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Measuring innovative literacy: conceptualization, scale development and validation

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Abstract

Purpose – There is a need to understand the role of innovative literacy in intellectual capital literature. This study aims to develop the innovative literacy scale, starting from the framework of innovative literacy, which is not prominent in the literature. Accordingly, this study develops and validates an innovative literacy scale.

Design/methodology/approach – A quantitative research methodology was used for this study, whereby a unipolar 5-point Likert scale self-report questionnaire was designed. Scale development analyses were performed in three steps: (1) The first item pool was created by literature review; (2) preliminary quantitative testing of the reliability and validity of the items, including confirmatory factor analyses (CFA), was performed; and (3) final scale validation through a discriminant and validity test was done using descriptive factor analyses (DFA) and structural equation modelling (SEM).

Findings – For the developed scale, the sample size was 220 in the first stage, 440 in the second stage, and 457 in the third stage. The validity and reliability analyses of the results were completed using Statistical Package for the Social Sciences (SPSS) and Analysis of Moment Structures (AMOS) programs. After the preliminary stages, the validity and reliability tests of the scale were carried out, and 17 items (in 4 dimensions) of the innovative literacy scale were finally developed.

Research limitations/implications – This research fills a conceptual gap in the literature. However, since this concept is evaluated using the human, customer and structural components of intellectual capital, future researchers may examine this concept together with other features of intellectual capital and with larger samples.

Originality/value – The article contributes to understanding innovation by developing a scale to evaluate InnoLiteracy, which may be an essential factor influencing innovative literate behaviours. The perceived multi-dimensional scale of InnoLiteracy will be beneficial for academicians and human resources professionals. Although there are studies in the related literature on the importance of the concept of innovative literacy, a scale from the perspectives of intellectual capital and sustainable innovation will be unique since there is no tool for its measurement yet. The findings of the InnoLiteracy research are meaningful, and the scale has the potential to meet the needs of researchers, schools, government agencies and businesses.

Keywords Innovative literacy, Innovative literacy scale, Innovation, Intellectual capital, Human capital

Paper type Research paper

1. Introduction

Due to the ever-increasing competition of today's business environments, developing innovation-related capabilities, both at the employee level and organisational levels, emerges as a necessity to build long-term competitive advantage (Klimontowicz, 2019).

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Hence, innovation is essential to organisational survival and success, with an increasing interest in academic and sectoral fields. Organisations should make the best use of their assets and capital in general, intellectual capital in particular to be more innovative. Intellectual capital as the combination of organisation's intangible assets (Wiig, 1997) is considered the primary antecedent for the organisational capacity to innovate and develop new products, services and solutions (Scafarto *et al.*, 2016).

Intellectual capital focuses on intangible assets and contributing to achieving competitive advantage and organisational goals (Hsu and Fang, 2009). Sveiby (1997) and Dierkes *et al.* (2003) suggested that through the effective use of these intangible assets, management can set strategic goals, thereby promoting the functioning and development of the organisational resources. Tangible assets are the conventional assets recognised on the balance sheet (Eustace, 2001). In contrast, the intangible ones refer to intellectual assets, capabilities, knowledge, culture, strategy, process, intellectual property and relational networks (Mouritsen, 2003). Focussing on exploring how an organisation can embrace innovativeness covers a large part of the innovation literature, addressing the unsubstituted role of intangible assets (Crossan and Apaydin, 2010). Intellectual capital is a critical antecedent to enhance and support continuous performance improvement in organisational performance (Marr and Schiuma, 2001). Organisation for Economic Co-Operation and Development (1999) defines intellectual capital as "the economic value of two categories of intangible assets of a company", that is, organisational and human capital. Human capital is intellectual capital's central element and is formed by the company individuals' competence, including knowledge, skills, experience, expertise and capabilities (Mention and Bontis, 2013; Vidotto *et al.*, 2017). Bontis (1998) argues that human capital, as a critical dimension of intellectual capital, is crucial since it serves as a source of innovation and strategic renewal.

Previous studies consider highly skilled human capital as a crucial dimension of innovation processes (Kianto *et al.*, 2017; Snell and Dean, 1992; Subramaniam and Youndt, 2005), highlighting the role of employees in firm innovativeness. Employees, who try to contribute to achieving organisational goals with an innovative tendency, are even more critical resource than other traditional resources, such as fixed or variable assets. In this, vein employees and their innovation-related skills, experience and knowledge refer to the specific characteristic of human capital. We expect one of those employee skills to be innovative literacy. Innovative literacy is the ability of individuals to manage their personal information and evaluate their behaviours to produce novel things in both short and long term, based on having an excellent investigative attitude to improve their work processes (Yüksel *et al.*, 2022). It refers to the basic skills that help understand the nature of innovation (Yüksel and Günce, 2017). Accordingly, innovative literate individuals are better aware of technological developments, and they have a better understanding of all innovation-related issues. Human capital is the entirety of the individual competencies of the employees. The products and services produced in organisations result from the employee's knowledge, experience and expertise (McGregor *et al.*, 2004). Thus, human capital with innovative literacy will contribute innovatively to organisational processes, such as decision-making, production and marketing.

This study aims to (1)enrich our understanding regarding innovative literacy, as a specific ability of human capital and (2) offer a tool to measure innovative literacy. The findings of this study will have important implications for scholars and industry professionals interested in innovation. A tool to measure innovative literacy will enable academicians, human resources managers and practitioners to evaluate the potential of human capital from an innovative base. Indeed, a well-designed innovative literacy tool that adequately captures and evaluates employee knowledge, skill and expertise regarding innovation, may give management a hint on the sufficiency of their human capital for superior innovative performance. In addition, defining and scaling the qualities that an innovative literate individual should have within

the human capital framework by expanding the boundaries will be a premise for future studies.

After an in-depth and detailed literature review of current definitions and measures, this study is divided into two parts. Firstly, it focused on developing the items and exploring the factorial structure of the innovative literacy scale structure. The second stage is based on the validity and reliability analysis of the innovative literacy scale. The innovative literacy scale developed as a result of the research will be an alternative measurement tool that other researchers can use. This resource anticipates that the article will fill a critical gap and contribute to strategic goals.

2. Literature review

The concept of intellectual capital is known to appeal to both practitioners and academics. The emerging field of intellectual capital is exciting for researchers and practitioners alike, as knowledge assets are on the verge of sustainable competitive advantage. The term "intellectual capital" first appeared in the popular press in Stewart's (1991) article entitled "Brain Power". Lynn (1998) describes intellectual capital as an intangible asset – knowledge that is transformed into some items of value to the organisation. Hudson (1993) quotes the economist Galbraith, who first used the term "intellectual capital" as early as 1969. Stewart (1994), Stewart (1997) indicated that means anything an enterprise can use to increase its competitive advantage in the marketplace, including knowledge, information, intellectual property rights and experience. Stewart (2001) argues that this goes back at least to 1958, while Marr (2005) claims it goes back even further.

Intellectual capital combines an organisation's intangible assets (Wiig, 1997; Organisation for Economic Co-Operation and Development, 1999). There are a variety of definitions and taxonomies regarding the content of intellectual capital. For instance, Edvinsson and Malone (1997), Stewart (1997), and Sveiby (1997). Stewart (1994), Edvinsson and Malone (1997), Johnson (1999), and Smith and Parr (1989), consider intellectual capital to be composed of three components: human capital, structural capital (organisational capital) and relational capital (customer capital). According to María Díez *et al.* (2010), intellectual capital is the combination of human, organisational and relational resources as well as an organisation's activities. There may exist a cause-and-effect relationship between human capital and other elements of intellectual capital, such that human capital may positively affect the other elements, and then these elements, in turn, affect performance outcomes (Scafarto *et al.*, 2016).

Human capital is the knowledge, skills and experiences that employees take with them when leaving a company. Employees generate such capital through their intellectual competence, attitudes and agility (Baima *et al.*, 2021). Different studies have coincided in defining human capital as the collective capacity of an organisation to develop the best solutions based on the combination of knowledge, capabilities and competencies of the individuals that compose an organisation, as well as the way in which they are managed and used (Edvinsson and Malone, 1997; Bontis, 1998; De Frutos-Belizón *et al.*, 2019). Lepak and Snell (1999) state that human capital provides an organisation with a crucial competitive advantage, giving employees unique and valuable skills. Creativity, attitudes, skills, experiences and knowledge of employees who make up human capital significantly affect the organisation's ability to innovate (Subramaniam and Youndt, 2005). Edvinsson and Malone (1998) highlighted the theory of human capital from the perspective of creativity and innovation. Bontis (1998) argues that human capital is substantial because it is a source of innovation and strategic renewal. Therefore, human capital is a fundamental building block in innovation activities (Yüksel *et al.*, 2022).

Undoubtedly, human capital's innovation-related knowledge, skills and expertise of human capital are worthy of examination. Innovative literacy is one of the novel concepts

related to human capital's innovative and creative features. In the following section, we will define innovative literacy and discuss its potential importance.

2.1 The definition and importance of innovative literacy

The extant literature considers highly skilled human capital as a crucial antecedent of firm innovativeness (e.g. Kianto *et al.*, 2017; Snell and Dean, 1992; Subramaniam and Youndt, 2005; Sun *et al.*, 2020). Firms will perform more innovatively when they have qualified human capital (Yüksel *et al.*, 2022). Nevertheless, what defines "qualified human capital" for superior innovative outcomes? We expect one of those qualities/skills to be innovative literacy. Innovative literacy is the ability of individuals to manage their personal information and evaluate their behaviours to produce novel things in both short and long term, based on having an excellent investigative attitude to improve their work processes (Yüksel *et al.*, 2022). Since literacy is defined as a continuum of learning that allows individuals to develop their knowledge and potential (UNESCO, 2008) innovative literacy refers to the possession and development of a better understanding of the nature of and the trends in innovation (Yüksel and Günce, 2017).

To strengthen innovation activities and achieve innovative outcomes, human capital needs to have innovative literacy. Innovatively literate individuals – who know innovation and can implement innovation-can better perceive and make sense of environmental changes, develop creative solutions and perform innovative behaviours. Human capital is entirely about the individual competencies of the employees. The products and services produced in organisations result from the employee's knowledge, experience and expertise (McGregor *et al.*, 2004). Thus, human capital with innovative literacy will contribute innovatively to organisational processes, such as decision-making, production and marketing. Moreover, qualified human capital is also a link between technological progress and socio-economic growth (Mincer, 1984). In this sense, nations as well as organisation require innovatively literate individuals to move further.

2.2 Innovative literacy scale

The current literature offers different approaches to how intellectual capital can be classified and measured. As Petty and Guthrie (2000) stated, intellectual capital research has a negligible innovation issue. In addition, there are very few studies investigating the effect of human capital on innovation. Innovation production requires special knowledge, skills and abilities that constitute individuals' human capital. The abstract output of invention directly affects intellectual capital through its components. Considering the complex and knowledge-based processes of intellectual capital, the nature of innovation, knowledge transfer and feedback, profoundly exploring the concept of innovative literacy becomes essential. Ferenhof *et al.* (2015) study findings make it possible to provide in-depth insights into their study, its dimensions and its development over time. While many studies in the literature present an approach to measure human capital (Vidotto *et al.*, 2017; Mention and Bontis, 2013; Dunham and Burt, 2014) bring forth one approach to quantify relation to their performance within in the dimension of organisations, however, their scale has some gaps in the measurement of human capital concerning the innovative features of human beings.

According to Yüksel *et al.* (2022) innovative literacy; is the ability of individuals to manage their personal information and evaluate their behaviou to produce new things in the short and long term, based on having an excellent investigative attitude to manage their working processes. According to the authors, individuals with innovative literacy are expected to have three basic abilities. These; include researching and evaluating information related to innovative decisions and using this information in solving problems.

Innovative literacy is the managerial and technical innovation activities of an employee at any level of the organisation by integrating his knowledge with a researcher, developer and innovative attitude in line with the institution's objectives. The importance of human resources and innovative thinking systematics has been examined in the literature with experimental and theoretical research in various dimensios. To advocate innovative literacy, it needs to be measured first and then based on the results, targeted interventions can be implemented.

There is yet to be a best or consensus solution for intellectual capital measurement, particularly human capital measurement (Lu *et al.*, 2010). Within the framework of the above explanations, there is theoretical information about the measurement of intellectual capital, and therefore human capital, although limited. Different models and taxonomies have been proposed (Stähle and Hong, 2002) nevertheless intangible assets, are difficult to measure (Bontis, 2001). A review of the literature shows that studies measuring and modelling human capital are scant. Here, a well-designed innovative literacy tool that adequately captures and evaluates employee knowledge, skill and expertise regarding innovation, may give management a hint on the sufficiency of their human capital for superior innovative performance. However, as far as we know, there is no such tool in the extant literature to measure innovative literacy. To fulfil this gap, we attempted to develop an innovative literacy scale. The following section provides the methodology of this scale development process.

3. Methodology

The research aims to develop an innovative literacy scale based on innovative literacy. The article's most important scientific contribution: The innovative literacy scale to be developed will play a role in efficiently using countries' human resources. Innovative literacy is included in a few studies in the literature. The findings of this article will provide new insights into the intellectual and human capital literature of innovative literacy. In addition, a validated scale that will fill the social sciences literature gap will benefit both academia and practitioners. The researcher may use it as a measurement instrument for further research on innovation performance.

There are few studies on conducting and reporting scale development attempts. Nevertheless, DeVellis's (2017), Kline's (2015), Sousa and Rojjanasrirat's (2011), and Nunnally's (1978) studies are widely accepted references in the scale development era. Our methodology is constructed based on these references. Moreover, we also followed De Frutos-Belizón *et al.* (2019), Vidotto *et al.*'s (2017), and Hee Kim (2006) studies since they tried to measure intellectual capital.

At this stage, we synthesise the findings from academic studies and to form a new conceptual view to integrate the theories to provide definitions of innovative literacy. We followed the planning, execution and reporting guidelines Tranfield *et al.* (2003) suggested. During the planning phase, a work plan was prepared and during the execution phase, keywords, data sources, and work selection criteria were determined and then, at the conclusion stage, the data were extracted and synthesised, and the findings were reported. Electronic databases sought were Emerald, Scholar, ScienceDirect, Scopus, Sage, PsycINFO, Taylor and Francis, Wiley, and Web of Science. The review of the literature in the previous sections of the article provided an overview of the work done by previous researchers to measure innovative literacy.

In the first stage, the literature was scanned in-depth and focused on finding the relevant concept, if any. As a result of the research, the concept of "innovative literacy" has not been found in the social sciences literature, except in Yüksel *et al.*'s (2022) study. Since there is no scale related to this concept, Davis (1992) principles were used to look at which questions/subjects should be evaluated. We used Yüksel *et al.*'s (2022) innovative literacy definition as a

beginning. Yüksel *et al.* (2022) define innovative literacy as "*the ability of individuals to manage their personal information and evaluate their behaviour to produce new things in the short and long term, based on having an excellent investigative attitude to manage their work processes*". This definition underlines three primary skills (1) the ability to search for new information, (2) evaluate this new information and (3) using it to solve problems. Based on those three skills, we developed our thematic word and searched those thematic words in publication titles, abstracts, keywords or full texts. At this point, we aimed to create a pool of questions by considering all the articles and scales that can measure innovative literacy. Studies on intellectual capital, in-house entrepreneurship, literacy, creativity, innovation capacity, employee innovation competence, innovation and organisational innovation, are similar to those (Kirton, 1976; UNESCO, 2008; Boeriswati, 2012).

As explained in detail by Lusardi and Mitchell (2014), four principles were considered in the design of these questions: The first is simplicity: The questions should measure knowledge of the building blocks essential for decision-making in an inter-temporal environment. Second is relevance: questions must relate to people's day-to-day financial decisions throughout their lifecycle; moreover, they should capture general ideas, not context-specific ones. The third is brevity: the number of questions must be sufficiently small to ensure widespread adoption, and the fourth is the capacity to differentiate.

An item pool can be a rich resource from which a scale can emerge. The item pool should contain many items suitable for the researched content (DeVellis, 2017). Based on these principles and explanations, the first statement pool of 114 items was created, accompanied by a literature review.

4. Result

An expert group of corporate elites with sufficient equipment and knowledge in the subject area understands the importance of working and can allocate enough time has been selected. It tried to express clearly what innovative literacy is to the participants. The characteristics of this expert group are given in Table 1.

According to DeVellis's (2017) recommendations, these items were sent to subject matter experts for feedback on content validity, clarity and developmental relevance. In addition, cognitive interviews were conducted with the pilots to identify and modify the elements that proved the draft questionnaire was problematic for the intended respondents. The first version of the scale was tried to be created on the experts' suggestions. The first requirement was to be clear about the originality of the items and what a scale would contain. To get the opinions of the experts, a 3-point rating was used. In the prepared form, experts were expected to choose one of the "appropriate", "partially appropriate" and "unsuitable" options for each item. Selected experts were asked to evaluate items in specific parameters such as relevance, acceptability, difficulty level and uncertainty. There were positive and negative comments.

In the next step, the statements in the experimental form with 114 statements were evaluated. Based on this review process and the focus group meeting held by the authors, the items were refined, developed and combined to form a preliminary scale consisting of 43 candidate items per sub-scale. Based on the statements obtained from the conceptual analysis

Table 1. Characteristics of the expert group

	Feature	Number
Gender	Female	4
	Male	5
	Academician (Educational Sciences + Statistics + Linguistics)	4
	Manager (Human Resources + R&D Specialist + Industrial Psychology)	5

evaluations and focus group meetings, the first pilot questionnaire containing 43 statements was thus created (Appendix).

4.1 First stage: a pilot survey study

The Likert scale was chosen to measure attitudes in the first version of the questionnaire. All the items were measured by using a seven-point Likert-type scale, with 1 = "strongly", disagree to = 5 "strongly agree". The first questionnaire was conducted to test the internal consistency and to reduce the number of items to a manageable size. The primary audience of this stage consists of middle and senior managers related to innovation. However, since it would not be possible to reach all people within the scope of this definition, the sample was narrowed, and The Scientific and Technological Research Council of Türkiye (TUBITAK), Universities, Research and Development Centers (R&D) and R&D institutions were chosen as the universe. The convenience sampling technique sent the questionnaires electronically to the accessible people with these qualifications in Türkiye. The implementation period of the survey was January–June 2021 period.

In the first version of the research, 550 people were sent a survey via e-mail, and it was seen that 220 people completed the survey entirely. The sample size was created by considering the scales created for the experiential value. In this study, based on generally accepted criteria, the sample size was determined not to be less than five times the number of items on the scale (Hair *et al.*, 2010). Since the study was conducted for scale development and will consist of three trial questionnaires, it would be sufficient for the sample number to be 220 in this first analysis. These analyses were made using the Statistical Package for the Social Sciences (SPSS) program. Since personal information is not crucial in the initial stages, demographic information is limited to the age range only at this stage. It was seen that the number of participants in the 26–35 age range was the highest, with 28.64%. The other age ranges were also close to each other.

Previous studies examined building on scale development and constructive validation literature (Hinkin, 1998; DeVellis, 2003; De Frutos-Belizón *et al.*, 2019). However prior studies have not examined the construct validity of the proposed scale and that the proposed scale is not based on validated scales. We used exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to assess internal consistency, using Cronbach's a to determine reliability (Hair *et al.*, 2006).

Structural concept validity and internal consistency tests were conducted to test the validity and reliability of the scales. EFA was performed to test the structural concept validity, and the Cronbach Alpha coefficient was calculated to test the internal consistency. EFA by Thurstone (1931), Thompson and Daniel (1996), and DeVellis (2017) will be performed to examine the covariance structure of the variables and to explain the relationships between these variables in terms of a much smaller number of unobserved latent variables called factors. The purpose of EFA is to reduce the factor structure of a set of variables by determining the number and nature of common factors. EFA is suitable for use in an exploratory study, especially when there is no prior theory about the interrelationship between variables (Stevens, 2002). The applicability of the factor analysis of the variables studied and the joint significance of the model was tested through the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity. In the preliminary evaluation to test the CFA suitability of the sample, it is understood that the data set is suitable for EFA since the KMO value is 0.916, the chi-square value obtained as a result of the Bartlett sphericity test = 16,288,176, the degree of freedom = 2556 and the level of significance (sigma) = 0.000.

As a result of the first analysis, a structure of 9 factors emerged that explained approximately 62% of the total variance. Thus, the overlapping and subsequent items with a factor load below 0.50 were removed from the scale. Then the change of factor loadings after

each subtraction was checked. This factor analysis process was repeated 15 times. When the factor loads that emerged from the EFA were examined, it was determined that there were ten problematic scale items. The EFA was repeated by eliminating ten questions gradually due to loading on a different factor, loading with factor loads less than 0.4, cross-loading and loading on an additional factor alone.

Factor loads are shown in Table 2. The current study follows the commonly used Cronbach alpha value of 0.70 or greater than 0.70 with a value of 0.82 (Cronbach, 1951; Lattin *et al.*, 2011; Nunnally, 1978). In this way, pre-determined and widely accepted criteria for internal consistency and factor analysis were followed by Field and Golubitsky (2009). As a result of CFA, it was determined that innovative literacy, consisting of 43 expressions, consists of a structure with five sub-dimensions (factors), which explains the total variance of 56,961.

Table 2. Distribution of first edition innovative literacy scale factor loads

	Factor load
IL1	
IL9 I can generate new ideas for solving problems	0.71
IL7 I have problem-solving skills	0.67
IL8 I think about how current problems can be solved with innovative methods	0.62
IL12 I am open to new ideas	0.62
IL10 I can see new opportunities and evaluate them	0.61
IL16 I synthesise information from different sources	0.59
IL5 I adapt quickly to innovations	0.59
IL15 I can use a systematic approach to solving problems	0.57
IL37 I am not afraid to try new things and make mistakes	
IL1 I am interested in inventions and discoveries	
IL2	
IL27 I know how to do primary research	0.69
IL3 I know how to conduct scientific research	0.69
IL14 I know what experimental research means	0.66
IL29 I know information collection sources	0.66
IL30 I follow scientific studies	0.52
IL2 I research topics that I am curious about it	
IL 3	
IL28 I know the concept of intellectual property rights	
IL26 I know the types of innovation	0.74
IL24 I know the concepts of innovation	0.73
IL23 I follow the support for innovation development	0.61
IL22 I am interested in innovation, R&D and project management	0.58
IL33 I would like to take part in innovation projects	0.51
IL 4	
IL34 I can use R&D and technology knowledge to solve daily problems	
IL35 I attach importance to accessing new information from a reliable source	0.64
IL13 I know what R&D means	0.62
IL39 I like to talk about new ideas, new products, etc.	0.57
IL25 I know the concepts of patent, inventions, etc.	0.57
IL40 I do not hesitate to ask questions when I want to learn new ideas	0.54
IL31 I think I am not inclined to new technology	0.52
IL5	
IL18 Intellectual property and patent issues are essential for innovation	
IL41 Many new ideas come to my mind in my daily routine	0.67
IL36 Researching and discovering something new is my passion	0.67
IL4 New ideas come to my mind all the time	0.65

Exploratory analyses show items loaded on each factor consistently. As a result of the study, a second version scale consisting of 33 items and five dimensions was obtained. Since this research will consist of 3 separate comments, it has been decided not to throw out more items and keep the statements that are thought to contribute to the theory conceptually, not discarding them at this stage and verifying with other analyses. Table 3 shows that the first statements were removed from the scale at this stage. Considering all these evaluations, the first structure of the "Innovative Literacy Scale" with five dimensions and 33 items was determined as a result of EFA. At this stage, the 33-items first version of the scale has a 5-factor structure with an eigenvalue greater than 1.

4.2 Second stage: substance purification phase

The 33-item questionnaire, which was reached because of the first analysis results, was applied again with 440 new participants. The most crucial point is that these consecutive analyses should not be done with the same sample. By adhering to this rule, a broad audience was reached. The sample of this stage consisted of academicians, students, corporate elites of the sector, R&D specialists, R&D Centres, Technopark and TUBITAK employees at universities with the convenience sampling method, at least within the constraint of high school graduates. In this stage, data from 440 participants are gathered.

The loadings factor provides evidence of adequate convergence of the constructs to evaluate the convergent validity. Convergent validity is accepted whenever factorial loads are higher than 0.5, and t coefficients are significant ($p < 0.001$) (Kline, 2015). So, we submitted to this new data to EFA. After the first loading, data with a load of 61.493% consisting of 7 dimensions, with KMO value was 0.936, were observed. To reach a more meaningful and interpretable solution, some items with low loadings or items loaded on more than one factor had to be deleted (Hair *et al.*, 1998). In the first elimination, items IL26, IL29, IL8, IL25, IL28 and IL11 were excluded because they did not load any factor, and item IL3 was excluded because of the overlapping load. After dropping those items, we submitted the data to EFA again. As a result, we obtained a total of 4 factors. The analysis results and factor load distributions are shown in Table 4. The eigenvalues of the factors are greater than 1 and explain 54.505% of the total variance. The total cumulative explanation percentage of the four factors obtained is 54,505%; the scale was studied for the first time. This figure shows that these four factors explain 54% of the change in the data set.

Moreover, we assessed the internal consistency or reliability of the scales by reporting Cronbach's a (Hair *et al.*, 2006; Kline, 2015). 0.7 is considered to be the threshold value Cronbach's a coefficients (Hair *et al.* (2006). The reliability analyses of the factors are summarised in Table 5, and it is seen that the Cronbach Alpha coefficients of all factors are above 0.7.

Table 3.
Substance Purification (10 extracted expressions)

Item no.	Issued item
IL42	Uncertainty scares me
IL19	I believe that innovation can solve many problems in the world
IL43	I give up when I fail in innovation efforts
IL6	I have a critical view
IL11	In a new study, I have trouble focussing on the target.
IL38	I can use past research results when I need them
IL21	I find it difficult to put knowledge into practice
IL32	I can reach experts in the field when I need them
IL17	Innovation is complex and tedious
IL20	It often takes time to get the information I need

Factors	Factor loads
IL 1	
IL24 I know the concepts of innovation	0.78
IL23 I follow the support for innovation development	0.78
IL22 I am interested in innovation, R&D and project management	0.73
IL26 I know types of innovation	0.70
IL34 I can use R&D and technology knowledge to solve everyday problems	0.56
IL8 I think about how current problems can be solved with innovative methods	0.52
IL18 Intellectual property and patent issues are essential for innovation	0.49
IL30 I follow scientific studies	0.46
IL2	
IL2 I research topics that I am curious about it	0.63
IL1 I am interested in inventions and discoveries	0.61
IL16 I synthesise information from different sources	0.56
IL7 I have problem-solving skills	0.56
IL12 I am open to new ideas	0.55
IL5 I adapt quickly to innovations	0.49
IL15 I can use a systematic approach to solving problems	0.47
IL 3	
IL41 Many new ideas come to my mind in my daily routine	0.78
IL4 New ideas come to my mind all the time	0.69
IL37 I am not afraid to try new things and make mistakes	0.62
IL10 I can see and evaluate new opportunities	0.61
IL39 I like to talk about new ideas, new products, etc.	0.54
IL40 I do not hesitate to ask questions when I want to learn new ideas	0.47
IL4	
IL27 I know how to do primary research	0.74
IL29 I know information collection resources	0.71
IL28 I know the concept of intellectual property rights	0.68
IL25 I know the concepts of the patent, invention, etc.	0.58
IL14 I know what experimental research means	0.54

Table 4. Second edition innovative literacy scale factor distributions (26 statements)

Factors	Number of questions	Cronbach's *a*
1	8	0.870
2	7	0.773
3	6	0.817
4	5	0.812

Table 5. Reliability coefficients of factors

Following EFA, we also employed CFA to check whether the sample data confirmed the proposed model (Brown, 2015; Byrne, 1998) and to test the factor or factors that emerged based on the relationships between variables (Tabachnick and Fidell, 2013). Using Analysis of Moment Structures (AMOS) program, we submitted the data collected from was collected from 440 participants with a 4-factor structure, and 26 items, obtained from the previous EFA results. Goodness-of-fit Index (GFI), Normed Fit Index (NFI), Incremental Fit lndex (IFI) and Comparative Fit Index (CFI) goodness-of-fits are expected to be above 0.90 to ensure structural validity, but it is stated that values above 0.80 can be seen as acceptable values in scale studies (Chow *et al.*, 2001; Schermelleh-Engel *et al.*, 2003; Segars and Grover, 1993; Jöroskog and Sorbom, 1987). The resulting measurement model result with an acceptable but

not a very good fit (χ^2 = 1025.19 df = 293, χ^2/df = 3.49, Root Mean Square Error of Approximation (RMSEA) = 0.075, CFI = 0.85, GFI = 0.84 modeling with some items having low standardised loading. We decided to drop those items (IL4, IL5, IL18, IL15 and IL24) and performed the CFA again. This time, our model showed a good fit showed (χ^2 = 1025.19 df = 293, χ^2/df = 2.51, RMSEA = 0.058, CFI = 0.93, GFI = 0.93, IFI = 0.93).

We used reliability estimates such as average variance extracted (AVE), composite reliability (CR) and Cronbach's alpha. CR values should be equal to or greater than 0.70 (Hair *et al.*, 1998); AVE values should be equal to or higher than 0.50; while the Cronbach alpha values should be equal to or higher than 0.70. All are above the threshold levels determined by Nunnally (1978). Except for the AVE coefficient (0.48) of the second dimension, all the measures met the threshold values. According to Fornell and Larcker (1981), an AVE value of 0.48 is acceptable if the CR value is above 0.70, although the AVE value is below 0.50. Since the CR value and Fornell-Larcker values also matched the values in the literature (Bagozzi and Yi, 1988), concluded that this four-dimensional scale has sufficient validity and reliability (see Table 6).

After validating the 4-factor measurement model of innovative literacy in the first-order factor analysis, a second-order model was developed to investigate whether a single high-level factor could explain the 4-factors. According to Finn and Wang (2014), this 1-factor model assumed that a larger latent construct only defines the relationships between the four constructs that emerged from the first-order model (Figure 1).

Similar to the first-order model, the results fit well at all levels. Table 7 compares first and second-level CFA results.

The innovative literacy scale was conceptually reviewed according to the factor dimensions when the data reached the desired fit values. The factor structure obtained from factor analysis and conceptual analysis of the innovative literacy scale was accepted as 4-factors and 21 expressions, as seen in Table 8.

The 4-factors that emerged from the factor analysis were examined in detail. In the naming of each factor, the meanings of the items were taken into consideration. Regarding the statements in Factor 1, the participants were familiar with the concepts of innovation and knowledge they had acquired together. In addition, images related to innovation and related competencies such as R&D, problem-solving, technology and R&D support have been gathered in a typical dimension. The sustainability of innovation structures requires the organisation to recognise and value human capabilities that take a more holistic approach to knowledge management. Advances in innovation in recent years have shifted the emphasis from people management to a new focus on knowledge management. Human abilities must be recognised, valued and encouraged for knowledge to reach value. Factor 1 is named "Innovative Awareness" because it describes a concept that transforms from the ability to be familiar with and know innovation concepts to knowledge that meets today's needs. By the variables grouped characteristics, this factor was called the *"Innovative Awareness"* dimension is between 0.77 and 0.46.

The statements under factor 2 indicate an individual's tendency to research, invent, etc., in their future-oriented innovative abilities. It has been seen that concepts expressing attitudes toward the future and development, such as interest in issues, problem-solving skills and

	Cronbach's alpha	CR	(AVE)
ILF1	0.85	0.89	0.58
ILF2	0.75	0.82	0.48
ILF3	0.80	0.86	0.55
ILF4	0.82	0.87	0.58

Table 6. Convergent and convergent validity

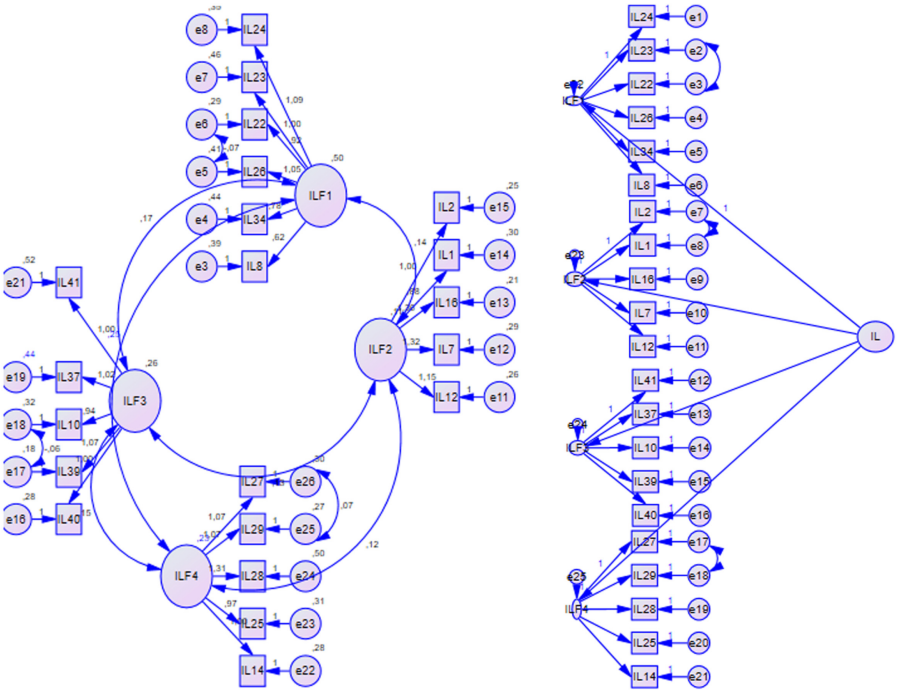


Figure 1.
Innovative literacy scale version 2 CFA diagrams 21 statements (first and second)

	(First order)	(Second order)
CMIN/DF	2.74	2.90
GFI	0.90	0.89
NFI	0.87	0.86
IFI	0.91	0.90
CFI	0.91	0.90
RMSEA	0.63	0.66

Table 7.
Comparative CFA Results (2nd edition)

openness to new ideas, come together. In this context, it was deemed appropriate to collect the name of this factor, which determines the behaviours of the future with today's attitudes, under the name of "Development Orientation". The items' load values in the orientation to development factor are between 0.63 and 0.47. In this context, by the variables grouped characteristics, this factor was called the "*Development Orientation*" factor and has a significant relationship with the relevant factor, two of which are at a high level and three at a moderate level.

Since all the items under factor 3 indicate how open to innovation the thinking, experimenting, asking questions and researching structures of people in their daily routine are, it was deemed appropriate to define the expression as "Innovation Openness". The innovative literate individual's openness to innovation determines his will and action towards innovation in the literate dimension. The load values of the items in this factor are between 0.80 and 0.55. In this context, by the variables' grouped characteristics, this factor was called the "*Innovation Openness*" factor and had a highly significant relationship.

Factors	Items (21)
Innovative Awareness	I know the concepts of innovation
	I follow the support for innovation development
	I am interested me subjects such as innovation, R&D and project management
	I know the types of innovation
	I can use R&D and technology knowledge to solve my daily problems
	I think about how current problems can be solved with innovative methods
Development Orientation	I research topics that I am curious about
	I am interested in inventions and discoveries
	I synthesise information from different sources
	I have problem-solving skills
	I am open to new ideas
Innovation Openness	Many new ideas come to my mind in my daily routine
	I'm not afraid to try new things and make mistakes
	I can see new opportunities and evaluate them
	I like to talk about new ideas, new products, etc.
	I do not hesitate to ask questions when I want to learn new ideas
Process Versatility	I know how to do basic research
	I know information collection sources
	I know the concept of intellectual property rights
	I know the concepts of patents, inventions, etc.
	I know what experimental research means

Table 8.
Second edition innovative literacy scale expressions and sizing

When the items under factor 4 are examined, the more advanced competency is basic research, literature knowledge, intellectual property rights, research types and patent invention, etc. The expressions seem to come together, and these statements are processes that complement innovation. Mastery of further innovation comes from familiarity with these processes. Factor 4 was named "Process Versatility" because it describes a concept that can transform innovation processes from the ability to be familiar and know to action. By the variables' grouped characteristics, this factor was called, the "*Process Versatility*" factor between 0.74 and 0.54. In this context, three items in the process disposition factor have a significant relationship with the relevant factor, 2 of which are at a high level.

4.3 Final stage: analyse the innovative literacy scale

At this stage, an analysis will be carried out regarding the values reached in the sample universe in the latest version of the 21-items 4-dimensional scale. First, a CFA was conducted to evaluate whether the 21-item "Innovative Literacy Scale", whose discovery phase of the new data was completed before, fits the structure and to bring the scale to the literature by making final validation with reliability and validity criteria.

To gather data, all Chambers of Industry and Commerce in different regions of Türkiye, TUBITAK, organisations, Universities, Technoparks, R&D Centres, R&D and human resources departments of large organisations are sent an e-mail with a comprehensive explanation of the purpose of the research to gather data. The number of e-mails was 4000, and as a return, 457 people participated in the survey. The sample of this study consists of at least graduates who are experts in their fields. 42% of the participants are female and 58% are male.

First CFA results did not provide a good level fit showed (χ^2 = 1025.19 df = 293, χ^2/df = 2.51, RMSEA = 0.058, CFI = 0.93, GFI = 0.93, IFI = 0.93). We dropped the items (Table 9) with low factor loadings, respectively and submitted this 21 item scale to a new CFA and we obtained a good fit showed (χ^2 = 1025.19 df = 293, χ^2/df = 2.51, RMSEA = 0.058,

CFI = 0.93, GFI = 0.93, IFI = 0.93). Below are the conceptual explanations of the items removed from the scale. In the disposal of these items, efforts were made not to damage the structure of the scale and to ensure the most appropriate integrity. In addition, including 4 to 5 items per factor provides that scale items are frugal to minimise the respondents' fatigue when answering long questionnaires (Clark and Watson, 1995). Thus, deconstructing items were eliminated in the purification.

We also conducted a second-order CFA to investigate whether a single high-level factor could explain the 4-factors with given 17 items. Figure 2 shows the "Innovative Literacy Scale" model fit diagrams and Table 10 shows fit measures for the first and second-level CFA comparatively.

Table 9.
Items Purification (4 discarded)

Item no.	Issued item
IL22	I am interested in innovation, R&D and project manent
IL26	I know the types of innovation
IL39	I like to talk about new ideas, new products, etc.
IL25	I know the concepts of patents, inventions, etc.

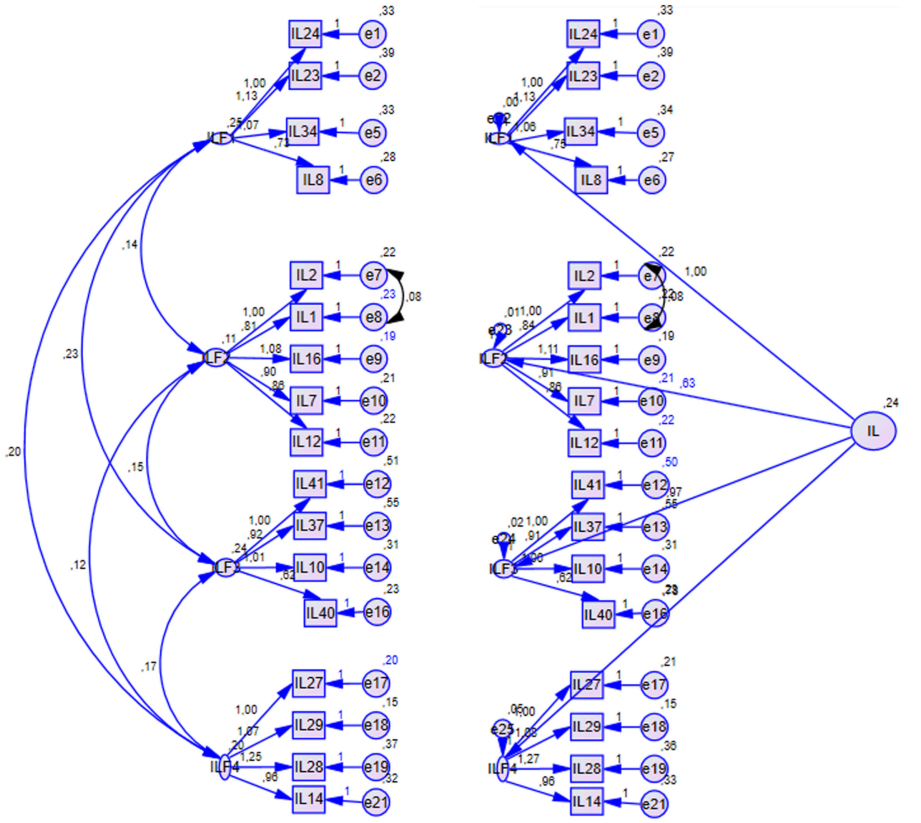


Figure 2.
Innovative literacy scale model fit diagrams

We again checked convergent validity and reliability, employing AVE, CR and Cronbach's alpha. According to Table 11, Cronbach's Alpha coefficients of the sub-dimensions of the scale are as follows. INF1: 0.74 for innovativeness; moderate reliability measures were calculated as 0.70 for INF2: Development Orientation, 0.78 for INF4: Process Responsiveness and low-reliability measures 0.66 for INF3: Innovation Openness . . . Even 007 represents the threshold level, 0.6 is also accepted for new developed scales (Hair *et al.*, 2006). In addition, our CR and AVE values met threshold levels, except the AVE value of second dimension. However, according to Fornell and Larcker (1981), if the AVE value is below 0.50 but the CR value is above 0.70, these AVE values are acceptable. Moreover, the results of CFA also show that all measures exhibit standardised loadings that exceed 0.60 with a 5% significance level, providing extra evidence for convergent validity.

We also checked the discriminant validity by following Fornell and Larcker (1981) criteria. According to Fornell and Larcker (1981), the square root of the AVE of each construct must be greater than the correlation pairs between the construct and other constructs. The correlation estimates of each variable. As seen in Table 12, our results met the criteria mentioned above. So, we concluded that all constructs exhibit satisfactory discriminant validity.

Another indicator of discriminant validity is that the correlations between factors are less than 0.85 (Kline, 2015). Therefore, the innovative literacy scale has reached an acceptable level at this stage. The final scale of innovative literacy consisting of 4 dimensions and 17 items, is shown in Table 13.

5. Discussion

In this study presents a scale to measure "innovative literacy", as shown in Table 13. From the literature review, the authors developed and applied a scale grounded in a questionnaire with

	(First order)	(Second order)
CMIN/DF	2.51	2.63
GFI	0.93	0.93
IFI	0.93	0.93
CFI	0.93	0.93
RMSEA	0.58	0.60

Table 10. Latest version first and second CFA analysis

	Crh's alpha	CR	AVE
INF1	0.74	0.83	0.56
INF2	0.70	0.81	0.46
INF3	0.66	0.80	0.50
INF4	0.78	0.86	0.61

Table 11. Structural reliability analysis

	INF1	INF2	INF3	INF4
1	*0.75*			
2	0.64	*0.68*		
3	0.68	0.64	*0.70*	
4	0.68	0.62	0.56	*0.78*

Table 12. Fornell-Lacker

Factors	Items
Innovative Awareness	I know the concepts of innovation
	I follow the support for innovation development
	I am interested in innovation, R&D and project management
	I can use R&D and technology knowledge to solve daily problems
Development Orientation	I research topics that curious about
	I am interested in inventions and discoveries
	I synthesise information from different sources
	I have problem-solving skills
	I am open to new ideas
Innovation Openness	Many new ideas come to mind in my daily routine
	I am not afraid to try new things and make mistakes
	I can see new opportunities and evaluate them
	I do not hesitate to ask questions when I want to learn new ideas
Process Versatility	I know how to do basic research
	I know information collection sources
	I know the concept of intellectual property rights
	I know what experimental research means

Table 13. Innovative literacy scale

quantifiable variables, the proposed scale offers contributions to innovative literacy, specifically from four variables.

Intangible assets and intellectual capital are the sources of the "new" economy and information society. However, how these resources work is not understood, and the scenario for value creation is not to be precise. Although various studies on innovation exist, gaps still to be found especially in defining innovative literacy and intellectual capital. In this research, innovative literacy was analysed conceptually from different perspectives in the literature. Individuals' ideas, research and development skills can be considered innovative literacy skills. Innovative literacy can be defined as the characteristic of an employee working in any organisation engaged in administrative or technical innovative activities and using their knowledge for development and innovation in line with the organisation's objectives. Planning the human resources in the organisation by this approach also increases innovation performance. Innovative individuals have selves that will inspire innovations.

Innovative literacy is the ability of individuals to evaluate their ideas and R&D abilities rationally and to manage their knowledge correctly. It can also be defined as an employee at any organisation who engages in managerial and technical innovation activities by integrating his knowledge with a researcher, developer, and innovative attitude in line with the institution's goals. The organisational structures in which the innovative literate take place are essential in providing the appropriate environment for these individuals to emerge, carry out activities in line with the institution's goals, have the psychological ownership of company growth, and develop and get results.

Our findings contribute to the existing literature in several ways. Individuals are expected to have three basic abilities in innovative literacy. First is defined as the ability to manage their personal information. Secondly might be described as evaluating their behaviour to produce new things in the short and long term. Lastly, having an excellent investigative attitude enables individuals to manage their work processes. These; include researching and evaluating information related to innovative decisions and using this information in the solution of problems and in a beneficial way. Innovative literacy, which tries to measure the competence of innovation in the individual, is an essential issue for future studies. It has been found in articles researched that innovation increases company performance, encourages entrepreneurship, contributes to intellectual capital and is associated with

organisational innovation. Since innovative literacy is not included as a concept, its relationship with these dimensions could not be determined.

This research contributes to the intellectual capital and innovative literacy literature and practitioner by offering an innovative literacy scale. Since qualified human capital is a crucial antecedent of firm innovativeness and performance, we expect a more qualified human capital with innovative literacy to contribute higher to organisational outputs, in terms of innovativeness. Managers require a tool to evaluate the innovative literacy level of their existing staff and new candidates. Moreover, management should take the necessary steps to nurture the InnoLiteracy of their human capital since such a capability results from the efficient management of human resources and concurrently influences strategic resources (Figure 3).

5.1 Theoretical contributions

In this study validated scale is helpful for both academia and practitioners. This study has added the "innovative literacy scale", lacking in the field of social sciences, to the literature by conducting reliability and validity tests. Academics can be used as a measurement tool to further research the human capital performance of innovation. This research makes valuable contributions to the existing literature. In terms of theoretical implications, it primarily defines the concept of innovative literacy in current studies in the fields of intellectual capital. Second, this study brings a new perspective to intellectual capital. Third, it reveals that although innovative literacy is vital to intellectual capital, the concept does not exist in any intellectual capital component. Fourth, it creates a 4-dimensional scale of the innovative literacy concept. Fifth, the research highlights gaps in the literature and offers recommendations for future research to explore the field further.

5.2 Managerial contributions

Our findings of this research also offer managerial implications. First, the evaluation of ideas, research and development capabilities, and practical knowledge management are indicators of innovative literacy ability at the individual level. Second organisational structures that include innovative literature and reduce barriers to participation in innovation activities are essential as they encourage the emergence and development of other innovative individuals. In this case, the firm's agility will increase and positively impact its sustainable innovation. Finally, innovative literate team members must be measured and uncovered to strengthen an organisation's intellectual capital structure.

This research aimed to be a pioneering step in defining and measuring innovative literacy. However, the debate over whether innovative literacy is a sub-set or synonym of human capital can be clarified by further exploring what we mean by "innovative literacy scale".



Source(s): Author's work

Figure 3. Innovative literacy model

While many studies examine innovation, this research offers a new conceptual view for integrating theories to provide the relationship between intellectual capital and innovative literacy by synthesising findings from academic studies. To be innovatively literate, individuals must demonstrate the necessary knowledge and skills. Innovative literacy aiming to improve one's knowledge and ability should be adapted to suit different demographic characteristics, life stages and learning styles. Therefore, different innovative literacy scales should be used.

A successful innovative literacy scale will improve an individual's ability to discern their lack of innovative literacy and allow educators to define education to achieve the desired outcome. Another significant result of a tool that effectively measures innovative literacy is that researchers can better identify which products are most impacted by a lack of innovative knowledge and skills. Anything that improves literacy has a positive effect on behaviour change.

5.3 Social contributions

Within the socio-cultural framework of a society, innovative literacy can play a role in measurement of human capital. The direct impact of innovative literacy and human capital on individual productivity can also increase social productivity. Its contribution to education can improve the socio-cultural background. In particular, the strong positive effect of education on earnings can positively affect social and cultural behaviours. Aside from the effects of strong human capital on productivity and earnings, it can also reduce the likelihood that an individual will engage in socially negative activities such as crime. A stable and democratic society will become more prosperous with the increasing innovative literacy of most citizens.

5.4 Limitations and recommendations

This study is not without limitations, which offer opportunities for future research. In future research, the idea of innovative literacy and its effects on other dimensions of human capital should be revealed. In conclusion, more work is needed before the innovative literacy measurement can become more detailed and specific. The validity of a scale is a long-term process (Peacock and Wong, 1990). It has been determined that innovative literacy has strong relationships in its contribution to human capital among individuals with different education and age ranges. Overcoming the limitations of current research and measurement designs, further assessments and studies of innovative literacy will enable better allocation of support and resources to meet the needs of this growing intellectual capital and innovation world.

Therefore, it is hoped that this article will contribute to the development of innovative literacy, the effective use of human resources, more efficient life-long innovative learning activities and the regulation of the scale to meet current and practical needs. This study focused on the relationship between limited demographic variables of gender, age range and educational status with innovative literacy. More comprehensive studies can be carried out by developing the limits of demographic variables. In conclusion, with replication in larger samples and further validation, InnoLiteracy provides a promising tool for theory and practice.

6. Conclusions

Innovative literacy is the ability to read, analyse, manage and communicate. Knowledge is a primary innovation that people need to compete in society. A person can understand and use innovative concepts. It uses knowledge and skills to manage and use innovative resources effectively. This study has brought dimensions of the "Innovative Literacy Scale", completed

after the survey studies were carried out with factor analyses and three different samples were distributed in a meaningful way and formed under the spirit of the research. Dimensions are conceptually structured as features expected in an innovative literate, such as innovation awareness, orientation to development, openness to innovation and propensity to process.

With this study, the "innovative literacy scale", lacking in the social sciences, has been brought to the literature by making reliability and validity tests. With this scale, analyses can be made to measure innovative literacy in innovation. This way, a helpful tool will be put forward that can significantly contribute to education and human resources policies. Finally, we analysed the scale validity by focussing on content validity, convergent validity and discriminant validity. The scale performed well in terms of consistency and pattern of factor structure, internal character, similarity, distinctiveness and validity.

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Appendix

Innovative literacy scale	Absolutely I agree	I Agree	Undecided	I Disagree	Absolutely I disagree
IL1. I am interested in inventions, discoveries and inventions					
IL2. I research topics that I am curious about them					
IL3. I know how to conduct scientific research					
IL4. New ideas come to my mind all the time					
IL5. I adapt quickly to innovations					
IL6. I have a critical view					
IL7. I have problem-solving skills					
IL8. I think about how current problems can be solved with innovative methods					
IL9. I can generate new ideas for solving problems					
IL10. I can see new opportunities and evaluate them					
IL11. I have difficulty focussing on a target in a new study					
IL12.I am open to new ideas					
IL13. I know what R&D means					
IL14.I knows what experimental research means					
IL15. I can use a systematic approach to solving problems					
IL16. I synthesise information from different sources					
IL17. Innovation is complex and tedious					
IL18. Intellectual property and patent issues are essential for innovation					
IL19. I believe that innovation can solve many problems in the world					
IL20. It usually takes time to get the information I need					
IL21. I find it difficult to put knowledge into practice					
IL22. I am interested in innovation, R&D and project management					
IL23. I follow the support for innovation development					
IL24. I know the concepts of innovation					
IL25. I know the concepts of patents, inventions, etc.					
IL26. I know the types of innovation					
IL27. I know how to do primary research					
IL28. I know the concept of intellectual property rights					
IL29. I know information collection sources					
IL30. I follow scientific studies					

(*continued*)

Table A1. First version innovative literacy questionnaire used in the study

Innovative literacy scale	Absolutely I agree	I Agree	Undecided	I Disagree	Absolutely I disagree
IL31. I think I am not inclined to new technology					
IL32. I can reach experts in the field when I need them					
IL33. I would like to take part in innovation projects					
IL34. I can use R&D and technology knowledge to solve daily problems					
IL35. I attach importance to accessing new information from a reliable source					
IL36. Researching and discovering something new is my passion					
IL37. I am not afraid to try new things and make mistakes					
IL38.I can use past research results when I need them					
IL39. I like to talk about new ideas, new products, etc.					
IL40. I do not hesitate to ask questions when I want to learn new ideas					
IL41. Many new ideas come to mind in my daily routine					
IL42. Uncertainty scares me					
IL43. I give up when I fail in innovation efforts					

Table A1.

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