Teachers and peers played an important role as pupils' sources of information. Teachers seemed to be less important for children aged between14-15 and much more important for younger pupils' (aged 12-13).

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 had a doubt about their possible choices their first action was to look around and see what other pupils do in similar decisions. Peer influence seemed to be equally important for all age groups (ages 12-14) included in the current study.

The study did not find any significant evidence as to whether children acknowledge the importance of transferring the skills learned within the school environment to other areas of their life.

From the results it seems that children believe that skills learned in a specific subject can only be applied to that specific subject and cannot easily be transferred.

5. A theoretical framework for analysing children's decision-making

Some factors that are likely to affect children's decision-making strategies were identified from the literature. The studies from the teachers' and children's perspectives identified some further factors that are involved in children's decision-making processes, as well as confirming some of those that emerged from the analysis of the literature. Based both on the literature sources and the outcomes of the research studies a theoretical framework of children's decision-making has been designed. The key factors that emerged are summarised in the following paragraphs.

From the literature reviewed (e.g. Hicks et al., 1982; Pedgley, 1999; Trimingham, 2008; Norman, 1998) it can be concluded that knowledge, skills and values are factors that play an important role in decision-making processes. Many decisions that are taken by children within design and technology classes are based on their existing knowledge, their persona/social values and their skills to work out the best possible choice. The involvement of knowledge, skills and values in children's decision-making process was also evident from the research studies conducted.

Prideaux (2003) points out that curriculum material includes all the planned learning experiences of a school. Therefore the requirements of curriculum materials play a central role in teaching and learning and hence in the development of decision-making opportunities within design and technology education. The effect of curriculum materials on their teaching was identified from the teachers who were interviewed. Teachers from Cyprus, England and Iceland expressed the belief that the curricula in all countries included decision-making opportunities, but in practice it is difficult to apply all those decision-

	Children Interviews (post-observational)	Observations	Post-test	Children Log-Books
Number of Participants	N=15	N=59	N=59	N=59
Duration (min)	15-20	3X4X45)* 540 (9h)	40	-

Table 1. Data collected in the third research study

making opportunities with children due to many limitations (time, resources and children's abilities). For example a teacher from Cyprus argued that "The guidelines of the national curriculum are giving many opportunities to teachers to set decision-making tasks. Despite that in practice, time limitations minimise those opportunities".

Davis and Krajcik (2005) argued that curriculum success is affected by characteristics of the teachers themselves, such as their knowledge, beliefs, and dispositions towards reflection and improving their own practice. In addition, research has indicated that teaching can be influenced by factors such as teachers' beliefs (McCormick, 1990); teachers' pedagogic knowledge (Banks et al., 1999); problems of curricular choice and coverage (Anning et al., 1996) and classroom and school administration expectations (Banks et al., 1999).

Teachers' responses in the interviews also showed that their own ideas about teaching and learning are affecting the decision-making tasks that are given to children. For example an English teacher said during the interview: "With younger children, Years 7 to 8 (aged 11-13) we structure the projects so that any major decisions – those related to the manufacture of the object – are already stated in the project". Similar responses were given by teachers from Cyprus and Iceland, for example a Cypriot teacher said during his interview "At age of 11, I normally set tasks that are giving fewer opportunities for decision-making because children are inexperienced, and need the teacher to give them very frequent guidance and feedback".

It also emerged that teachers believe that most books that are in use in design and technology classes do not include sufficient decision-making opportunities. For example a Cypriot teacher said: "The textbooks that are used for secondary education don't include many opportunities for decision-making". By the same token, English teachers expressed similar opinions, for example a teacher said: "Many of the books that we use for design and technology teaching are extremely focussed on delivering information". In the case of Cyprus where specific, compulsory books are used in design and technology education, their role is significant in determining the decision-making opportunities that are given to children.

From the literature reviewed it emerged that people follow a number of decision-making strategies in order take a decision. Some of them include heuristics approaches (Tversky, 1972; Gigerenzer, 2001) and some other decision-making strategies follow a sequence of rational decision-making steps (Bazerman, 2005; Hammond, Keeney and Raiffa, 1999). Therefore children's own decision-making strategies will affect their design decisions. Age also seemed to be another important factor that plays a significant role in children's decision-making strategies according to other research studies (Davidson, 1991a, 1991b; Klayman, 1985).

From the results of the study of decision-making from children's perspectives it could be seen that children at the age of 14 were more able to describe how one decision might affect their forthcoming decisions when compared with children at the age of 12. At the same time the research study found that older children (age 14) use different sources of information when compared to younger children (age 12). From those outcomes it is emerging that the effects of age are significant factors in children's capabilities and difficulties in reaching a decision.

Transfer of thinking skills from school activities to other areas of life is an important issue, but seems to be complicated. Research studies suggest that there is little evidence to support its existence (Carraher and Schliemann, 2002; Welch, 2007). It is often anticipated that children will transfer the skills gained though designing to their everyday decisions. The classroom study identified the difficulties of transferring skills from the school environment to other everyday activities. There is some evidence from the research studies about the transfer of children's skills from one design task to other tasks within the same domain (i.e. design projects). Both teachers and children seem to agree that learning is mainly domain specific and very rarely can it be observed to transfer to other activities.

From the observations and children's interviews it is emerging that peers seem to have effects on children's decision-making strategies. Children are discussing with peers their ideas and sometimes adopt similar ideas to them.

A number of potential difficulties that children face during their decision-making strategies have been identified. Most children do not search for any kind of relevant information in order to develop their theoretical background to support their design decisions. They also face difficulties in setting or handling evaluation criteria to base their decisions on. Another difficulty that emerged from the research studies is the lack of motivation that children have for the designing part of their projects, and as a result towards their design decisions.

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Taking into account the literature reviewed and the results of the research studies, a framework was designed that addresses possible factors that are involved in children's decision-making processes in design and technology education. A graphical form of this framework based on the literature sources and research studies is presented in the following diagram (Figure 1).

In the framework, the curriculum plays a central role in the teaching of design and technology and hence to decision-making opportunities given through the subject. The content and the requirements of the curriculum will affect the nature of the design tasks that are required from the pupils. However the way teachers implement the curriculum, their own ideas about teaching and learning and the teaching resources that they are using in their classes will also have an influence on the development of children's decision-making strategies.

In addition to the curriculum and the teacher's role, children's strategies, their age, the influence of their peers, their possible ability to transfer skills from one area to another and possible difficulties they are facing as a result of being 'fledgling designers' (Trebell, 2007) will have an influence on their ability to make decisions. The term 'fledgling designers' was developed to broaden the five levels of expertise, which consist of 'novice', 'beginner', 'competent', 'proficient' and 'expert' (p.93) to add a category particularly for pupils in schools, who will be employed in designing without prior experience and proficiency in the field (Trebell, 2007). Difficulties that were identified from the research studies and added to the theoretical framework are children's lack of motivation, difficulty in handling evaluation criteria and the use (or the lack of it) of relevant sources of information to support their decisions.

Design decision-making is dependent on knowledge, skills and values and the relationship and the interaction between the factors that are described in the theoretical framework shown in Figure 1. These factors, their relationships and interactions need to be explored through further research in order to examine their contributions to children's decision-making strategies.

6. Discussion

Education should offer children decision-making opportunities in order to provide an environment within which their (children's) decision-making skills can be developed. This is particularly important within design and technology education where children are learning to take decisions, which, 'in the real world', would have significant impacts on key issues e.g. sustainability and innovation. For example, the majority of adverse environmental impacts are traceable to design decisions. It is vital that teachers understand and develop capability in decision-making, and that research supports those targets. It would appear that appropriate pedagogy for design decision-making is largely unexplored throughout the literature. The design of the theoretical framework as presented in the current study can improve our understanding of the development of children's decision-making skills.

The development of the theoretical framework proposes a number of factors that are involved in children's decision-making processes within design and technology education. The framework is based on the analysis of the available literature in areas that are related with decision-making skills and the results of research studies conducted to gain the teachers' and children's perspectives.

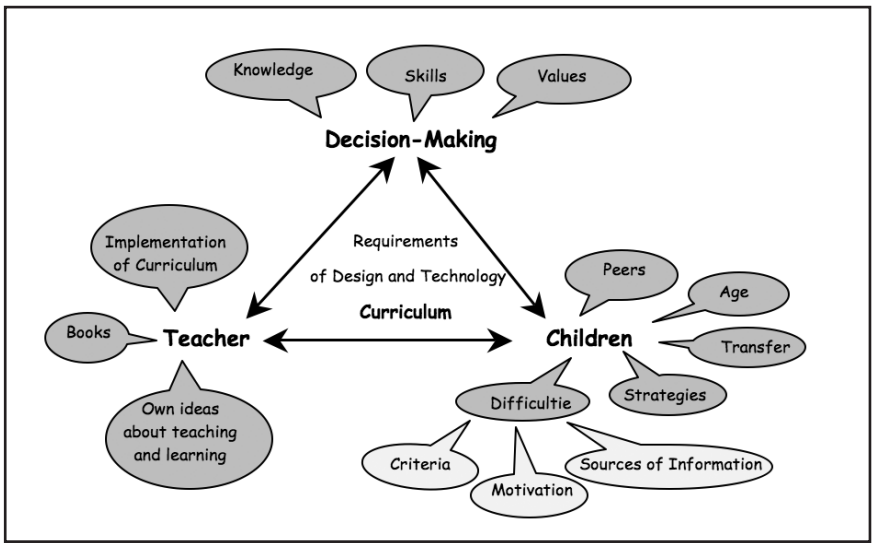

Figure 1. Framework for the analysis of children's design decision-making

From the research studies conducted, it emerged that pupils do not usually search for relevant information in order to develop the appropriate theoretical background before taking a design decision and they usually use their prior empirical knowledge when facing design decision-making problems in order to make judgements. A similar outcome was reported by

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Gilbert (1991) with slightly younger pupils. It is important that empirical studies are carried out within design and technology education in order to understand better children's behaviour in this area. With greater understanding of children's current behaviour, it should be possible to design appropriate pedagogical interventions to address the emerging issues.

This framework will be examined through a larger scale research study and will be improved with any emergent issues that influence children's decision-making processes.

7. Conclusions

The literature search conducted revealed possible factors that are involved in children's decision-making in the area of design and technology education. Literature on children's decision-making strategies and the role of knowledge, skills and values were analysed. In addition to this the role of curriculum materials and the role of teachers seem to be very important in order to support students' decision-making opportunities in design and technology education. From the literature sources it can be concluded that decision-making is a complex process and involves many factors.

Research studies were also conducted in order to gather more information on how children acquire decision-making skills through design tasks within the school environment. Some initial results indicate that curricula in Cyprus, England and Iceland include many opportunities for decision-making in design and technology classes. However in practice teachers believe that some of the requirements of the curricula are not feasible to apply. Another potentially significant outcome for curriculum developers is that children very rarely search for information, or set appropriate criteria to support their design decisions. Children rely on teachers and past experience in order to reach decisions, and age seems to have effects on their decision-making strategies.

Based on the literature sources and the research studies a theoretical framework has been designed. This framework identifies possible factors that are involved in children's decision-making process and suggests some of the relationships between those factors. As presented in the theoretical framework shown in Figure 1, some issues that might affect decision-making in the educational environment are the requirements of the national curriculum, books, teacher ideas, children's strategies and difficulties they might face during decision-making, their age, peers and factors like children's knowledge, skills and values.

The theoretical model that is presented in this paper gives a framework within which children's decision-making can be explored and hence related teaching strategies improved. The development of a framework through the analysis of prior literature and of initial research studies employing a grounded theory approach demonstrates a valuable strategy for researching complex areas like decision-making and also provides a valuable tool for both educators and curriculum development. It will be further detailed and articulated as a result of its use in the analysis of research data that has been gathered in Cypriot classrooms, but it could be of considerable value to both researchers and curriculum developers in its initial form.

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