*Journal of Research in Nursing*
2021, Vol. 26(7) 684–700

DOI: 10.1177/17449871211020061
journals.sagepub.com/home/jrn
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# Development of the Scientific Research Competency Scale for nurses

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## Abstract

**Background:** The planning, implementation, finalisation and reporting of high-quality research depends on the knowledge, skills and competencies of the many individuals who make carrying out the research possible.

**Aims:** This study aims to develop a valid and reliable scale in order to identify the scientific research competencies of nursing professionals at undergraduate and graduate level.

**Methods:** This methodological study was carried out on 937 nursing personnel, 422 (45%) of whom were academic members and 515 (55%) were undergraduate students. The Anxiety Scale Towards Research and the Attitude Scale Towards Scientific Research were used for the criterion validity.

**Results:** The Scientific Research Competency Scale comprises 57 items in four sub-dimensions named as 'technical skills', 'attitude and behaviours', 'estimation capacity' and 'foreign language skill'. The Cronbach alpha, Guttmann split-half and Spearman Brown reliability coefficients for the scientific research competency scale were, respectively, 0.98, 0.96 and 0.96. The sensitivity and specificity value, by which the research competency of individuals could be determined with minimum error, was indicated to be at 190 breakpoints of the scientific research competency scale.

**Conclusions:** As a result, the scientific research competency scale developed is a valid and reliable tool that can be used to determine the scientific research competencies of nursing professionals.

## Keywords

competency-based education, methodological study, nursing, reliability and validity, research-competency scale

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## Introduction

Competency is defined as 'a combination of knowledge, personal attributes, interests, experiences and capabilities related to the job which enables their owners to play a role above the average level' (Tafti et al., 2017, p.19). Competencies relate to the behaviours that need to be shown by an individual in order to obtain an efficient performance rather than the results (Fukuda, 2018). Competence is a set of observable behaviours and actions shaped around personality, abilities, interests, motivation and past experiences (Dedehayır, 2003; Turan, 2015).

Research is defined as 'a process of collecting, analysing, interpreting and evaluating data in a planned and systematic way with the aim of seeking reliable solutions for problems' (Karasar, 2000, p. 22). Institutions, such as the International Council of Nurses and the American Association of Colleges of Nursing (AACN) state that professional nursing can be implemented through research-based practices, and therefore highlight the fact that research should be conducted, research capacity should be improved and that nurses and students should critically evaluate their research and, in order for them to do so, scientific research is required (AACN, 2006; Halabi and Hamdan-Mansour, 2010).

As it is the researcher who has the greatest and most direct influence on research, it is suggested that the basic prerequisite for conducting quality research is to train qualified researchers (Bakioğlu and Kurnaz, 2014). An individual who has completed a Bachelor's degree in any department of the Council of Higher Education in Turkey within the framework of the Bologna process is expected to have acquired an investigative identity (Yavuz Konakman and Yanpar Yelken, 2015). When a person completes his/her research training and has at least become a good research consumer, s/he also acquires to some extent research productivity competencies, depending on the level of training (Karasar, 2014). The planning, implementation, finalisation and reporting of high-quality research depends on the knowledge, skills and competencies of the many individuals who make carrying out the research possible (Beirne et al., 2011).

Competencies are not fixed; they are skills that can be improved through training (Fukuda, 2018; Tafti et al., 2017). Nursing research training at all levels aims to increase the contributions made by the profession to the improvement of health services provided to individuals and society. First-level (qualified) nurses are expected to read, understand, implement and share research findings, and to be able to interpret and evaluate them for application, to work with others and collaborate with research teams in order to identify potential research problems. While it is considered appropriate for nurses who have taken a Master's degree to undertake responsibilities, such as identifying system problems and practices, conducting research, reflecting research results on care services, collaborating with other researchers, providing consultancy to facilitate research and solving problems, nurses who have taken Doctoral degrees are expected to develop methods for the measurement and solution of nursing problems at a scientific level. This in turn enables them to take the lead in nursing research, to maintain intellectual research with the aim of expanding their knowledge of nursing and to conduct independent research. Moreover, those who have taken postdoctoral education are expected to make use of the opportunity to develop funded programmes of research (AACN, 2006; Grove and Gray, 2018).

Although academic life requires a balance between research and education, as well as other services, the usual way to obtain academic advancement and state funding comes through research activities and this generally places research at the forefront of these factors (Bakioğlu and Kurnaz, 2014). The criteria used in academic elevation and

assignments are research productivity based according to the number of research reports published by a researcher, and no certain/specific research competency is measured (Turhan-Damar et al., 2018). Conversely, it is suggested that research competency has more influence on research productivity than either the researcher's personality traits or the institutional support received for the research (Wichian et al., 2009).

The number of research studies for developing knowledge in nursing is observed to be limited (Turhan-Damar et al., 2018). One reason for this lack might be that the research competencies of the nursing researchers have not been addressed. This study therefore aims to develop a valid and reliable scale in order to identify the scientific research competencies of nursing professionals at undergraduate and graduate level.

## Methods

This methodological study was conducted on nursing professionals at undergraduate and graduate level between June 2016 and February 2017.

### *Participants*

The initial aim of the study was to include every school ($n = 119$) that provides nurse education at an undergraduate level within the borders of Turkey. However, the study ultimately included third and fourth grade nursing students ($n = 1737$) who are taking or have taken courses such as research, epidemiology and biostatistics, at four universities, and who have access to academic personnel ($n = 1585$), such as professors and associate professors who work at the department of nursing of 68 universities that allowed data collection. This research aimed to reach 1000 people, taking as its base the opinions of Comrey and Lee (1992). While the heterogeneity of the selected sample showed that the scale performed well in every case, it also increased factor loads and variance in the factor analysis (Kline, 1994). Therefore, the study group for the research was made to be heterogeneous and comprised a total of 937 nursing personnel, 422 (45%) of whom were academic members (professor doctor, associate professor, assistant professor doctor, lecturer, research assistant doctor, research assistant) and 515 (55%) were undergraduate students. If the study sample was composed of only academic members, competency measurement would not be meaningful for a group that proved their research competency at many stages during their careers. Likewise, if it was developed only for a group of students, the scale would only measure whether the student was more successful than his/her friend and not determine the level of competency. For this reason, we tried to form a heterogeneous group from all undergraduate and graduate levels. Working on a heterogeneous group indicates that the scale performs well in all situations. Therefore, the term 'nursing personnel' is used to cover both groups.

### *Data collection tools*

The Anxiety Scale Towards Research (ASTR) (Büyüköztürk, 1997) and the Attitude Scale Towards Scientific Research (ASTSR) (Korkmaz et al., 2011) were used for the criterion validity of the Scientific Research Competency Scale (SRCS) developed in the study.

The ASTR is a five-item Likert scale developed by Büyüköztürk in 1997, gathered under one factor and comprising 12 items. The Cronbach's alpha reliability coefficient of the scale is 0.87 (Büyüköztürk, 1997) and for this study it is 0.89.

The ASTSR was developed by Korkmaz et al. in 2011. It is a five-item Likert scale, gathered under four sub-dimensions, which are reluctance to help researchers, negative attitude towards research, positive attitude towards research and positive attitude towards researchers, and comprises 30 items. No total score is obtained from the scale and each sub-dimension is separately assessed. The Cronbach's alpha reliability coefficients of the sub-dimensions are 0.85, 0.81, 0.80 and 0.76 (Korkmaz et al., 2011), respectively, and for this study they are 0.88, 0.90, 0.93 and 0.92, respectively.

## Statistical analyses

Pearson product-moment correlation analysis was used to identify item-total and item-remainder values for the item distinctiveness of the scale's items, whereas the independent samples *t*-test was used to compare the item scores of the lower and upper 27% groups. An exploratory factor analysis was conducted using the SPSS program in order to test to what extent the structure validity and factorised structure in the scale was confirmed by the collected data. Before conducting the factor analysis, the Kaiser–Mayer–Olkin analysis and Barlett sphericity test were conducted for sample sufficiency and sample test size, respectively, in order to identify the relevance of data to the factor analysis. The eigenvalues of the items in the scale and the contributions made by the components to the variance were examined using the Varimax rotation technique. It is indicated in the literature that the factor load value can be taken as 0.32, 0.40, 0.45 (Tabachnick and Fidell, 1989) and 0.60 (Büyüköztürk, 2002; Kline, 1994; Şencan, 2005). As factors are aimed to comprise strong items, the factor load value is taken as 0.60 in this study. An examination was made of the amount of difference in load in the items that have taken load in more than one factor; the items were eliminated one by one, starting from the overlapping items, in which the amount of difference in load was lower than 0.10 (Çokluk et al., 2012; Field, 2009; Seçer, 2015), and analyses were repeated. Pearson product-moment correlation analysis was conducted in order to identify the relationship between the scores obtained from the ASTSR and the ASTR, which were simultaneously applied along with the SRCS for criterion validity. The reliability analyses of the SRCS and its sub-dimensions were calculated using the Cronbach's alpha reliability coefficient, Spearman Brown correlation coefficient and Guttman split-half reliability formula. The receiver operating characteristic curve (ROC) analysis was conducted using the MedCalc program with the aim of identifying the breakpoint of the scale.

## Procedure

The study was conducted in 10 steps. These are: (a) the preparation of item pool and draft scale; (b) validity of content (scope); (c) provision of institutional permissions and application of the draft scale on the sample; (d) data preparation; (e) analyses of item-total and item-remainder; (f) analyses regarding item distinctiveness; (g) structure validity (exploratory factor analysis); (h) criterion validity; (i) reliability; and (j) finding the breakpoint of the scale.

*Preparation of item pool and draft scale.* In this study, the research competency derived from the definition of competency was conceptualised as the features (academic curricula, behaviour indicators required to be demonstrated/acquired during and after training, attitude,

personality, abilities, interests) that specify the research productivity of nursing personnel at undergraduate and graduate level. As the first step, the items of the scale, which are the indicators of research competency and inclusive of conceptualised research competency, were written by the researcher and an item pool ($n = 103$) was created.

*Validity of content (scope).* For the second step and for the validity of content (scope), the item pool created in the first step was submitted to a total of 17 experts. In order to identify the content validity of the scale the Lawshe's content validity ratios (CVRs) were calculated.

The Lawshe CVR coefficients vary between –1 and +1. The ratios obtained were compared with the minimum Lawshe's CVRs given at a reliability interval of $P = 0.05$ for differing numbers of experts. The minimum Lawshe's CVR for 17 experts is therefore 0.49 (Lawshe, 1975). The CVRs of 103 items in the item pool vary between 0.52 and 1.00. Therefore, no item was removed from the item pool and no amendment was made to any item.

*Provision of institutional permissions and application of the draft scale on the sample.* Following the provision of research ethics committee approval and institutional permissions, the questionnaires created online for the faculty personnel were sent to the academics via e-mail. The academics who did not reply or fill in the questionnaire were sent two reminder e-mails per month. The questionnaires for the undergraduate students prepared beforehand were filled out by the researcher through a face-to-face interview method. The students, who were present at the school on the days during which the data were collected, were willing to be involved in the study, and who filled in the data collection form completely, were included in the study group. Seventeen questionnaires with the extreme abnormalities in their responses and had not been filled in sincerely were excluded from the study.

*Data preparation.* Outliers were checked using $z$ scores for each item, and $z$ scores greater than +3 or less than –3, that was multivariate outliers, were not identified in the dataset. Before starting analyses, skewness and kurtosis coefficients were checked as the assumption of normality, and it was found that skewness and kurtosis coefficients were between –1 and +1, and their absolute values were not greater than twice their standard errors. Then, the normal distribution curve on the histogram was evaluated by the visual method. It was also in favour of normal distribution that there were no outliers in the boxplot, it was a symmetrical graph, and the median line was symmetrical with approximately the centre of the box. Points, spreading close to the 45° line in the normal Q-Q plot and random distribution above and below the horizontal line in the detrended Q-Q plot, confirmed that there were no contradictions to normal distribution. Finally, the normal distribution was tested with the Kolmogorov–Smirnov test, and obtaining $P > 0.05$ (statistic 1.151; $P = 0.142$) had been considered as a proof that the scores did not show excessive deviation from the normal distribution. As a result, it was determined that the total score distribution of the draft scale was suitable for a normal distribution.

## Results

Of the 937 nursing personnel who comprised the study group, 422 were faculty members and 515 were undergraduate students; of these, 85.7% ($n = 803$) were women. The mean age of the study group was $27.97 \pm 8.64$ (min. 19; max. 71) years and while 14.5% ($n = 61$) of the

academic staff were continuing their graduate studies, 30.3% ($n = 128$) of them were continuing their doctoral studies. In total, 91.7% ($n = 387$) of the academic personnel were working at public universities. During their undergraduate studies 50.5% ($n = 213$) of the academic staff and 43.5% ($n = 224$) of the undergraduate students had experience of research.

*Analyses of item-total and item-remainder.* The corrected item-total correlation coefficients varied between 0.61 and 0.83, and the item-remainder correlation coefficients varied between 0.35 and 0.69; all items were statistically significant.

*Analyses regarding item distinctiveness.* As a result of the independent group $t$-test of the mean item scores of lower and upper 27%, there were significant differences ($P < 0.01$) for all items among the averages of the lower and upper groups of the scores obtained from the items.

*Structure validity (exploratory factor analysis).* The KMO coefficient was found to be 0.99, whereas the result of the Barlett's test was found to be $\chi^2$ (5253) = 107,652.018, $P < 0.001$. No correlation coefficient smaller than 0.30 or greater than 0.90 was found among the items. The mutual factor variances of the items in the SRCS varied between 0.425 and 0.742. As a result of the Varimax rotation technique, it was observed that the eigenvalues of the items in the scale were gathered under seven factors greater than one and explained 70.31% of the total variance; however, the difference between the eigenvalues and the contributions made by the components to the variance was observed to decrease after the fourth factor. When the scree plot was examined, the slope of the line was seen to crawl horizontally from the fifth point onwards (Figure 1). Therefore, it was decided that the scale should comprise four sub-dimensions. The total variance amount of the scale gathered under four sub-dimensions was 66.78%. As the factor load value was below 0.60, 46 items were eliminated from the scale. The items of the sub-dimensions and factor load values are given in Table 1. The factor loads of 57 items gathered under four sub-dimensions varied between 0.624 and 0.788, and explained 69.87% of the total variance. The items gathered under each sub-dimension were examined in terms of content; the first sub-dimension was named 'technical skills,' the second sub-dimension was named 'attitude and behaviours', the third sub-dimension was named 'estimation capacity' and the fourth sub-dimension was named 'foreign language skill'. The correlations among the sub-dimensions of the scale varied between 0.581 and 0.799 (Table 2).

*Criterion validity.* The criterion validity of the SRCS was determined by empirically investigating its relationship to other important criteria to which research competency is considered to be related, namely, attitude towards scientific research and anxiety towards research. It was hypothesised that individuals with high levels of research competency would have more positive attitudes towards scientific research. Furthermore, it was hypothesised that individuals with high levels of research competency would have less anxiety towards research. The data presented in Table 2 generally support these hypotheses. A negative relationship was identified among the scores of the SRCS, the scores of the sub-dimensions of the ASTSR, which are 'reluctance to help researchers ($r = –0.331$)' and 'negative attitude towards research ($r = –0.343$)', and the scores of the ASTR ($r = –0.541$). A positive relationship was identified among the scores of the SRCS and the scores of the

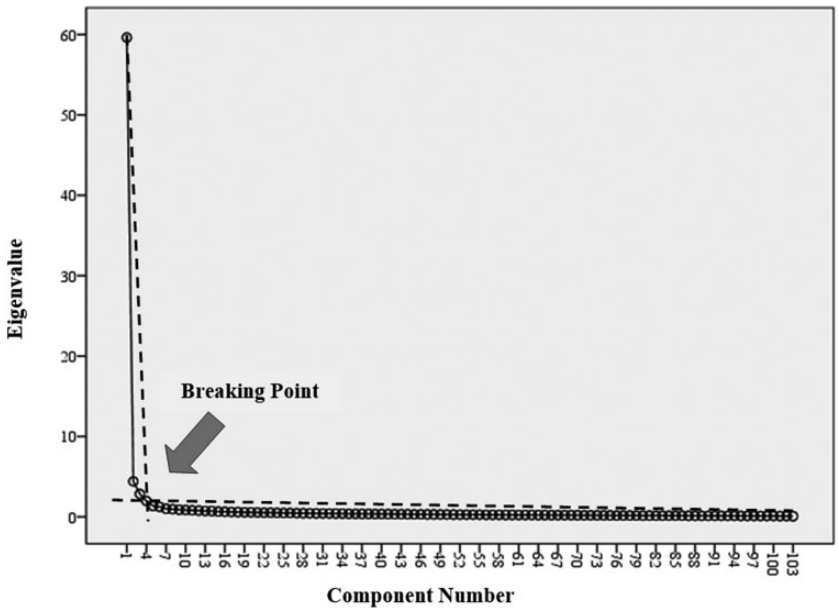



**Figure 1.** Scree plot of the items in the scientific research competency scale.

sub-dimensions of the ASTSR ($P < 0.001$ for each, Table 2), which are 'positive attitude towards research ($r = 0.640$)' and 'positive attitude towards researchers ($r = 0.469$)'.

*Reliability.* The Cronbach's alpha reliability coefficients of the SRCS were between 0.911 and 0.983 at the sub-dimensions, whereas it was 0.987 for the scale in general. The Guttmann split-half reliability coefficient was between 0.816 and 0.966 at the sub-dimensions, whereas it was 0.936 for the scale in general. The Spearman Brown reliability coefficient was between 0.903 and 0.968 at the sub-dimensions, whereas it was 0.941 for the scale in general (Table 3).

*Finding the breakpoint of the scale.* The size of the area below the ROC curve (AUC) was 0.763 (Figure 2). The sensitivity and specificity value, by which the research competency of individuals could be determined with minimum error, was indicated to be at 190 breakpoints of the SRCS. The sensitivity of the SRCS in determining the research competency of individuals was found to be 72.76%, its specificity was found to be 67.16%, its positivity ratio (+LR) was found to be 2.22 and negativity ratio (–LR) was found to be 0.41.

## Discussion

As a result of the findings obtained from the research, the discussion is conducted under two headings.

### *Development phases of the SRCS*

Content validity is an indicator the aim of which is to measure whether a representative sampling of the behaviour field is provided by the items of the scale and to identify whether

**Table 1.** Rotated component matrix after factor analysis of scientific research competency scale.

| Items | | Sub-dimensions | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| Item 36 | The ability to design sampling plan | 0.764 | | | |
| Item 37 | The ability to define the data required for research | 0.754 | | | |
| Item 34 | The ability to choose a sample that can represent the population | 0.751 | | | |
| Item 35 | The ability to determine the suitability of the people/associations to be included in research | 0.749 | | | |
| Item 33 | The ability to define population | 0.744 | | | |
| Item 38 | The ability to define dependent variables of the research | 0.740 | | | |
| Item 39 | The ability to define independent variables of the research | 0.734 | | | |
| Item 40 | The ability to choose effective measurement tools for research | 0.708 | | | |
| Item 47 | The ability to process/code the collected data properly | 0.700 | | | |
| Item 45 | The ability to choose a reliability method suitable for the structure of data collection tool | 0.679 | | | |
| Item 23 | The ability to explain the aim of the study in accordance with the research problem | 0.674 | | | |
| Item 43 | The ability to collect the necessary data in a systematic and planned manner | 0.673 | | | |
| Item 44 | The ability to use robust and consistent methods in order to conduct data collection activities in an ethical manner | 0.670 | | | |
| Item 25 | The ability to choose a research model suitable for the problem | 0.668 | | | |
| Item 50 | The ability to interpret the analysed data | 0.668 | | | |
| Item 46 | The ability to choose a validity method suitable for the structure of data collection tool | 0.666 | | | |
| Item 26 | The ability to choose a research design in compliance with the theoretical/conceptual framework | 0.664 | | | |
| Item 32 | The ability to construct the theoretical/conceptual framework of the research in a valid manner | 0.660 | | | |
| Item 24 | The ability to use a research design in compliance with the statement of aim | 0.658 | | | |
| Item 21 | The ability to form a correct/valid hypothesis | 0.657 | | | |
| Item 31 | The ability to assess the theoretical/conceptual frameworks for the feasibility of the study | 0.655 | | | |
| Item 30 | The ability to infer the type of a research article from its title | 0.654 | | | |
| Item 49 | The ability to analyse data | 0.653 | | | |
| Item 29 | The ability to assess the strengths/weaknesses of research methods | 0.640 | | | |
| Item 48 | The ability to use appropriate data analysis techniques which are consistent with the aim and design of the study | 0.635 | | | |
| Item 22 | The ability to use a research design in compliance with the problem statement | 0.631 | | | |
| Item 41 | The ability to interpret the psychometric features of a measurement tool | 0.624 | | | |
| Item 101 | Compliance with scientific honesty standards | | 0.788 | | |
| Item 94 | Being open-minded | | 0.772 | | |
| Item 100 | Compliance with ethical behaviour standards | | 0.769 | | |

(continued)

**Table 1.** Continued.

| Items | | Sub-dimensions | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| Item 97 | The ability to form effective purpose-oriented relationships with the relevant people | | 0.764 | | |
| Item 99 | The ability to use written communication effectively in order to express his/her ideas | | 0.764 | | |
| Item 93 | Being attentive in their studies | | 0.761 | | |
| Item 98 | The ability to use oral communication effectively in order to express his/her ideas | | 0.747 | | |
| Item 102 | The ability to consider the way s/he works in order to improve his/her performance/study | | 0.732 | | |
| Item 87 | The ability to follow the work in progress until obtaining results | | 0.724 | | |
| Item 86 | Making efforts required to complete the undertaken work | | 0.720 | | |
| Item 88 | Working in a certain manner systematically / in a planned manner | | 0.710 | | |
| Item 103 | Guiding someone through his/her research in case of having relevant experience | | 0.706 | | |
| Item 90 | The ability to find alternative in cases of crisis | | 0.687 | | |
| Item 96 | The ability to change his/her personal opinions in cases of objective findings | | 0.676 | | |
| Item 92 | The ability to stay patient when finalising works | | 0.675 | | |
| Item 84 | Being happy about providing support for research | | 0.664 | | |
| Item 95 | Being cautious | | 0.654 | | |
| Item 89 | The ability to remain calm in the event of a crisis | | 0.641 | | |
| Item 85 | Feeling free to use his/her own initiative when necessary | | 0.626 | | |
| Item 13 | The ability to write a grant proposal for the research | | | 0.736 | |
| Item 15 | The ability to perceive threats to internal validity regarding research | | | 0.734 | |
| Item 11 | The ability to take measures regarding threats to research beforehand | | | 0.712 | |
| Item 14 | The ability to calculate interest regarding research | | | 0.711 | |
| Item 16 | The ability to perceive threats of external validity regarding research | | | 0.708 | |
| Item 10 | The ability to predict opportunities regarding research | | | 0.689 | |
| Item 9 | The ability to conduct risk analyses regarding research | | | 0.676 | |
| Item 12 | The ability to calculate costs regarding research | | | 0.633 | |
| Item 63 | The ability to communicate orally using at least one foreign language | | | | 0.733 |
| Item 62 | The ability to communicate in writing using at least one foreign language | | | | 0.728 |
| Item 61 | The ability to follow scientific publications in at least one foreign language | | | | 0.665 |
| Initial eigenvalues | | 32.93 | 3.84 | 1.87 | 1.17 |
| % of Variance | | 57.77 | 6.74 | 3.29 | 2.05 |

**Table 2.** Correlation analysis results between the scores of the scientific research competency scale, the attitude scale towards scientific research and the anxiety scale towards research.

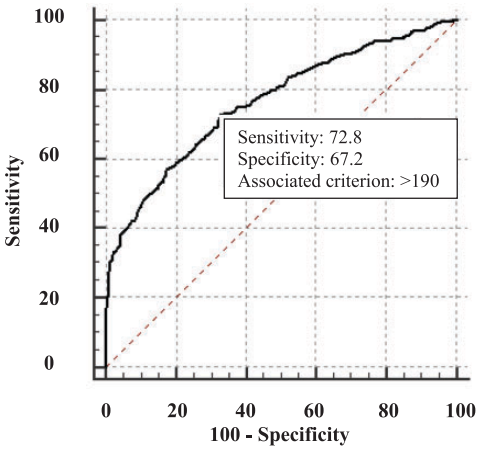
| Scale/sub-dimensions | Item no. | $\overline{X} \pm SD$ | Correlation | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | 27 | 95.39 ± 24.62 | – | – | – | – | – | – | – | – | – | – |
| 2 | 19 | 70.47 ± 16.46 | 0.796** | – | – | – | – | – | – | – | – | – |
| 3 | 8 | 25.81 ± 7.38 | 0.798** | 0.632** | – | – | – | – | – | – | – | – |
| 4 | 3 | 9.37 ± 3.39 | 0.708** | 0.610** | 0.674** | – | – | – | – | – | – | – |
| 5 | 57 | 201.06 ± 47.24 | 0.968** | 0.897** | 0.835** | 0.758** | – | – | – | – | – | – |
| 6 | 8 | 18.65 ± 6.90 | –0.358** | –0.363** | –0.280** | –0.238** | –0.365** | – | – | – | – | – |
| 7 | 9 | 18.65 ± 7.08 | –0.403** | –0.457** | –0.269** | –0.221** | –0.419** | 0.733** | – | – | – | – |
| 8 | 7 | 26.71 ± 6.40 | 0.648** | 0.668** | 0.488** | 0.500** | 0.675** | –0.440** | –0.525** | – | – | – |
| 9 | 6 | 24.26 ± 5.18 | 0.481** | 0.515** | 0.340** | 0.319** | 0.498** | –0.361** | –0.507** | 0.663** | – | – |
| 10 | 12 | 29.26 ± 9.50 | –0.512** | –0.554** | –0.373** | –0.371** | –0.536** | 0.482** | 0.596** | –0.688** | –0.539** | – |

**$P < 0.001$.

[1]technical skills; [2]attitude and behaviours; [3]estimation capacity; [4]foreign language skills; [5]scientific research competency scale; [6]reluctance to help researchers; [7]negative attitude towards research; [8]positive attitude towards research; [9]positive attitude towards researchers; [10]anxiety towards research.

**Table 3.** Reliability coefficients of scientific research competency scale and sub-dimensions.

| Scientific research competency scale and sub-dimensions | Item no. | Cronbach alpha | Guttmann split-half | Spearman Brown |
|---|---|---|---|---|
| Technical skills | 27 | 0.983 | 0.966 | 0.968 |
| Attitude and behaviours | 19 | 0.970 | 0.954 | 0.958 |
| Estimation capacity | 8 | 0.943 | 0.948 | 0.948 |
| Foreign language skills | 3 | 0.911 | 0.816 | 0.903 |
| Scientific research competency scale | 57 | 0.987 | 0.936 | 0.941 |




| ROC Method | AUC ± SE (95% CI) | Z statistic AUC > 0.5 | *p* | Cut-off | Sensitivitiy | Specificity |
|---|---|---|---|---|---|---|
| Nonparametric | .763 ± .0153 (.735 - .790) | 17.167 | < .001 | > 190 | 72.76 | 67.16 |

*Note.* AUC: Area Under the ROC Curve, CI: Confidence Interval

**Figure 2.** ROC curve analysis of the scientific research competency scale total score.
AUC: area under the ROC curve; CI: confidence interval; ROC: receiver operating characteristic curve.

the scale and each item in the scale serves the purpose. The minimum Lawshe's CVR given at a reliability interval of $P = 0.05$ was 0.49 for the 17 experts (Lawshe, 1975). The Lawshe's CVRs of the items in the scale were at least 0.52 and above 0.49. Therefore, no item was removed from the pool in the scale as a result of the expert opinions in the content validity stage and no amendment was made to any item.

The competencies of the items in the scale in distinguishing people are identified through the item-total and item-remainder correlations. In this study, the corrected item-total score correlation coefficients of the SRCS were at least 0.61 and met the criterion of being above 0.30 (Field, 2009; Şencan, 2005). The item-remainder correlation coefficients of the SRCS were at least 0.35 and above 0.25 (Tavşancıl, 2006). When determining item distinctiveness, which is another validity criterion, a significant difference ($P < 0.01$) was identified for all items in the lower and upper of 27% of the raw scores obtained from the scale. This finding shows that the scale is distinct with regard to measuring scientific research competencies

between the highest score and lowest score obtained from the scale. According to the results obtained, the item-total, item-remainder and item distinctiveness features of the SRCS can be said to be at a sufficient level.

Structure validity (exploratory factor analysis): as there was not any theory initially and there was a need to understand the structure of the draft scale (Şencan, 2005), there was a shift from structure validity to the exploratory factor analysis. The fact that the KMO coefficient was found to be higher than 0.60 and the Bartlett sphericity test was found to be significant shows that the size of the sample is sufficient and the dataset we have is suitable for conducting a factor analysis. No correlation coefficient smaller than 0.30, which is interpreted as a sign that mutual factors cannot be created, and greater than 0.90, which is an indicator of a multicollinearity problem (Field, 2009; Şencan, 2005), was identified in the correlations among the items. In this case the mutual factor variances of the items were at least 0.42 and no problematic item was identified. In the exploratory factor analysis, the four sub-dimensions of the SRCS, which meets the criterion for the existence of at least three variables/items for each sub-dimension (Şencan, 2005), explain 69.87% of the total variance. The total variance by which the sub-dimensions of the SRCS are explained was observed to be sufficient and the structure validity of the scale was provided.

Criterion validity is the comparison of the results obtained from the developed scale with the scores of a measurement criterion identified as a standard, and the provision of the correlation coefficient obtained as a result of this comparison was high. The correlation coefficients among the SRCS, the ASTSR and the ASTR were at least 0.33 and met a value of no less than 0.30 (Şencan, 2005). Thus the SRCS provides criterion validity.

Reliability: The fact that the Cronbach's alpha reliability coefficients were above 0.80, the Guttmann split-half reliability coefficients were above 0.60 and the Spearman Brown reliability coefficients were above 0.70 (Şencan, 2005) is an indication that the scale had reliability at a very high level.

Breakpoint of the scale: The ROC curve is a graph that shows the relationship between the correct positive ratio (sensitivity) and incorrect positive ratio (1-specificity) of a tool developed with the aim of diagnosing and scanning for different cut-off scores. The closest point to the left upper corner in the ROC curve indicates the most suitable place for sensitivity and specificity. The more the AUC approaches 1.0, the more the probability of two different groups being correctly distinguished increases (Tomak and Bek, 2010). In this study, the size of the AUC was identified as 0.763 and to have acceptable distinctiveness (Hosmer et al., 2013), and the selected cut-off point and real situation were indicated as 76% compatible. The probability of the SRCS result of an individual, who has an experience in research, being positive is 2.22 times higher than that of the SRCS result of an individual who does not have any experience in research being positive. The probability of the SRCS result of an individual, who has experience in research, being negative is 0.41 times higher than that of the SRCS result of an individual who does not have any experience in research being negative.

## *Sub-dimensions of the SRCS*

As a result of the exploratory factor analysis, it was seen that the SRCS was composed of four sub-dimensions. The statements in the sub-dimensions that were obtained play an important role in determining scientific research competencies.

It is stated that the mistakes made in a research study, as well as the unnecessary time and money spent and efforts made during the research, could be prevented by providing sufficient

research training for scientists through graduate courses, and by helping them to acquire technical research competencies, scientific attitude and behaviours (Erdem, 2012). The items under the heading 'Technical skills', which is the first sub-dimension of the SRCS, include the skills that a researcher is required to attain during the phases of the scientific research process, starting with determining the subject of the research, to the collection of the data, their evaluation and interpretation. It is also proposed that the mistakes made in the introduction, problem statement, hypothesis, definition and limitations of a research study may lead to contradictions in the method stages, sample and data collection of scientific research as well as having an impact on data collection tools and statistical techniques (Saleh-Velez et al., 2016). Therefore, statements such as the 'Ability to form a correct/valid hypothesis', the 'Ability to state the aim of the study in accordance with the problem of the research', the 'Ability to choose a research model suitable for the problem', the 'Ability to use appropriate data analysis techniques that are consistent with the aim and design of the study' are included in the technical skills sub-dimension of the scale. It is recommended that theories or models should be used effectively in nursing research, in order to contribute to occupational knowledge; however, the use of theories/models in the research conducted by nurses is limited and they are not included in all stages of the research process (Mete and İsbir, 2015). This is referred to in the scale as the 'Ability to construct the theoretical/conceptual framework of the research in a valid manner', the 'Ability to choose a research design in consistency with theoretical/conceptual framework' and the 'Ability to assess the theoretical/conceptual frameworks for the feasibility of the study'. The research method is defined as the backbone of research for scientific studies and the provision of procedural standards is considered as a significant variable for the quality of the research (Bakioğlu and Kurnaz, 2014). It is of utmost importance to use measurement tools, the reliability and validity of which are approved, in order to reach a sound conclusion in scientific research and to generalise the results of the research to a population (Şencan, 2005). If there is any doubt about the reliability of the data collected, the results obtained from these data will have no value (Bakioğlu and Kurnaz, 2014). Therefore, competencies such as the 'Ability to choose effective measurement tools for the research,' the 'Ability to interpret the psychometric features of a measurement tool,' the 'Ability to choose a reliability method suitable for the structure of data collection tool' and the 'Ability to choose a validity method suitable for the structure of data collection tool' become crucial. Nurses claim that the failure to indicate statistical analyses in articles in a way that is comprehensible is a significant obstacle for the use of research findings in practice (Shifaza et al., 2014). In point of fact, for the data collected by a researcher to be comprehensible and meaningful, even for those who have no knowledge of research, is only possible through analysis (Bakioğlu and Kurnaz, 2014). Therefore, the items, the 'Ability to analyse data' and the 'Ability to interpret the analysed data' are included in the technical skills sub-dimension of the scale.

The items under the heading 'Attitude and behaviours,' which constitutes the second sub-dimension of the SRCS, reflect the features that a researcher is required to attain in the process of scientific research. Academic ethics is considered as one of the three indispensable concepts of an ideal university, and the World Medical Association (WMA) Declaration of Helsinki imposes various ethical obligations regarding research on all researchers, writers, sponsors, editors and publishers (WMA, 2013). Therefore, features such as 'Compliance with ethical behaviour standards', 'Compliance with scientific honesty standards' and 'Being attentive in their studies' are included in the attitude and behaviours sub-dimension of the scale. It is indicated that the sophisticated health issues today are not suitable for single-disciplined approaches and require more than one perspective through multidisciplinary research, which are also a fundamental feature of nursing research (AACN, 2006). It therefore becomes crucial for a researcher to

acquire the competency 'Ability to form effective purpose-oriented relationships with the relevant people.' Two criteria were used in the research competency model developed by Sondari et al. (2016) for faculty members: showing efficient performance and showing outstanding performance. People who display outstanding research competency are suggested to have a higher tendency towards showing people-oriented behaviours rather than task-oriented behaviours, when compared with those who display efficient research competency (Sondari et al., 2016). Therefore, statements such as, 'Guiding someone through his/her research in case of having relevant experience' and 'Being happy about providing support for research' are included in the scale. Overcoming difficulties encountered regarding research is suggested to encourage enthusiasm towards research (Warkentin et al., 2014). This is reflected in the scale as the 'Ability to stay calm in the event of a crisis' and 'Ability to find alternatives in the event of a crisis'.

Research planning requires a significant amount of knowledge, experience, education and groundwork. Moreover, human resources, time, academic and material resources must be estimated before the research begins (Bakioğlu and Kurnaz, 2014). The third sub-dimension of the scale therefore comprises 'Estimation capacity,' which includes the evaluation of opportunities and risks regarding research. Since competent and comprehensive research requires financial funding, inadequate financing is reflected in the productivity and quality levels of research (Bakioğlu and Kurnaz, 2014). Moreover, nurses consider the creation of an additional budget for research as a facilitating factor for the use of research in practice (Ay et al., 2014). This is reflected in the scale through items such as the 'Ability to write grant proposals for research', the 'Ability to calculate costs regarding research' and the 'Ability to conduct risk analyses regarding research'.

As universities are considered international institutions that produce and disseminate an infinite amount of information, the language of science and academics is considered to be of vital importance. The language of science and scientists is currently English, and it is said that this will continue for the foreseeable future. Despite claims that academics do not have enough time for their own studies because of the importance attached to foreign language examinations, a foreign language has become compulsory in scientific and educational environments (Amano et al., 2016; Yavuzer and Göver, 2012). Therefore, 'Foreign language skills', comprising the fourth sub-dimension of the scale, including statements such as the 'Ability to communicate orally in at least one foreign language', the 'Ability to communicate in writing using at least one foreign language' and the 'Ability to follow scientific publications in at least one foreign language', are taken into consideration.

As the training curriculum for nurses comprises various disciplines (physiology, pharmacology, psychology, sociology, etc.) regarding health and it is said that nurses have a unique attribute to participate in inter-disciplinary research teams and to lead, because of the focus put on the integrity of these disciplines in the delivery of care (AACN, 2006), the draft scale included statements such as 'Acquiring effective skills for teamwork', 'Being competent in leading research', the 'Ability to combine information regarding their field of expertise with those in different disciplines to form new information'; however, as a result of the exploratory factor analysis, these statements were not included in the final version of the scale.

### *Limitations*

The present study has some limitations. First, convenience sampling weakens the generalisability of the findings in the present study. The e-mail addresses of the academic members could be

reached from their institutions, but e-mail addresses of all students in Turkey could not be obtained from Universities' Student Affairs. For this reason, the study ultimately included third and fourth grade nursing students who are taking or have taken courses such as research, epidemiology and biostatistics, at four universities that allowed access. Because it would be hard to gain access to nursing students throughout the whole of Turkey for the sample selection, the inclusion in the sample of the nursing students from four universities was the limitation of this study. Second, the absence of a parallel form, in which the validity and reliability study was conducted in the language in which the scale was developed and measures research competency, was another limitation in this study. Finally, the SRCS comprises 57 items in four sub-dimensions, and scale length was a limitation, too. We believe that this limitation will be overcome by applying the sub-dimensions at different times in the process for educational assessments. Still, scale length will be a limitation in studies in which the scale will be applied in one time measurement, such as a cross-sectional research design.

## Conclusions and recommendations

The SRCS in our study comprises 57 items that are included in four sub-dimensions. The 'technical skills' sub-dimension comprises items from 1 to 27. The sub-dimension 'attitude and behaviours' comprises items from 28 to 46. The sub-dimension 'estimation capacity' comprises items from 47 to 54. The sub-dimension 'foreign language skill' comprises the items from 55 to 57. It has been determined that together with the ASTSR and ASTR it provides criterion validity, and the internal consistency among the items is high. The scale is scored using the five-item Likert rating. The minimum obtainable score from the scale is 57, whereas the maximum obtainable score is 285. The breakpoint of the scale is 190. In terms of scientific research competency, those who obtain 190 and below on the scale are considered to be 'not competent', whereas those who obtain over 190 are considered 'competent'.

As a result, in this study the SRCS, which is a valid and reliable tool, has been developed with the contributions of 17 experts and 937 nursing personnel. The SRCS represents the area to be measured and sufficient to distinguish those who are 'competent' and those who are 'not competent'. The SRCS developed is a valid and reliable self-evaluation tool that can be used to determine the scientific research competencies of nurses holding baccalaureate or postgraduate education. The SRCS can also be used in the screening of PhD candidates. It is important for the theoretical structure of the scale for it to be tested on different sample groups, so that the reliability and validity of the scale can be generalised. It is therefore suggested that the reliability and validity works of the scale are repeated using different samples.

### Key points for policy, practice and/or research

- It is the researcher who has the greatest and most direct influence on research.
- Competencies relate to the behaviours that need to be shown by an individual in order to obtain an efficient performance rather than the results.
- The SRCS is sufficient to distinguish those who are 'competent' and those who are 'not competent'.
- The SRCS developed is a valid and reliable tool that can be used to determine the scientific research competencies of nursing personnel.

## Authors' contributions

Study conception and design: Pınar Duru and Özlem Örsal
Data collection: Pınar Duru
Data analysis and interpretation: Pınar Duru and Özlem Örsal
Drafting of the paper: Pınar Duru
Critical revision of the paper: Pınar Duru and Özlem Örsal

## Declaration of conflicting interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Ethics approval

Prior to the study start, research ethics committee approval (dated 04/03/2016 and no. 2016-4) from the education and humanities ethics committee at the Eskisehir Osmangazi University and institutional permissions from the other universities were obtained.

## Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported financially by the Department of Scientific Research Projects of Eskisehir Osmangazi University under grant number: 201742A203-1338.

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