TÜRK FEN EĞİTİMİ DERGİSİ
Yıl 14, Sayı 4, Aralık 2017

Journal of
TURKISH SCIENCE EDUCATION
Volume 14, Issue 4, December 2017

http://www.tused.org

Studies Conducted on Entrepreneurship in Science Education: Thematic Review of Research

İsa DEVECİ[1], Salih ÇEPNİ[2]

[1] Asst. Prof. Dr. Kahramanmaras Sutcu Imam University, Kahramanmaras-TURKEY
[2] Prof. Dr. Uludag University, Bursa-TURKEY

Received: 20.01.2017 **Revised:** 03.03.2017 **Accepted:** 20.04.2017

The original language of article is English (v.14, n.4, December 2017, pp.126-143, doi: 10.12973/tused.10209a)

ABSTRACT

In recent years in many educational curriculums, entrepreneurship has attracted much attention as a concept, from primary education to higher education. In this sense, attention is given to the concept of entrepreneurship that is included in both national and international science education curriculums. In this research, the aim was to investigate studies conducted on entrepreneurship in science education in terms of their general characteristics (publication year, number of authors, publication type) and characteristics of their content (purpose, method, data collection tool, sample type, conclusion and suggestions). As a result of the research, it is noteworthy that studies have been published in recent years in general. On the other hand, it was identified that there are studies much more published as literature review, document analysis, theoretical. In some research, it was seen that the teaching model, curriculum and modules are developed and integrated within science education to promote entrepreneurship. In addition, it is observed that in most of the studies have been reached positive results about the concept of entrepreneurship should be integrated with science education. Depending on the results, it should be said that teaching curriculums can be designed and implemented that are likely to improve students' entrepreneurial skills in science courses.

Keywords: Entrepreneurship, science education, thematic review.

INTRODUCTION

Entrepreneurship is among a number of skills that students should consider to gain, and the concept of entrepreneurship is mentioned in the majority of teaching curriculums. Therefore, the knowledge and skills of teachers concerning entrepreneurship is seen as important. Entrepreneurship has special significance in terms of science education. Because the concept of entrepreneurship is one of the concepts frequently pronounced in science education, especially in recent years.

When definitions are considered in the field of business and economics, for example, according to Schumpeter, the entrepreneurship is defined the new combination of existing factors (Schumpeter, 1934). Also, Knight (1921) stated that entrepreneurship is related to uncertainty. Gartner (1988) expressed that entrepreneurship is the process of creating new ventures. When definitions are considered in the field of education, it was seen that

Corresponding author e-mail: deveciisa@gmail.com

entrepreneurship is attributed to an individual's ability to transform ideas into action (European Commission, 2011). On the other hand, it has been stated that entrepreneurship in education is about students improving the characteristics and mentality that enables them to transform creative ideas into entrepreneurial action (European Commission, 2016). In this sense, the basic competencies in science education are ranked as collaboration, listening to the ideas of others, critical thinking, being creative and taking the initiative, solving problems and taking risks, and making decisions (European Commission, 2015). Therefore, it can be said that entrepreneurship and science education have some common aims.

It is emphasized that the links between science, innovation, creativity and entrepreneurship are important (European Commission, 2015). It was noted that entrepreneurship has an important implementation area in terms of education in physics, chemistry and biology (Agommuoh & Akanwa, 2014; Ejilibe, 2012; Ezeudu, Ofoegbu & Anyaegbunnam, 2013; Hilario, 2015). Also, the concept of scientific entrepreneurship is mentioned. It seems that scientific entrepreneurship means the process of producing innovative, science-based products based on the ability to forecast a new product that is not on the market (Peter & Anne, 2000). In addition, it is stated that students can gain entrepreneurial characteristics through science laboratories, workshop practices, in-class and extracurricular activities (Adeyemo, 2009). Table 1 briefly summarizes some studies carried out in the field of science education.

Table 1. *Related literature in science education*

The scope of the research	Studies conducted in literature
Investigating the opinions of students, prospective teachers, teachers and educators	Agommuoh & Akanwa, 2014; Buang, Halim, & Meerah, 2009; Bolaji, 2012; Deveci & Çepni, 2015b; Deveci, 2016b; Deveci & Seikkula-Leino 2016; Habila-Nuhu-Clark & Pahalson, 2014; Pan & Akay, 2015; Çelik, Gürpınar, Başer & Erdoğan, 2015
Informative literature review and theoretical research.	Abdu, 2011; Achor & Wilfred-Bonse, 2013; Adeyemo, 2009; Bacanak, 2013; Erarslan, 2011; Ejilibe, 2012; Nwakaego & Kabiru, 2015
Suggestions of entrepreneurial activity, enterprising education module and (hands-on) laboratory kits.	Deveci, Zengin & Çepni, 2015; Hsiao, 2010; Young, 1991
Examination of curriculum (for example, acquisitions, activities).	Güven, 2009; Güven, 2010
Experimental studies on characteristics of taking risks	Çelik, 2010; Yıldız, 2012
Examination of teaching practices.	Koehler, 2013; Hsiao, 2010;

As seen in Table 1, most research regarding entrepreneurship in science education has examined the perceptions and opinions of students, prospective teachers, teachers and educators. It can be said many literature reviews and theoretical research studies have been performed to improve the understanding of entrepreneurship in science education. Some studies have introduced training modules and investigated hands-on lab kits as examples of entrepreneurial activity based on entrepreneurship. Also, experimental studies have been conducted to determine the effects of project-based learning and problem-based learning on students' characteristics of taking risk. It is possible to come across qualitative studies that directly examine teachers' practices. However, no thematic review conducted on entrepreneurship in science education has been encountered. Therefore, this research will contribute to the literature in different ways.

First, we will attempt to understand the studies conducted on entrepreneurship in science education, and their point of view. Second, we will identify the methods and data collection tools used in studies on entrepreneurship. Third, we will determine which dimensions have deficiencies. Finally, we will have an idea what teachers or educators think about integrating entrepreneurship into a science curriculum. The aim of this study is to investigate studies conducted on entrepreneurship in the literature of science education. Therefore, the questions that arise are as follows:

- What is the distribution of studies according to their general characteristics (year, author, publication type)?
- What is the distribution of studies according to the characteristics of their contents (aims, methods, data collection tools, results, and suggestions)?

METHODS

In this research, the studies on entrepreneurship in science education were examined thematically through content analysis. For this, in much research, a matrix was used as a guide (Çalık, Ayas & Ebenezer, 2005; Kurnaz & Çalık, 2009; Unal, Çalik, Ayas & Coll, 2006; Yücel-Toy, 2015). Content analysis is divided into three groups: "meta-analysis, meta-synthesis (thematic content analysis) and descriptive content analysis". It has been stated that meta-synthesis (thematic content analysis) means synthesized and evaluated studies carried out on a specific subject using a matrix created by researchers (Çalık & Sözbilir, 2014). The matrix generally contains the themes, such as the aims, methods, data collection tools, important findings, and important results. Each study was examined separately using this matrix (Table 2). The general trends in the studies were identified in this way.

a) Data Collection

Databases were scanned using the following keywords to identify publications: "enterprise" or "entrepreneur" or "entrepreneurship" or "entrepreneurship education" and "teacher education" or "teacher" or "elementary school" or "secondary school" or "biology education" or "chemistry education" or "physics education", and were written in English, provided that the concept of "science education" was fixed. A total 38 publications were retrieved from the databases according to matrix in Table 2. These publications are marked with "*" in the reference section (for example, *Chigozie, 2014).

The databases included the Education Resources Information Center (ERIC), Education Research Complete, Academic Search Premier (EBSCO), ScienceDirect, PsycArticles (ProQuest), Social Science Citation Index, Taylor & Francis Online Journals, Emerald Journals and Theses Database, Web of Science – SocINDEX With Full Text, Wiley Online Library, Bibliography of Asian Studies, First World War Portal, Sage Research Methods Online, Springer LINK Contemporary, PROQUEST Dissertations and Theses Full Text, Councıl of Higher Education Thesis Center, and TUBITAK ULAKBIM.

Table 2. *Matrix*

Themes	Codes	Explanations
General Characteristics	Years of publication	Year of published study
	Number of authors	Number of authors in the study
	Type of publication	Group of publication (articles, congress, thesis, etc.)
Content Characteristics	Aims	Aim of the study
	Methods	Qualitative (case study, phenomenology etc.) Quantitative (survey, experimental, etc.)
	Data collection tools	Tools used in obtaining the data (observation, interview, Likert scale, etc.)
	Results	Basic results of study

b) Data Analysis

The above matrix was used to analyse the studies accessed from the databases. At first, codes were prepared to correspond to each category. For example, each study is categorized according to year of publication and number of authors. Then, the aims of the studies were coded. Studies with common objectives are grouped under the same code. Studies with a similar general purpose have been named under the theme name by combining codes. For example, as seen Table 4, studies aiming to determine the perceptions and opinions of participants about entrepreneurship are shown under the theme named as perceptions and opinions. Similar processes were followed in the creation of other codes and themes.

c) Reliability of Study

The use of data collection tool in many research shows it is reability tool (Çalık et al., 2005; Kurnaz & Çalık, 2009; Unal et al., 2006; Yücel-Toy, 2015). On the other hand, the codes and the themes created by a different researcher are used to provide reliability. And then, these codes and themes created researcher author and a different researcher who is specialist in science education were compared. The percentages of codes and themes agreed on by researcher author and a different researcher was 84. The codes and themes re-examined by researcher author and a different researcher that cannot be agreed on. Finally, both researchers accepted the codes agreed upon by arguing.

d) Limitation of the Study

This research is limited to publications such as articles, theses and conference papers available using databases. National and international reports prepared in the context of science education are excluded. Also, this research is limited to studies carried out about entrepreneurship in science education. In addition, this research is limited to the databases mentioned above within the scope of this research. For research ethics, the coding process was overseen by a researcher other than the research authors. It is aimed at reducing the prejudices in this way.

FINDINGS

This section contains findings about the general characteristics and characteristics of the content of the studies under investigation. Table 3 contains findings related to the general characteristics of the studies.

Table 3. *General information about the studies*

Themes	Codes	f	Total
Years of publication	1999 and before	1	38
	2000-2003	2	
	2004-2007	1	
	2008-2011	8	
	2012-2016	26	
Number of authors	1	20	38
	2	12	
	3	5	
	4	1	
Type of publication	Article	29	38
	Conference/seminar/congress/symposium	2	
	Thesis	7	

When the studies' general characteristics were examined, it was seen that most of the studies were conducted from 2012 to 2016. With regards to number of authors, studies with one or two authors are far more common, while in terms of publication type scientific articles are more preferred. Table 4 shows the distribution of studies according to their aims.

Table 4. *Distribution of studies according to aims*

Themes	Codes	f	Total
Perceptions and opinions	Determination of prospective teachers' perceptions and competences related to entrepreneurship.	2	16
	Examining the opinions of science teacher educators about the process of entrepreneurship education.	2	
	Investigation of physics teachers' perceptions about entrepreneurial characteristics.	1	
	Exploring the thoughts of entrepreneurial scientists who have developed innovative products on their own initiative.	1	
	Examination of science teachers' perspectives on integrating entrepreneurship education with science curriculum.	1	
	Investigation of the views of teachers about the effects of science courses on the entrepreneurial characteristics of students.	1	
	Examination of the level entrepreneurial characteristics acquired by students through a physics education curriculum.	1	
	Examining prospective teachers' views on the necessity of an entrepreneurial education.	1	
	Examining the level of productivity of chemistry students for entrepreneurship.	1	
	Determination of how science teachers perceive entrepreneurship in education.	1	
	Determining the levels of entrepreneurial characteristics of prospective teachers.	1	
	Investigating the entrepreneurial characteristics of prospective teachers in terms of some variables.	1	
	Examining the views of science teachers about the entrepreneurial characteristics of the students.	1	
	Examining the learning styles of students according to their entrepreneurial characteristics.	1	
The importance	Provide better understanding of the basic concepts related to the		6

of the concept of entrepreneurship	concepts of entrepreneurship.	
	Provide an understanding of the problems and challenges faced by entrepreneurship in chemistry education.	
	Clarification of the importance of entrepreneurship in biology education.	
	Shed light on the teaching of entrepreneurship in a primary education life science curriculum.	
	Discussion of the great gap between creating job opportunities and education in terms of science and technology education.	
	Emphasize the need to develop the entrepreneurial characteristics of chemistry graduates from the view point of entrepreneurship in education.	
Applied studies	Providing training to teachers on being inventive and innovative, and becoming entrepreneurs.	6
	Explaining what engineering is in a science curriculum with the definition of science teachers, and explaining the development process of hands-on laboratory kits.	
	An examination of two science teachers who created entrepreneurial learning opportunities for students going beyond classroom practices in science education.	
	Development of entrepreneurial characteristics of scientists in the field of science at universities.	
	Identification of the difficulties faced by prospective teachers in the entrepreneur project development process.	
	Development, implementation and evaluation of a science-based enterprise training module in middle school science courses.	
Experimental studies	Investigation of the effect of a problem-based learning approach on students' higher-order thinking skills and the level of academic risk-taking.	3
	Examination of the effect of a problem-based learning approach on students' attitude towards the science and technology course and the effects of their academic risk-taking.	
	Determination of the effect of a project based learning approach on students' problem-solving skills and the effects of their academic risk-taking.	
Structuring the teaching curriculum	Discussion on the need to restructure science, technology and mathematics education in terms of entrepreneurship.	2
	Attention is drawn to the fact that an education curriculum for science teachers should be restructured in terms of entrepreneurial education.	
Teaching curriculum	Investigating the acquisitions of a science curriculum in terms of entrepreneurial characteristics.	2
	Investigation of the Primary Education Life Science teaching curriculum in terms of entrepreneurial characteristics.	
Scale development	Developing an entrepreneurship scale for prospective science teachers.	2
	Development of a science laboratory entrepreneurship scale.	
Other	Suggest ideas and activities that will enable students to take risks.	1

When the aims of the studies are examined, it seems that a large number of studies aim to determine the perceptions or competencies of educators, teachers, prospective teachers and students (15). On the other hand, in some research, emphasis is placed on the importance of the concept of entrepreneurship and entrepreneurial characteristics (6). In addition to these aims, variables affecting academic risk taking have been investigated

using experimental investigations (3). Furthermore, studies have been encountered that were aimed at restructuring a science teaching curriculum in terms of entrepreneurship (2); aimed at examining a science teaching curriculums in terms of acquisitions, workbook activities and textbook activities (2); aimed at developing a scale (2); and aimed at suggesting ideas and activities that will enable students to take risks (1). Table 5 shows the distribution of studies in terms of preferred methods.

Table 5. *Distribution of studies according to preferred methods*

Research approach	Methods	f	Total
Quantitative research	Survey research	9	12
	Experimental research	3	
Qualitative research	Phenomenological research	7	13
	Case studies	2	
	Stated that only qualitative research	4	
Other	Literature review / Theoretical research	8	13
	Unspecified	5	

When table 4 is examined, it was seen that the survey research method was preferred in some studies (9), and the experimental research method was preferred by other studies (3) in the quantitative research category. According to the qualitative research category, it was determined that some studies used a phenomenological research method (6); two studies preferred the case study method, and some researchers simply explained that they used a "qualitative method" (4). Additionally, some research was carried out as a literature review and theoretical research (8), whereas in other research it was observed that there was no statement about the method of study (5).

Table 6. *Distribution of studies according to preferred data collection tools*

Data Collection Tools	f
Likert scales / Graduated scales	13
Interviews	12
Open ended questions	4
Documents / Archives (workbook, textbook, learning outcomes etc.,)	3
Observations	2
Field notes	1
Unspecified	9

As seen in Table 6, researchers preferred Likert type scales to obtain data (13) - this was followed by collecting data through interviews (12). In addition, it was observed that open-ended questions (4) are also used to gather data. Moreover, it has also been found that studies benefit from observations (2) and field notes (1). Distribution of the studies according to preferred sample groups is given below.

Table 7. *Distribution of the studies according to preferred sample groups*

Participants / Sample	Level	f	Total
Educator / Teacher	Primary school	1	17
	Middle school	8	
	High school	5	
	University (academic-lecturer)	4	
Student	Primary school	0	13
	Middle school	3	
	High school	3	
	University (prospective teachers)	7	
Unspecified		11	11

When the preferred sample groups in Table 7 are looked at, it can be seen that some research preferred educators who were working at primary school level (1), working at middle school level (8), working at high school level (5), and working at university level (4). Moreover, it was observed that other research preferred students who received training in middle schools (3), students who received training in high schools (3), and prospective teachers who received training at university (7). On the other hand, it was determined that there was no expression concerning sampling in the rest of the studies (11). Findings obtained from the research results are given below.

Table 8. *Distribution of studies according to obtained results*

Themes	Codes	f
Educators	Teachers have enough knowledge about the concept of creativity and entrepreneurship, and they have taken into account verbal expressions in order to gain entrepreneurial characteristics.	8
	It has been stated that teacher trainers focus on the risk taking characteristic of students, they include cooperative learning, and invite entrepreneurs into the classroom.	
	Teachers believe that they should have entrepreneurial characteristics, such as effective communication, effective planning, competitiveness and risk taking.	
	Teachers are informed about entrepreneurship in education, and they have become more conscious about the possibilities and meanings of entrepreneurial education.	
	It is stated that teachers' entrepreneurial activities create an innovative learning field; for students, educational opportunities are supported by external society.	
	It is concluded that entrepreneurial scientists could evaluate candidates in various positions for science-based innovation.	
	It has been determined that teacher trainers are involved techniques like teamwork and brainstorming in their classes, and they focused on characteristics of creativity and risk taking for students.	
	It has been pointed out that the entrepreneurial characteristics of teachers influence the development of the entrepreneurial characteristics of students.	
Students and prospective teachers	It is stated that prospective teachers find entrepreneurial education very important in terms of it being in their educational curriculum.	6
	It is stated that prospective science teachers have many more entrepreneurial characteristics than among the teacher education departments of Turkish, Science, Mathematics, English, Primary School, and Pre-school.	
	It is stated that men are better than women in terms of taking risks and being innovative, and that senior prospective science teachers have more innovative characteristics than other grade levels.	
	It was determined that students with a kinaesthetic learning style were more effective in their entrepreneurial characteristics.	
	It was determined that science-based, entrepreneurial education modules positively reflected students' awareness on entrepreneurship.	
	It is stated that this situation reflects positively on the scientific process skills of students when their entrepreneurial characteristics are increased.	
Integration of entrepreneurship with	The result is that science teachers have a positive perception about integrating entrepreneurship with science education.	6

science education		In terms of entrepreneurship, it is stated that the curricula of chemistry teaching should be reviewed and changed.	
		It is stated that entrepreneurship training has to be included in chemistry education.	
		One of the steps in the process of change in science and technology education is to create an entrepreneurial environment.	
		In order to increase entrepreneurship in biology education, biology has played an important role in enhancing national development.	
		It is stated that an entrepreneurial education should be a part of teacher education curriculums, especially in the field of chemistry education.	
Curriculum		It has been determined that acquisitions in the primary school curriculum do not meet a majority of entrepreneurial characteristics.	6
		In terms of entrepreneurial characteristic, the acquisitions of the 2005 Life Science Curriculum have become more prominent, but not sufficient, in comparison to previous years.	
		Emphasis is on the appropriateness of the acquisitions of the curriculum to the student level, and the preparation of the learning and teaching environments supporting the entrepreneurship of the teachers.	
		It was emphasized that entrepreneurship should be included among the purposes of teachers' education curriculum.	
		It has been suggested that a learning model composed of 5-steps can be used in a science curriculums	
		Risk taking levels are divided into 5 categories and sample activities are introduced.	
Experimental Results		It is concluded that the project-based learning approach has a positive effect on the risk taking characteristics of students.	3
		It has been determined that the probing-based learning approach has a positive effect on the level of taking risks of students.	
		It has been determined that the probing-based learning approach has no effect on the level of taking risks of students.	
Development of scale		It appears that a scale consisting of taking risks, being innovative, self-confidence, seeing opportunities and emotional intelligence has been developed.	2
		It appears that a scale consisting of communication, self-efficacy, taking risks, the need for success and creativity has been developed.	
Deficiencies	Students	It has been stated that physics students have low entrepreneurial characteristics.	6
	Prospective teachers	It has been stated that no courses in teacher education will increase the understanding of innovation and entrepreneurship of prospective teachers.	
		It has been determined that prospective teachers have a limited and insufficient understanding of entrepreneurship.	
		It has been determined that prospective teachers have difficulty in creating innovative ideas and foreseeing unexpected situations.	
	Teachers	It is stated that the teachers do not have enough knowledge about engineering, and they do not consider important elements about engineering.	
		It is stated that teachers do not have the necessary knowledge about entrepreneurship.	

Table 8 shows that the results for educators obtained in the studies are much higher (8). Also, it has been reached the results about the integration of entrepreneurship into the science curriculum (6). It is seen that the results related to the acquisitions, goals and activities of the teaching curriculums have also been reached (6). Moreover, results related to deficiencies or difficulties faced, in terms of students, teachers, and prospective teachers, have also been reached (6). Some of the studies have been reached the positive results about students and prospective teachers (6). In the studies composed taking into account expremental design, researchers focused on characteristics of taking risk (3). In addition to, it is seen that there are studies towards Likert type scale development in the literature (2). Table 9 below gives the distribution of studies according to suggestions.

Table 9. *Distribution of studies according to suggestions*

Themes	Codes	f
Suggestions for Teacher Education	(4) Science teachers must be educated through in-service education, continuing education or seminars.	13
	Duties ensuring prospective teachers communicate with different institutions or organizations should be increased.	
	Entrepreneurship in education should be an integral part of science teachers' curriculums and integrated into all disciplines.	
	Entrepreneurship in education should be integrated into science teachers' curriculums. Also, it should be integrated into science subjects in particular.	
	Educational content should be given that will increase prospective teachers' knowledge and experience related to entrepreneurship in science education.	
	Seminars and workshops related to entrepreneurship must be arranged that allow the participation of prospective teachers.	
	Entrepreneurship in education should be made part of teacher education in terms of chemistry education.	
	Teachers should try to understand the problems students face in the process of improving their entrepreneurial characteristics.	
	Entrepreneurial scientists should establish an effective communication network.	
	Entrepreneurship in education among teachers should be emphasized, and a suitable environment for this education should be provided.	
Suggestions for approach, strategy, method, technique and learning environments	Minor projects should be carried out using accessible materials for entrepreneurial teaching in chemistry education in schools.	9
	Science educators should benefit from additional methods and techniques in entrepreneurial education, such as probing-based learning, collaborative learning, creative problem-solving techniques, a learning diary and project-based learning.	
	Interactive demonstrations should be made using an innovative laboratory kit related to entrepreneurship and engineering for 9-12 grade level.	
	Strategies, methods, techniques, models and course content will positively affect entrepreneurial characteristics, and should be prepared by increasing the number of applied studies.	
	For students, visits must be organized to various industries, zoos and fields related to biology.	
	In order to support entrepreneurship, appropriate learning-teaching environments should be prepared that are open to teachers.	
	Activities should be created to improve the entrepreneurial characteristics of students.	
	Training environments should be equipped with more human resources in parallel with developments over time.	
	Students should be supported by student-centred learning approaches to ensure that they can take risks	
Suggestions for curriculum	Entrepreneurial acquisitions should be added to the curriculum at each grade level of primary education according to the development of the individual.	7
	Acquisitions that can benefit entrepreneurial characteristics should be given more prominence in future studies on life science, curriculum development.	
	An entrepreneurial education, and concepts related to this education, should be	

	included in all educational curriculums.	
	Entrepreneurial characteristics and creativity must be gained to students at an early age.	
	Entrepreneurial characteristics must be integrated with scientific process skills.	
	Science, technology and mathematics curriculums must be restructured to include entrepreneurship.	
	Chemistry students' productivity skills should be further supported.	
Suggestions for applied studies	Applied studies on entrepreneurship in science education should take into account variables of participants' gender, work experience, reward and grade level.	6
	The training modules that are most effective in developing entrepreneurial characteristics should be determined.	
	A learning model called "entrepreneurial scientific thinking" has been proposed.	
	Different methods should be tried to improve students' high-order thinking skills, and to develop risk taking.	
	The levels of entrepreneurial characteristics acquired by students in private schools should also be studied, and in different science subjects.	
	For students with kinaesthetic and visual learning styles, students should be directed to entrepreneurship by preparing appropriate learning environments.	
Suggestions for survey study	Survey studies should be carried out using laboratory entrepreneurship scales, developed according to different variables.	2
	Comparative studies should be conducted using a developed entrepreneurship scale.	
Unspecified		1

As seen Table 9, a large majority of the suggestions are stated towards teacher education (13). There are also suggestions on approach, strategy, method, technique and learning environments to realize entrepreneurship in science education (9). Moreover, it seems that thee are suggestions regarding the structure of a science teaching curriculum in terms of acquisitions, concepts related to entrepreneurship, and entrepreneurial characteristics (7). On the other hand, it is also possible to see suggestions for applied studies (6), and for survey studies (2).

DISCUSSION and CONCLUSION

a) General Characteristics

When the general characteristics are examined, it is apparent that in recent years an increasing number of studies have been published on entrepreneurship in science education; this shows that interest in, and the importance of, entrepreneurship is growing. This situation can be attributed to the concept of entrepreneurship that has become more pronounced in the field of science education in recent years, consequently this concept began to take place in the science curriculum. For example, in a European Commission report on science education, it was emphasized that the links between science, creativity, entrepreneurship and innovation must be strengthened (European Commission, 2015). As a result, this has been included the concept of "entrepreneurship" among the life skills in the 2013 and 2017 science curriculum for grades 5-8 in Turkey (Ministry of Education, 2013; 2017). Therefore, it can be said that entrepreneurship is integrated with the science curriculum in Turkey. On the other hand, Finland, which has a broad education strategy concerning entrepreneurship in its latest five-year development plan for education and research (2011-2016), has aimed to develop entrepreneurship at all levels (Audiovisual and Culture Executive Agency, 2012). These developments, both internationally and nationally, may have led to the search for entrepreneurship in science education in scientific research.

Moreover, in the current study, according to author numbers, it appears that articles with a small number of authors were published. This situation can be attributed to the fact

that there are no projects or cooperative work in this area, because entrepreneurship is a new research topic in science education. We know that when publications emerge from projects or collaborative research they can have multiple authors. However, in the coming years it could be possible to see publications by multiple authors in this area. Finally, it was observed that in terms of publication type, publications are mostly printed as articles. It was also determined that there are few conference presentations and theses.

b) Aims

When the distribution of publications is examined according to their aims, it is noteworthy that they aim at getting participants' opinions, perceptions and qualifications about entrepreneurship in science education (Armstrong & Tomes; 2000; Bolaji, 2012; Çelik, Gürpınar, Başer & Erdoğan, 2015; Deveci, 2016b; Deveci & Seikkula-Leino, 2016). Furthermore, it seems that studies whose aims are theoretical, or are a literature review on entrepreneurship in science education, seem to be more numerous (Deveci & Çepni, 2014; Ezeudu, Ofoegbu & Anyaegbunnam, 2013; Nwakaego & Kabiru, 2015). This can be attributed to giving priority to studies designed as theoretical or literature reviews, which is informative in this respect as entrepreneurship is a new research topic in science education. Therefore, when an original research problem is defined, the current situation should be determined first, then educational dimensions about the related concept should be discussed.

It can also be seen that the number of studies aiming at developing the education module (the curriculum and the teaching process related to entrepreneurship), seems to be quite high (Kleppe, 2002). The cause of this situation can be attributed to researchers progressively focussing on the practice dimension about entrepreneurship in science education. This is because how entrepreneurship is integrated into science education is a subject of curiosity in the literature.

On the other hand, experimental studies examining the impact of different variables on the ability to take risks were also found in the literature (Çelik, 2010; Çınar, 2007; Yıldız, 2012). It is noteworthy that these research studies especially focused on the characteristic of taking risks. This situation is normally acceptable because the most emphasized characteristics in an entrepreneurial education is the characteristic of risk taking. Thus, risk taking is an accepted prerequisite for success (European Commission, 2014). In this sense, a researcher suggested activities for developing the characteristics of risk taking (Young, 1991).

Moreover, it is also possible to see studies that intend to focus on the restructuring of science teaching curriculums in terms of entrepreneurship (e.g. Ezeudu et al., 2013), and some studies aim to examine learning outcomes in terms of entrepreneurship (Güven, 2009; Güven; 2010). In this instance, the question that arises is to what extent the structure of teaching curriculums are appropriate to gain entrepreneurial characteristics. As expected, it seems that some researchers intend to solve this problem using both curriculum construction and current acquisitions. In addition, some researchers developed scales about entrepreneurship in science education (Çelik, Bacanak & Çakır, 2015; Deveci & Çepni, 2015a). It can be said that Likert type scales are needed to observe the development of some entrepreneurial characteristics in students or prospective teachers.

c) Method

When the studies were examined in terms of method, it was observed that many more used a survey or phenomenological research. The fact that the survey research method is too high indicates that studies about the opinions of participants about entrepreneurship are weighted. Therefore, these findings can be interpreted in that most researchers first try to

determine the opinions of educators, students or teachers who have encountered new concepts, such as the concept of entrepreneurship. We know that the survey research method could be used to obtain some aspects or properties of a particular group on a topic, e.g. abilities, opinions, attitudes, beliefs, and/or knowledge (Fraenkel & Wallen, 2006). Similarly, the reason why the phenomenological research method is preferred can be attributed to researchers who want to determine the perceptions of educators, students or teachers about their knowledge and experiences regarding entrepreneurship.

It was stated that an experience has a different meaning for different people (Ary, Jacobs, Sorensen & Razavieh, 2010). It was seen that there are many more literature reviews and theoretical research about entrepreneurship in the science education literature (Adeyemo, 2009; Deveci & Çepni, 2014; Ejilibe, 2012). Actually, it can be said that the educational dimension of entrepreneurship has not become widespread in the literature of science education until recently, therefore in recent years researchers have tried to clarify what this means. For example, Ezeudu et al., (2013) shed light on the importance of entrepreneurship in chemistry education. Similarly, Ejilibe (2012) draws attention to the importance of entrepreneurship in biology education. On the other hand, Deveci and Çepni (2014) draw attention to the importance of dimensions like environment, pedagogy, educator, school, administrator, business world, and science teacher education. Accordingly, it may be said that the number of literature reviews and theoretical research regarding the importance of the educational dimension of entrepreneurship in science education will increase in the coming years.

d) Data Collection Tools

In the studies under investigation it was noted that the most preferred data collection tools were Likert type scales and interviews (Agommuoh & Akanwa, 2014; Boloji, 2012; Deveci & Çepni, 2015b; Deveci, 2016b). The preference of Likert type scales indicates that more studies were conducted on large sample groups. On the other hand, the preference of interview method showing that there are the studies was conducted on small sample groups. Therefore, it can be said that both Likert type scales and interviews are preferred at approximately the same rate in the literature. However, some of the data collection tools are not preferred, e.g. observations and field notes.

e) Sample Group

The research preferred educators as participants (Deveci & Seikkula-Leino, 2016; Hsiao, 2010; Koehler, 2013; Habila-Nuhu-Clark & Pahalson, 2014). In fact, it is a matter of curiosity as to what kind of practices educators do related to entrepreneurship, and what the educators think about it. For this reason, it can be said that many more studies are conducted on educators. In parallel with this situation, it was also observed that many more studies are conducted on students (Çınar, 2007; Deveci, Zengin, & Çepni, 2015; Yıldız, 2012). Therefore, it appears that studies are widely used to determine what variables influence the entrepreneurial characteristics of students, e.g. risk taking (Çelik, 2010; Çınar, 2007; Yıldız, 2012). Moreover, research carried out on prospective teachers is also quite high (Çelik, Bacanak & Çakır, 2015; Deveci, 2016b; Deveci & Çepni, 2015b). This situation indicates that the dimension of teacher education of entrepreneurship should not be ignored. This is because it is crucial that prospective teachers, who are the practitioners of teaching curriculums, understand the educational dimension of entrepreneurship.

f) Results

It is noteworthy that there are much more the results reached about educators in investigated studies (Agommuoh & Akanwa, 2014; Bacanak, 2013; Deveci, 2016b; Deveci

& Seikkula-Leino, 2016; Kleppe, 2002). In this sense, it could be said that science teachers or educators, who have great responsibility as practitioners of a new concept like entrepreneurship in science education, play an important role. Thus, it seen that the most emphasized dimension for entrepreneurship from an educational perspective in the European Commission reports is teacher education (European Commission, 2011; European Commission, 2013).

In the research, it is seen that researchers have tried to clarify subjects, such as what entrepreneurial characteristics teachers should have, what methods and techniques teachers should use, what activities teachers should undertake outside school, what entrepreneurial characteristics of students teachers should develop, and what knowledge and experience teachers should have about entrepreneurship.

Another point highlighted from the research results is that entrepreneurship must be integrated with science education (Abdu, 2011; Achor & Wilfred-Bonse, 2013; Deveci & Çepni, 2014; Ugwu, Laah & Olotu, 2013). This situation can be attributed to the fact that entrepreneurship and science education have common goals. As a matter of fact, it has been emphasized that the concept of entrepreneurship can easily find applications in areas of physics, chemistry and biology (Abdu, 2011, Agommuoh & Akanwa, 2014; Ezeudu et al., 2013; Ejilibe, 2012; Nwakaego & Kabiru, 2015).

Another point, drawn from the research results, is that of teaching curriculums. Some studies examined the aims and acquisitions of science curriculums (Güven, 2009; Güven 2010). Other studies make recommendations for activities and a learning model (Buang & Halim, 2007; Young, 1991). In fact, it can be said that research, which examines entrepreneurial characteristics in science teaching curriculums, has an important role in developing science curriculums. Therefore, the number of such studies is expected to increase in the coming years.

On the other hand, another factor that attracts attention in the research results is that of deficiencies for entrepreneurship. There are some shortcomings in terms of students, teachers and prospective teachers. For example, some studies indicated that teachers do not have sufficient knowledge and experience about engineering and entrepreneurship (Bacanak, 2013; Hsiao, 2010). It is also stated that prospective teachers' knowledge and experience about entrepreneurship is inadequate (Deveci, 2016b). It can be said that these results are very important for science teacher education. It is possible to prepare action plans that identify deficiencies in developing entrepreneurship within science teacher education.

g) Recommendations

In many studies, it is recommended that entrepreneurship must be part of science teachers' education (Hilario, 2015; Achor & Wilfred-Bonse, 2013; Nwakaego & Kabiru, 2015). In fact, this suggestion may seem right. This is because entrepreneurship has not yet become fully widespread in science teacher education. Thus, teacher training curriculums do not have adequate training in entrepreneurship (Seikkula-Leino, Ruskovaara, Hannula & Saarivirta, 2012). In this sense, attention is drawn to the need for good teacher education in order to benefit from entrepreneurial training in the field of education (European Commission, 2013). In the suggestions of some studies should be given in the educational process that allows prospective teachers to gain knowledge, skills and experience about entrepreneurship (Deveci, 2016a; Deveci, 2016b; Pan & Akay, 2015). It could be said that these suggestions reveal a lack of science teacher education in terms of entrepreneurship in education.

The recommendations of some studies seem to be related to the methods and techniques approach, strategy, method, technique and learning environments (Abdu, 2011;

Hsiao, 2010). These suggestions show that teachers have difficulty regarding the implementation of entrepreneurship. It was stated that they have problems in finding methods and content for entrepreneurship in the educational process (Seikkula-Leino, 2008; Solomon, 2007). In this sense, it appears that there are considerably more suggestions for a science curriculum related to entrepreneurial characteristics (Güven, 2010; Kleppe 2002; Buang & Halim, 2007). These suggestions can be generally be interpreted to mean that a science curriculum is not sufficiently developing the entrepreneurial characteristics of students. This is because it is known that science curriculums are not prepared taking into account the concept of entrepreneurship. In some studies, it is recommended that applied studies and survey studies should be carried out (Buang et al., 2009; Çınar, 2007; Deveci & Çepni, 2015a; Nwoye, 2012).

Finally, it is noteworthy that studies on entrepreneurship have been published at all in recent years. Also, most of the studies' aims were to determine perceptions, opinions and competences about entrepreneurship. Moreover, in terms of method, survey research, literature review, theoretical research and phenomenological research were preferred by most studies. In terms of data collection tools, most studies preferred Likert type scales and interviews. Furthermore, in terms of sample groups, most studies preferred middle school science teachers and prospective science teachers. In the most of the studies were reached the results for educators/teachers. Most of the suggestions has been stated for science teacher education.

h) Recommendations of current research

The following proposals can be made about conducting studies on entrepreneurship in science education:

- In terms of methods for future research, experimental design, action research and a case study may be preferred.
- It can be said that, in terms of sample groups, the number of studies conducted on primary school teachers and middle school students can be increased.
- In future research, studies could be conducted related to entrepreneurship in pre-school science education.

REFERENCES

*Abdu, B. (2011). Chemistry education and entrepreneurial development in Nigeria: Issues and challenges. *Coconut volume, 4*(1), 107-114.

*Achor, E.E., & Wilfred-Bonse, K. U. (2013). The need to integrate entrepreneurship education into science education teachers' curriculum in Nigeria. *Journal of Science and Vocational Education, 7,* 111-123.

*Adeyemo, S.A. (2009). Understanding and acquisition of entrepreneurial skills: A pedagogical re-orientation for classroom teacher in science education. *Journal of Turkish Science Education, 6*(3), 57-65.

*Agommuoh, P.C., & Akanwa, U.N. (2014). Senior secondary school physics teachers assessment of enterpreneurial skills needed for global competitiveness. *IOSR Journal of Research & Method in Education, 4*(1), 25-29.

*Armstrong, P., & Tomes, A. (2000). Entrepreneurship in science: Case studies from liquid crystal application. *Prometheus, 18*(2), 133-147.

Ary, D., Jacobs, L.C., Sorensen, C., & Razavieh, A. (2010). *Introduction to research in education* (8th edition). Belmont: Wadsworth Cengage Learning.

Audiovisual and Culture Executive Agency, (2012). *Entrepreneurship education at school in europe, national strategies, curricula and learning outcomes*. by the Education,

Audiovisual and Culture Executive Agency (EACEA P9 Eurydice and Policy Support). ISBN 978-92-9201-252-6. doi:10.2797/80384

*Bacanak, A. (2013). Teachers' views about science and technology lesson effects on the development of students' entrepreneurship skills. *Educational Sciences: Theory and Practice, 13*(1), 622-629.

*Bolaji, O.A. (2012). Intergrating enterpreneurship education into science education: Science teachers perspectives. *Journal of Science, Technology, Mathematics and Education (JOSTMED), 8*(3), 181-187.

*Buang, N.A., & Halim, L. (2007). *Development of entrepreneurial science thinking model for malaysian science and technology education*. Seminar Pendidikan Kejuruteraan dan Alam Bina (Seminar on Engineering and Natural Development Education), Malaysia.

*Buang, N. A., Halim, L., & Meerah, T. S. M. (2009). Understanding the thinking of scientists entrepreneurs: Implications for science education in Malaysia. *Journal of Turkish Science Education, 6*(2), 3-11.

Calik, M., & Sözbilir, M. (2014). Parameters of content analysis. *Egitim ve Bilim*, *39*(174), 33-38.

*Chigozie, S.N.N. (2014). *Assessment of productive skill competency levels based on gender among senior secondary school chemistry students for entrepreneurship*. Thesis of Doctorate Degree, Faculty of Education, Mnamdi Azikiwe University, Awka.

Çalık, M., Ayas, A., & Ebenezer, J.V. (2005). A review of solution chemistry studies: Insights into students' conceptions. *J Sci Educ Technol*, *14*(1), 29–50.

*Çelik, E. (2010). *The effect of problem based learning approach in science education on students' academic achievement, attitude, academic risk taking level and retention of knowledge.* Unpublished master's thesis, Gazi University, Ankara.

*Çelik, H., Bacanak, A., & Çakır, E. (2015). Development of Science Laboratory Entrepreneurship Scale. *Journal of Turkish Science Education*, *12*(3), 65-78.

*Çelik, H., Gürpınar, C., Başer, N., & Erdoğan, S. (2015). Öğrencilerin yaratıcı düşünme ve girişimcilik becerilerine yönelik fen bilgisi öğretmenlerinin görüşleri. *Uluslararası Eğitim Bilimleri Dergisi*, 2(4), 277-307.

*Çetin, B. (2015). *The examınatıon of entrepreneurıal skılls on students accordıng to learnıng styles*. Unpublished master's thesis, Kırıkkale University, Kırıkkale.

*Çınar, D. (2007). *The effects of the problem based learnıng approach on the hıgher level thınkıng skılls and levels of academıc rısk takıng ın prımary scıence educatıon*. Unpublished master's thesis, Selçuk University, Konya.

*Deveci, I. (2016b). Perceptions and competence of Turkish pre-service science teachers with regard to entrepreneurship. *Australian Journal of Teacher Education*, *41*(5), 153-170.

*Deveci, İ. (2016a). Science-based entrepreneur project development process for pre-service science teachers. *Research in Teacher Education, 6*(1), 30-35

*Deveci, İ., & Çepni, S. (2014). Fen bilimleri öğretmen eğitiminde girişimcilik. *Journal of Turkish Science Education, 11*(2), 161-188.

*Deveci, İ., & Çepni, S. (2015a). Öğretmen adaylarına yönelik girişimcilik ölçeğinin geliştirilmesi: Geçerlik ve güvenirlik çalışması. *International Journal of Human Sciences*, *12*(2), 92-112.

*Deveci, İ., & Çepni, S. (2015b). Examining science teacher candidates' entrepreneurial characteristics according to some variables. *International Online Journal of Educational Sciences*, *7*(3), 135 – 149.

*Deveci, İ., & Seikkula-Leino, J. (2016). Finnish science teacher educators' opinions about the ımplementation process related to entrepreneurship education. *Electronic Journal of Science Education*, *20*(4). 1-20.

*Deveci, İ., Zengin, M.N., & Çepni, S. (2015). Fen tabanlı girişimcilik eğitimi modüllerinin geliştirilmesi ve değerlendirilmesi. *Journal of Educational Sciences & Practices*, *14*(27), 59-80.

*Ejilibe, O. C. (2012). Entrepreneurship in biology education as a means for employment. *Knowledge Review, 26*(3), 96-100.

*Eraslan, L. (2011). Entrepreneurship teaching at primary education curriculum (sample of life science lesson). The *Journal of The Industrial Arts Education Faculty of Gazi University, 27*, 82-94.

European Commission, (2011). *Entrepreneurship education: enabling teachers as a critical success factor. A report on teacher education and training to prepare teachers for the challenge of entrepreneurship education*. Final Report, Entrepreneurship Unit, Bruxelles.

European Commission, (2013). *Entrepreneurship education: a guide for educators*. June 2013. European Union, Bruxelles: Entrepreneurship and Social Economy Unit.

European Commission, (2014). *Entrepreneurship Education: A Guide for Educators*. Entrepreneurship 2020 Unit Directorate-General for Enterprise and Industry, 1049, Brussels. doi:10.2769/51003

European Commission, (2015). *Science educatıon for Responsible Citizenship. Report to the European Commıssıon of the expert group on scıence education*. Luxembourg: Publications Office of the European Union.

European Commission (2016). *Entrepreneurship Education at School in Europe*. Eurydice Report. Luxembourg: Publications Office of the European Union.

*Ezeudu, F.O., Ofoegbu, T.O., & Anyaegbunnam, N.J. (2013). Restructuring STM (Science, Technology, and Mathematics) Education for entrepreneurship. *US-China Education Review A, 3*(1), 27-32.

Fraenkel, J. R., & Wallen, N.E. (2006). *How to design and evaluate research in education (*6th Edition) New York: McGraw Hil,

Gartner, W.B. (1988). Who Is an Entrepreneur? Is the wrong question. *Entrepreneurship Theory and Practice, 13*(4), 47-68.

*Güven, S. (2009). New primary education course programmes and entrepreneurship *Procedia-Social and Behavioral Sciences, 1*(1), 265-270.

*Güven, S. (2010). Hayat bilgisi dersi öğretim programlarının girişimcilik özellikleri açısından incelenmesi. *NWSA: Education Sciences, 5*(1), 49-57.

*Hilario, J.S. (2015). Integrating an Entrepreneurial Motivated Approach (EMA) in teaching and learning of general chemistry. *International Journal of Innovative and Applied Research, 3*(5), 34-42.

*Hsiao, A. (2010, June). *Nanomaterials in Newfoundland: Designing a lab kit for grades 9-12 to bridge the gap between science and engineering*. Proceedings of the 1st CEEA Conference: Queen's University Kingston, Ontario.

*Kleppe, J.A. (2002). Teaching invention, innovation, and entrepreneurship to Northern Nevada high school science and math teachers. *IEEE Antennas and Propagation Magazine, 44*(5), 115-119.

Knight, F.H. (1921). *Risk, uncertainty and profit*. Boston: Houghton and Miffling.

*Koehler, J.L. (2013). *Entrepreneurial teaching in creating third spaces for experiential learning: A case study of two science teachers in low-income settings*. For The Degree of Doctor of Philosophy in Curriculum and Instruction, University of Illinois, Urbana, Illinois.

Kurnaz, M.A., & Çalık, M. (2009). A thematic review of 'energy' teaching studies: focuses, needs, methods, general knowledge claims and implications. *Energy Educ Sci Technol Part B Soc Educ Stud, 1*(1), 1–26.

Ministry of Education, (2013). *Primary schools (primary and secondary schools), science course (3, 4, 5, 6, 7 and 8. grades), Curriculum*, Ankara: Head council of education and morality.

Ministry of Education, (2017). *Primary schools (primary and secondary schools), science course (3, 4, 5, 6, 7 and 8. grades), Curriculum*, Ankara: Head council of education and morality.

*Nwakaego, O.N., & Kabiru, A.M. (2015). The need to incorporate entrepreneurship education into chemistry curriculum for colleges of education in Nigeria. *Journal Of Educatıonal Policy And Entrepreneurial Research*, *2*(5), 84-90.

*Nwoye, A.N. (2012). *Assessment of resources and the level of entrepreneurial skills acquired by secondary school physics students in anambra state*. A Thesis Presented To The Department of Science Education, Nnamdi Azikiwe University, Awka.

*Habila-Nuhu-Clark, M.D., & Pahalson, C.A.D. (2014). Entrepreneurship education for science teachers as a means of achieving national transformation. *International Journal of engineering Research and Applications, 1*(4), 153-156.

*Pan, V.L., & Akay, C. (2015). Eğitim fakültesi öğrencilerinin girişimcilik düzeylerinin çeşitli değişkenler açısından incelenmesi. *NWSA- Education Sciences, 9*(6), 125-138.

Peter, A., & Anne, T. (2000). Entrepreneurship in science: Case studies from liquid crystal applications. *Prometheus*, *18*(2), 133-148.

Schumpeter, J. (1934). *Theory of economic development: An inquiry into profits, capital, credit, ınterest and the business cycle*. Cambridge: Havard University Press.

Seikkula-Leino, J. (2008). *Advancing entrepreneurship education in the Finnish basic education – the prospect of developing local curricula*, in Fayolle, A. and Kyro, P. (Eds), *The Dynamics between Entrepreneurship, Environment and Education*, pp. 168-90. Cheltenham: Edward Elgar Publishing.

Seikkula-Leino, J., Ruskovaara, E., Hannula, H., & Saarivirta, T. (2012). Facing the changing demands of Europe: Integrating entrepreneurship education in Finnish teacher training curricula. *European Educational Research Journal*, *11*(3), 382-399.

Solomon, G. (2007). An examination of entrepreneurship education in the United States. *Journal of Small Business and Enterprise Development*, *14*(2), 168-182.

*Ugwu, A.I., Laah, E., & Olotu, A. (2013, September). *Entrepreneurship; performance indicator for innovative/skill acquisition: Imperative to science and technology education (STE)*. World Conference on Science and Technology Education, Sarawak, Borneo, Malaysia.

Unal, S., Çalik, M., Ayas, A., & Coll, R.K. (2006). A review of chemical bonding studies: needs, aims, methods of exploring students' conceptions, general knowledge claims and students' alternative conceptions. *Res Sci Technol Educ*, *24*(2), 141–172

*Yıldız, Z. (2012). *The effect of project based learning approach to high school students' level of creative thinking, problem solving, taking academic risk*. Unpublished master's thesis, Gazi University, Ankara.

*Young, R.D. (1991). *Risk-taking in learning, K-3. nea early childhood education series*. National Education Association Professional Library, Washington :National Education Association.

Yücel-Toy, B. (2015). Türkiye'deki hizmet öncesi öğretmen eğitimi araştırmalarının tematik analizi ve öğretmen eğitimi politikalarının yansımaları. *Eğitim ve Bilim, 40*(178), 23-60.